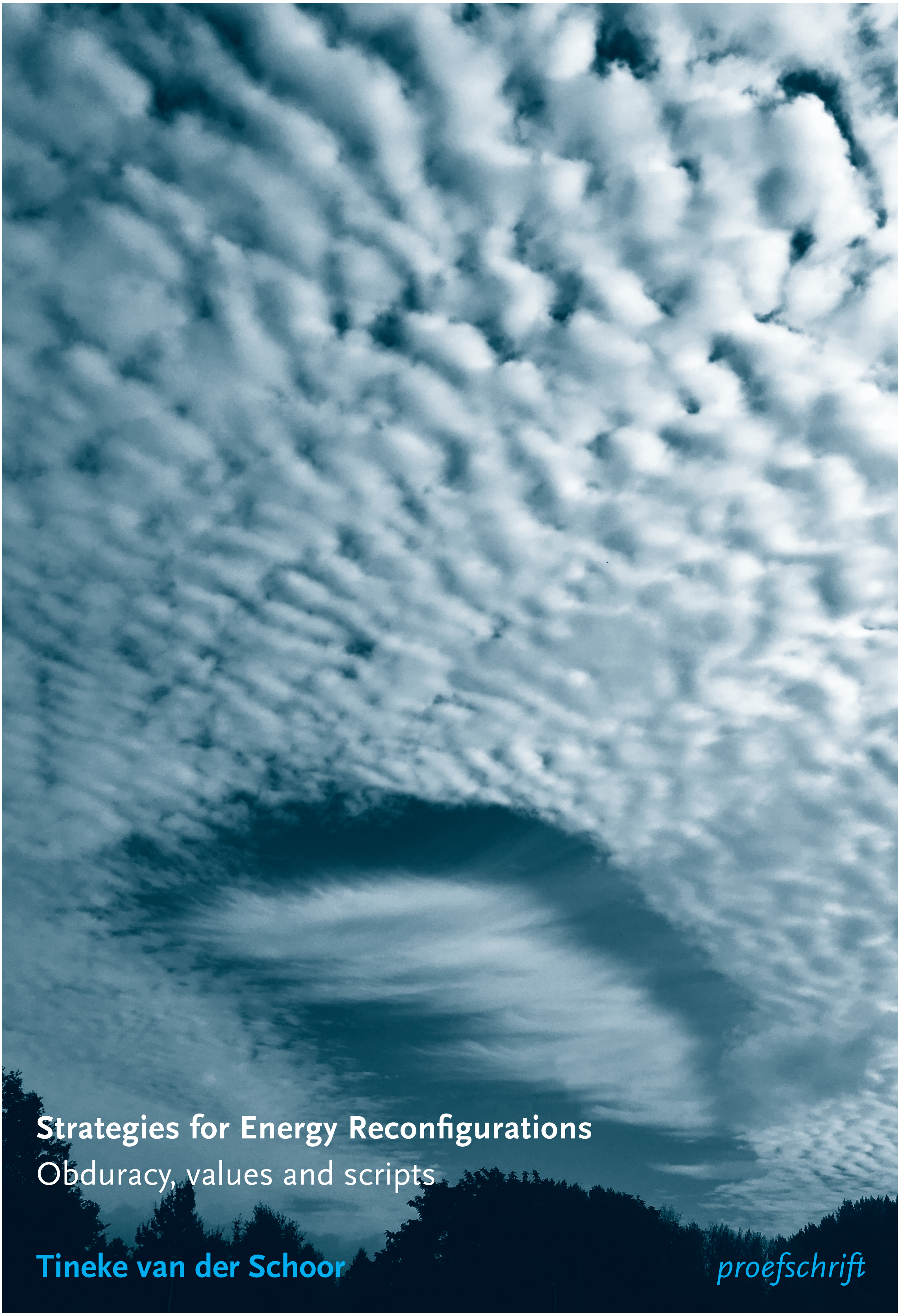
Strategies for Energy Reconfigurations



Strategies for Energy Reconfigurations

Obduracy, values and scripts

Tineke van der Schoor

proefschrift

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Proefschrift

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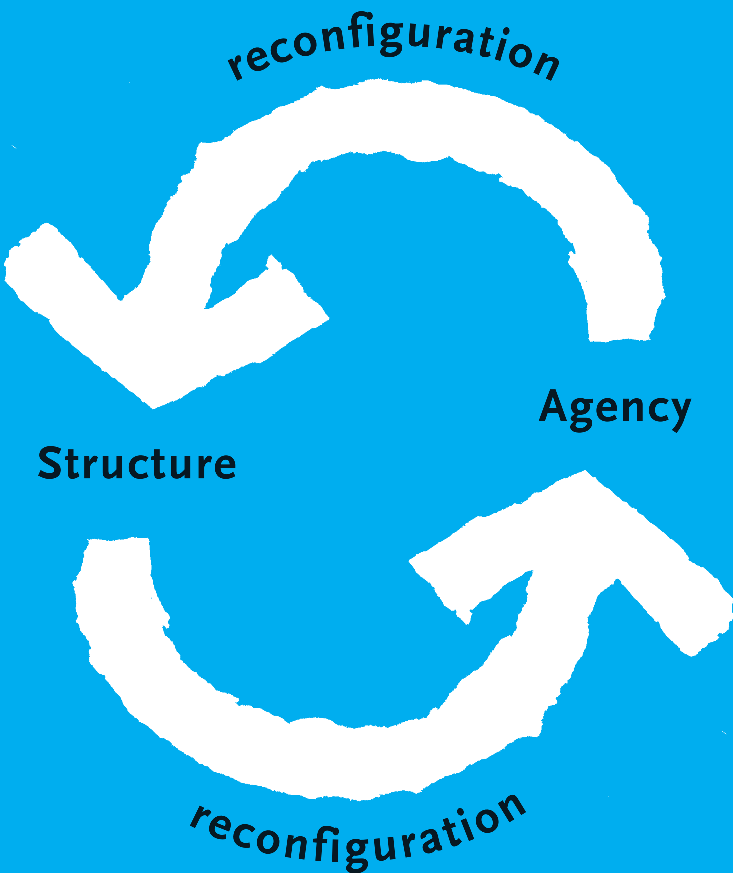

1.1. Introduction

In order to keep the rise of global warming below 1,5°C, in the Paris Agreement the 196 countries attending the 21st Conference of the Parties of the Framework Convention on Climate Change have agreed to reach zero net anthropogenic greenhouse gas emissions during the second half of the 21st century (UNFCCC2015). To achieve that goal, a transition to a sustainable energy system has to take place. This transition challenges both the production and consumption of energy. The energy transition, however, takes place within an existing world, with companies, regulations, and material infrastructures, which both constrains and enables the transformations that are envisaged and attempted. This duality is the main interest of this thesis: novel forms to produce and consume energy are not just *configurations* of, say, infrastructures, behavioural patterns and regulations, but always also *reconfigurations*. Novelties are necessarily shaped from existing situations and this requires specific strategies. Before delineating how to study strategies for energy *reconfigurations*, I will first sketch the attempts to reconfigure the energy configurations.

Indeed, the existing energy system is an intricate web of regulations, policies, incumbent companies, technologies, knowledge, material installations and infrastructures (T.P. Hughes, 1983). It is a largely centralized system geared to facilitate large scale commercial companies. It thus takes a lot of effort to realize small scale cooperative ventures. Although there are signals that the energy system is gradually making room for cooperative production, existing patterns and incumbent interests are extremely powerful.

In the future, the production of energy will be increasingly based on renewable energy instead of fossil fuels. Renewable energy can be produced on a small scale, for example on houses, and it can be stored in small batteries, for example in cars. Compared to fossil fuel plants, renewable energy production assets require less capital investment. This means that the energy transition probably will lead to a decentralization of energy production. Moreover, new actors, such as prosumers and citizens' cooperatives can play a much more active part in the new energy system. Simultaneously, to reach the Paris goals, the reduction of energy demand from buildings implies retrofitting the majority of the existing building stock.

In the last decade, the production of renewable energy came within reach of individual homeowners. Furthermore, in many European countries, as well as in the US, Canada and Australia, citizen's groups have started local sustainable energy projects. Such energy initiatives aim to reconfigure the existing energy system so that it will be environmentally sustainable, democratically organized and supportive of the local economy (Van Der Schoor, Van Lente, Scholtens, & Peine, 2016). Their activities include the collective sales of PV-panels, information campaigns to insulate dwellings, competitions of energy efficient schools, cooperative ownership of windmills and solar parks. The rise of energy initiatives was made possible by the liberalization of energy regulations in the EU, which allows consumers to choose their own energy provider. Other stimulating trends were the decreasing costs of solar units, which were actively pursued by environmental organisations around 2000. Policies in several countries, such as the UK, Germany and later also the Netherlands, further encouraged and facilitated cooperative energy production. In the Netherlands, installed solar capacity rose from 287 MW in 2012 to 2903 MW in 2017 (CBS[1]). PV panels on households amounted to 182 MW in 2012 to 1261 MW in 2017 (CBS[2]). In the same period, registered solar panels installed by energy cooperatives rose from 1,3 MWp to 74,4 MWp (Schwencke, 2018). This shows that citizens and their organisations were an important stimulator of this development.

Furthermore, local energy cooperatives increasingly cluster their activities on a regional and national scale, which enables them to exchange knowledge, engage in new types of activities and develop larger projects. On a national scale, energy networks succeed in influencing national policy to better facilitate cooperative energy projects. A new social movement seems to challenge the existing governance structure of the energy system.

Many national and EU policies have been installed to reduce the consumption of energy in the built environment, including measures and standards for energy retrofit, energy neutral new buildings, and energy efficient appliances. Estimates for the energy use in the built environment vary considerably, depending on the energy categories included. Anderson et al. (2015) find that the built environment is

1. CBS Statline, Hernieuwbare elektriciteit; productie en vermogen, accessed 27-06-2019
2. CBS Statline, Zonnestroom; vermogen, bedrijven en woningen, regio 2012-2017, accessed 27-06-2019

responsible for 62% of final energy use and 55% of greenhouse gas emissions. This includes the use of energy by individual buildings, such as embedded energy, heating and appliances, and energy on the urban scale, for example transportation, consumption, and infrastructure (Anderson, Wulfhorst, and Lang 2015). For the Netherlands, 38% of energy use is attributed to the built environment (RVO, 2017, p. 20). This includes dwellings (22%) and services (15%). Reduction of energy use in the built environment requires an extensive retrofit of the existing building stock. It often requires tailor-made solutions for specific building types, and the engagement of a multitude of actors is necessary. For building owners and users, a major renovation is expensive, messy and time-consuming. Nevertheless, the mean final energy use in buildings has slowly decreased, which is expected to continue over the coming decades (ECN, 2015; RVO, 2017, p. 24). Heating, primarily by natural gas, accounts for the largest share with 275 PJ/yr. In the future, the use of natural gas will increasingly be targeted because of the gas-induced earthquakes in Groningen, a province in the North of the Netherlands. So far, energy efficiency programs and policies fail to effect large changes in energy use in the existing building stock. Reconfiguration on an urban scale turns out to be a tough challenge.

So, the energy transition is underway, but considerable challenges remain, both regarding renewable energy production as well as reduction of energy demand. In this thesis the main focus is on the energy transition in the built environment, especially concentrating on energy reconfigurations and the strategies that actors use to achieve such reconfigurations. While such energy reconfigurations and strategies can be expected in many corners, this study focuses on two situations, which are especially challenging and arguably will bring a good diversity. One situation starts with communities that seek to change their energy provisions ('agency'), the other situation starts with buildings to be renovated ('structures').

The first situation concerns the governance of electricity networks, and investigates the development of citizens' energy cooperatives, which aim to provide bottom up renewable energy companies that produce energy in a decentralized and sustainable way. Here, I have examined energy cooperatives and regional energy networks. What strategies are employed to permit and effectuate a larger role for citizens and local communities? Energy initiatives employ multiple activities to achieve their goals, such as communicating their vision, volunteering, organizing, lobbying, developing new knowledge and ensuring funding. This thesis points out that it is important for local cooperatives to collaborate on a regional level with other energy cooperatives, as well as develop a local network. On a national level, community energy representatives are involved in climate and energy related negotiations, so they become more successful in lobbying for their interests. Organisation development and democratic leadership is important for continuity and the ability to handle larger projects. The community energy movement is heavily dependent on volunteers, which is both an asset and a risk for local organizations. Development of shared visions and a high level of activities strengthen the impact and strength of the cooperative.

The second situation concerns the improvement of energy efficiency in buildings, in particular historical buildings, and investigates how actors combine cultural-historical and sustainability values in restoration projects. How can we conserve and re-use historical buildings, while at the same time making them both comfortable and energy efficient? What strategies are used to achieve both conservation and energy retrofit of historical buildings? Furthermore, I will examine valuation practices that account for both sustainability and historical values, because such valuation methods support careful choices in restoration projects. The built environment has an important influence on social life. In this respect, based on historical examples, I follow how embedded values are instrumental in influencing energy practices.

The transformation processes in these two situations are interpreted as ongoing reconfigurations, where agency and structure mutually constitute each other. Actors employ agency for the creation of new material and social structures, which in turn influence future actions and resist new change. This means that structures become obdurate, or in other words resistant to change. Actors have to overcome constraints to achieve their goals. Reconfiguration thus is an alternation of processes of agency and impacts of structure and can be visualized as a cycle (Figure 1).

Reconfiguration processes are analyzed with the help of three specific concepts that are drawn from the literature (see Chapter 2): obduracy, scripts and values. Together, the concepts of obduracy, values and scripts allow to trace how structural characteristics of buildings (materiality, situatedness and durability) connect with human agency. While their scholarly status is explored in detail in the next chapter, I will briefly introduce them here to sketch the breadth of the argument of this thesis.

The first concept of obduracy relates to the material, social, cultural, and economic obstacles encountered in reconfiguration processes. Buildings and infrastructures are 'obdurate', that is, they are resistant to change. Therefore, reconfiguration of buildings and infrastructures takes a lot of effort; it requires knowledge, creativity, patience, money, organization and negotiation skills. Although buildings and physical infrastructures are durable and obdurate objects, the built environment is in constant flux. Changing demands of owners, users and city planners lead to changes in the form, material or layout of buildings. Natural impacts such as weathering lead to the necessity of regular maintenance, conservation or even restoration. Because of these human and natural impacts, buildings constantly require interventions such as planning, redesigning, retrofitting, rebuilding, re-using and re-interpreting, and once in a while they run the risk of being demolished.

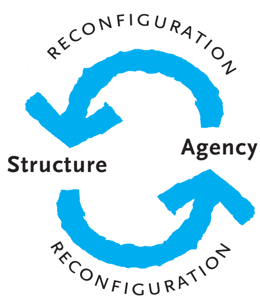

Figure 1. Reconfiguration cycle.

Second, values are relevant for investigating the motives for reconfigurations and the growth and decline of networks of stakeholders. On the one hand, values are embedded in the design of buildings and infrastructures, influencing our (energy) behaviours. New values for energy governance are, for instance, introduced by the community energy movement. On the other hand, in the situation of restoration of buildings historical and sustainability values tend to conflict as they point to different strategies.

Thirdly, I use the concept of scripts, which connects agency of users with the activities of designers and the material artefact itself. Buildings and infrastructures exercise influence on the actions of users, they limit certain actions and facilitate others. Such material structures contain embedded action programs, schemas or scripts. Design of buildings is thus not value-free, it can be used to achieve specific goals, from the exercise of power to the fostering of sustainable behaviours. Script analysis of buildings can reveal social relations that are materialized in the built environment.

In social life, actors employ various strategies, or purposeful actions, combined in more or less elaborate plans, to reach their goals (Mintzberg, 1987). According to Mintzberg, strategy can also refer to perspective, ploy, pattern or position. These definitions of strategy actually complement each other (Mintzberg, 1987, p. 20). Indeed, according to Actor-network Theory, entire organizations: 'may be seen as a set of such (..) strategies which operate to generate complex configurations of network durability' (Law, 1992,

p. 7). We understand strategies as sets of social and technical activities employed by actors or organisations to attain a goal. In this thesis, the aim is to examine the strategies that are used to foster the energy transition in the built environment. To that end, I study situations that show how actors overcome obduracy, realize and protect values and change scripts in the built environment. In Figure 2, the concepts and chapters are displayed in relation to the cycle of reconfiguration.

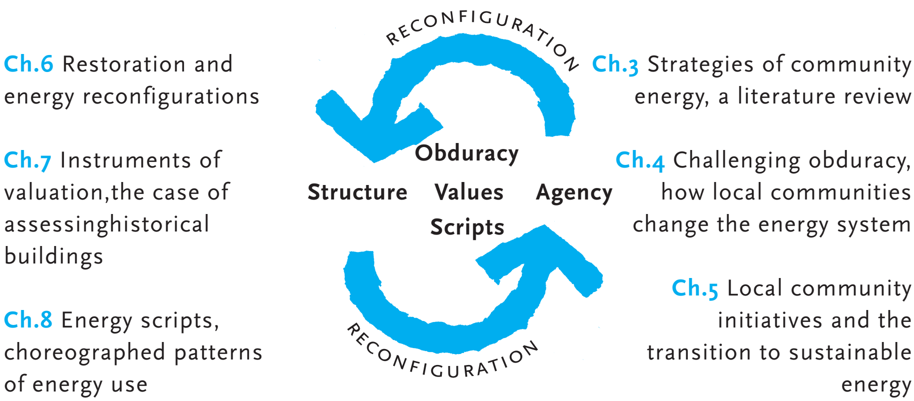

Figure 2. Overview of concepts and chapters

1.2. Research questions

The purpose of my research is to contribute to our understanding of energy reconfiguration strategies. In this section, I will further elaborate the (sub) questions that are taken up in this thesis, as well as refer to the chapters where these questions are addressed.

1.2.1 Main question: What strategies are employed in energy reconfigurations?

The main interest in this thesis is how energy configurations in the built environment take place. In particular, I will focus on how local actors deal with the enabling and constraining influence of the existing environment. The research question, thus, is: What strategies are employed in energy reconfigurations and how do these strategies play out in the cycle of reconfiguration? How are values embedded in the existing built environment, and how are aspired values such as sustainability and democracy integrated in new designs of buildings and infrastructures. Lastly, what are the influences of the existing built environment on local actors.

1.2.2 Situation 1: Communities and sustainable energy production

The community energy movement aims to replace the existing centralized fossil fuel-based energy system with a decentralized democratic governance model based on renewables.

The first question is how the community energy movement has developed in an international perspective. To that end, in Chapter 3 a literature review of community energy is presented, which focuses on the main theoretical approaches used and the distribution of the literature over countries and journals.

The second question relates to the new social and political structures that are developed to create a sustainable and democratic energy system. In Chapter 4, I follow the development of new regional networks in the community energy movement. I use social movement theory to explain how the community energy movement is developing a sustainable alternative to the present fossil fuel-based energy system.

The third question for this situation is what strategies are used to challenge the existing energy system. In Chapter 5, I describe how local energy communities organize themselves on the basis of a series of case studies of energy initiatives.

1.2.3 Situation 2: Historical values and energy efficiency

In the heritage sector, different values have to be reconciled to arrive at energy efficient historical buildings while keeping historical values intact. The conservation of historical buildings entails striking a balance of multiple demands and (sometimes conflicting) values.

The first question for this situation is what strategies are employed to achieve energy efficient restorations. To this end, I investigated several restoration processes to identify strategies that help to combine demands of comfort, energy and historical values. In Chapter 6 three groups of strategies that are used in restoration cases are identified.

The second question is how sustainability and heritage values are reconciled in valuation practices. In a case study of a valuation instrument (DuMo), which helps actors to integrate energy demands with historical values, I examined how cultural-historical values and sustainability values are reconciled. In Chapter 7, I present how an instrument (DuMo) allows to combine valuations of energy and historical values in one metric.

The third question refers to the constraining role of buildings, as referred to above. How do embedded scripts guide the use of energy and the distribution of heat in buildings? So far this remains outside the scope of literatures that focus on energy efficiency or user behaviour (Anderson et al., 2015). Therefore, I performed a brief literature study and apply script analysis on structure, layout and materials of buildings. I draw on four examples, each representing a different aspect or domestic space: the kitchen; cool storage and cooking range; natural gas for households; and passive house design. In this chapter, I develop the concept of 'energy script', an expansion of the script notion to include energy demand in buildings.

1.3. Methodology

The separate chapters each contain a description of the methods and data, nevertheless I will briefly elaborate on methods in the following paragraphs. For this thesis I mainly used case studies, based on qualitative interviews. Interviews and relevant documents were analysed according to methods outlined in grounded theory. Furthermore, I conducted a literature study. Lastly, I performed script analysis of buildings.

1.3.1 Literature study

Chapter 3 contains a report on a literature study of community energy. In order to evaluate the contribution of community energy to the energy transition, we performed a literature search in Scopus for the time period from 1997 to 2018 on search terms related to community energy. In addition, we fine-tuned the corpus to studies concerning local and regional cases in which citizens were involved in a meaningful way. As a result, we ended up with 263 academic articles, which are listed in Appendix A.

We analysed the resulting list of research articles with Atlas.ti, which allowed us to identify keywords and search for theoretical approaches and geographical names in the articles as a whole. Our findings provide an encompassing overview of the literature about community energy initiatives, both initiated by citizens and municipalities.

1.3.2 Case studies

In chapters 4, 5, 6 and 7 the empirical basis is formed by case studies. 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, cited by Thomas (2011, p. 21). Following Yin (1994), we used our case studies to search for conceptual patterns and categories, which helps to understand a certain phenomenon. The choice of cases aims at the inclusion of a wide array of qualitative aspects, to be able to study as much relevant patterns as possible. This process is called strategic selection and is described by Glaser and Strauss (2009), Strauss and Corbin (1990), Stake (2013) and Flyvbjerg (2006). The number of cases is usually limited, for example in the literature used for Chapter 4, we typically find between two and ten cases. Therefore, case studies do not lend themselves to statistical analyses.

A case study often includes multiple methods of data gathering (Stake, 2013). In my studies, information was mainly gathered through qualitative interviews. The interviews were transcribed, coded and analysed with NVivo (later Atlas.ti). In the analysis of the interviews I used an inductive approach (Charmaz, 2014). We first identified and coded meaningful quotations in the interviews. We then performed a thematic analysis and compared the identified themes to the relevant literature, depending on the subject of the study.

For the research of community energy, I conducted observations during public meetings and activities, organized small-scale surveys, and performed site visits. We also studied websites published by the initiatives, printed material and grey literature. Moreover, to get an overview of the potential for energy production and energy saving, we did quick scans of the natural and built environment of the communities. Further information was gathered by visiting websites, Facebook pages, and documents produced by the organisation in our study, as well as blogs and policy documents regarding the Dutch Energy Covenant. These materials were also content analysed with NVivo.

For the chapters on historical buildings, 14 case studies were performed. For each case several keypersons were interviewed. Here, I also relied on technical studies of energy interventions in case study buildings and assessments of cultural-historical values.

Case Chapter 4

Chapter 4, *Challenging obduracy, how local communities transform the energy system*, is based on a single case study, in which we observed the regional networks that have been formed since 2012. We have undertaken qualitative interviews of initiators/ board members of these four organisations in four interviews which each lasted 1,5 hours. To gather insights in the relations between local and regional networks we interviewed initiators/ board members of two local cooperatives in the province of Groningen and Drenthe. One of these cooperatives has been active for three years and is actively involved in the regional network. The other cooperative has recently been set up and can be regarded as a newcomer in the community energy movement. In this manner we seek to include varying perspectives in our case study, as is common in case study research.

Cases Chapter 5

The main empirical material for Chapter 5, *Local community initiatives and the transition to sustainable energy*, was gathered in the period 2010-2013. For this paper, we analysed the activities of thirteen local community energy initiatives in the North of the Netherlands. All initiatives consisted of volunteering citizens. We contacted these initiatives at regional information meetings on the subject of local energy production. These community groups have diverse backgrounds but tend to converge as to their goal of promoting local energy production. They range from political parties, commercial ventures, and energy cooperatives, to village working groups. An overview is provided in Chapter 5, table 9.

The initiatives are set within villages or cities that differ widely as to population size. The smallest initiative in our sample Wessinghuizen) is set in a community of only 28 inhabitants, whereas the largest one (Groningen) is in a city of 200 thousand. Nine of the thirteen initiatives are set within a village of less than 2,000 inhabitants, and three in a village with a population between two and twenty thousand. They are located in different geographical landscapes and focus on various energy technologies.

Cases Chapter 6

The empirical basis of Chapter 6: *Restoration and energy reconfigurations*, lies in the research project 'Energieke Restauratie', which ran from 2013-2015. In the course of this project, in total 50 restoration projects were investigated using desk research, qualitative and walk-through interviews with restoration-architects, owners, energy advisers, users, and heritage protectors, and technical studies, such as thermography analysis and energy transmission calculations. Historical aspects of the buildings were identified using archival material and building history.

For this chapter, we analysed processes and strategies in fourteen case studies, which are listed in table 1. In total 41 interviews were conducted in these cases. The interviews were transcribed and subsequently coded and analysed with Atlas.ti. Based on this analysis a framework of 'obduracy strengthening strategies' was developed, which identifies three categories:

design strategies, identity strategies and communication strategies. As an illustration, the case study of the restoration of the youth society's building in Franeker is described. In this case study six interviews were conducted, respectively with the architects, civil servants, historical buildings board, and user representatives. We also received photographs of all stages of the restoration process, taken by the architect's team, and layouts of the reconfiguration plans. The case-description follows the format of a tour through the building, highlighting important decisions, actors, and developments.

Case Chapter 7

The research for Chapter 7, *Instruments of valuation: the case of assessing historical buildings*, was also set up as a single case study, employing various materials to investigate the case of the development, goals and application of the DuMo-instrument. To explore practices with DuMo-assessments we held qualitative interviews with four members of the national steering group that was responsible for the development of DuMo. This includes architectural historians and building engineers, representing the main disciplinary perspectives in our study. The interviews were transcribed and analysed in Atlas.ti.

We also studied documentation on the DuMo-method and its application. First, we relied on the DuMo-Handbook, which describes the method's procedures and gives examples of finished projects. The Handbook also provides (online) assessment sheets. We investigated how experts are addressed in the Handbook and how specific professional values are transmitted through the instructions and energy improvement strategies. Secondly, we examined a sample of full DuMo-reports and archival materials of listed buildings across the Netherlands. A full report is typically between 75 and 100 pages long and includes detailed descriptions and illustrations of valuable features in the investigated building. Lastly, we analysed the overview of 41 DuMo assessments, all performed by NIBE, a sustainable building consultancy that was involved in the development of DuMo. These buildings were restored with a high energy ambition and revealed design strategies used to reconcile energy and historical values. The NIBE-overview provided insights in the results of DuMo-assessments, the applied restoration strategies and allowed comparison of the buildings to search for regularities, for example in building type, age and applied energy measures. In this chapter we describe five themes; cultural-historical values, energy performance, intangible values, economic aspects and expert knowledge.

1.3.3 Script analysis

Building is creating and organizing spaces for us to live in; buildings provide for as well as determine our way of life. For Chapter 8, *Energy scripts, choreographed patterns of energy use*, my primary goal was to investigate the possibilities of developing a new conceptual approach to energy demand in buildings. Drawing on historical studies, I investigated four examples of energy-using practices, and how they were influenced by the design of buildings. Script analysis, or de-scription, is the opposite movement of design, or in-scription, by the engineer or designer (Akrich & Latour, 1992). In Chapter 8, I develop this further with the approach of Markus and Cameron (2002, pp. 44–45), who identify five steps from language to the actual experience and use of a building:

1. General discursive text with aspirations, intentions, visions, objectives, purposes.
2. Categories of people, ideas, activities, processes and/ or objects. These are ordered in a classification.
3. Constructing a set of labels to accommodate the categories in step 2.
4. Designing and producing the building in accordance with step 3.
5. Management of the building's programme, by implicit or explicit rules, and the use-pattern and behaviour of the occupants.

These steps provide a clear method for the analysis of buildings by studying texts, emphasizing the influence of commissioners, regulators and users. The architect is expected to more or less dutifully interpret the categorisations and to materialize the requirements of the commissioners/sponsors/ regulators in the actual building.

However, 'reading' buildings not only includes reading the written labels and preparatory, regulatory or evaluative texts, but also studying the layouts and other architectural drawings. Moreover, reading an architectural drawing encompasses the 'imagined bodily movement around a drawn plan' (Forty, 2000, p. 39), to arrive at the description of the expected experience of a building. Furthermore, reading texts and drawings should be combined with uncovering meaning; what are the expected uses and behaviours of human actors and what does the building tell us about the social relations between them. So, by analysing texts, drawings, historical context and social relations the social aspects of a building can be described.

2.
Social theory and the built environment

2.1. Introduction

The main subject of this thesis is how energy configurations in the built environment take place. This raises relevant and pertinent questions since the built environment has been built in the past and both enables and constrains further actions. How does this come about and what strategies are used to realize and alter configurations in this context? The label 'built environment' is commonly used to refer to the human-built world, as produced by culture and technology (T.P. Hughes, 2004). The built environment not only contains buildings, but also encompasses other built structures and infrastructures, such as cities, roads, dikes, energy grids and so on. The argument in Chapter 1 was that the so-called reconfiguration cycle is a continuing cycle of events, a cycle of agency and structure, as sociologists would coin it. In other words: we shape the built environment and the resulting material and discursive structure then goes on to shape us. I relate this reconfiguration cycle to three main concepts: obduracy, values and scripts (see also 1.1.1). In this thesis, I will use these three concepts to investigate the reconfiguration cycle in various settings.

The purpose of this chapter is to prepare the ground for these exercises and to benefit from a wide range of studies. This chapter, thus, seeks to review the social study of the built environment along the lines of the reconfiguration cycle (Figure 1). This chapter is complemented by the next chapter. While this chapter will focus on buildings – as these have been highlighted more in social studies of the built environment – the next chapter will focus solely on the literature on community energy. Together, the two chapters give a proper overview of previous research regarding the two situations of energy reconfigurations of this thesis: buildings and energy communities.

In the next section of this chapter I introduce and discuss social theoretical perspectives on the built environment (2.2.1), followed by a section on STS-studies that take the reciprocal relationship of buildings and society, of structure and agency, as starting point (2.2.2). In particular I will address Gieryn's notion of the 'double reality of buildings' (2.2.3), which forms the basis of the reconfiguration cycle (Figure 1).

In the third and fourth section I will trace in more detail literature on the reconfiguration cycle, highlighting agency (section 2.3) and structure (section 2.4) respectively. Here, the three central concepts of this thesis – values, script and obduracy – will be elaborated, too.

2.2. The reciprocal relationship of buildings and society

2.2.1 The built environment in social science

In a sense, it is common knowledge that the built environment has a reciprocal relationship with society: it has been built in the first place and, in its turn, influences social life. As Churchill famously said 'We shape our buildings, and afterwards our buildings shape us'[4]. This shaping of buildings is not an isolated endeavour, but a social-material process, the result of actions and intentions of a whole range of actors, such as architects, clients, commissioners, municipalities. The design of a buildings is also influenced by building regulations and EU-policies, which are the result of social processes as well. In the building phase, builders and engineers influence the actual outcome of the design.

Moreover, the shaping of buildings goes on after they are built. In their lifetime, buildings often undergo multiple changes, reflecting the socio-economic circumstances and needs of the time. Users of buildings reconfigure the building to fit their own needs. They re-interpret or re-design the buildings they live in, or, as Scruton says, architecture is vernacular: 'every normal man may participate, and indeed does participate, to the extent that he builds, decorates or arranges his rooms' (Scruton, 1979, p. 16). However, reconfiguration of buildings is constrained for material, financial and administrative reasons.

On the other hand, buildings and infrastructures influence their users; they shape us. In design as well as in practice, some actions are constrained, and others enabled. Views on how buildings are expected to influence their inhabitants are intentionally taken up in architectural designs. This alternating process of agency and structure means that architecture stabilizes or constitutes social life.

The social nature of the built environment has attracted the attention of sociologists who were interested in how social norms and ideologies were literally set into stone. There are of course different roads of entry into the social study of the built environment. For example, we can start with the social production of built structures, as is done by King and Bourdieu; we can start with texts about buildings and architecture, as Lefaivre & Tzonis (1990), and Markus & Cameron (2002) are doing; we can start with following the designers and investigate their activities, like Latour& Yaneva (2008) or Woodhouse& Patton (2004). Finally, we can start with the agency of users,

4 'We shape our buildings, and afterwards our buildings shape us. Having dwelt and served for more than forty years in the late Chamber, and having derived very great pleasure and advantage therefrom, I, naturally, should like to see it restored in all essentials to its old form, convenience and dignity.' Speech in the House of Commons (meeting in the House of Lords), 28 October 1943 Retrieved from https://winstonchurchill.org/resources/quotes/famous-quotations-and-stories/(Last accessed July 29th 2019), see also https://www.parliament.uk/about/living-heritage/building/palace/architecture/palacestructure/churchill/(Ibid.)

how are they reconfiguring, appropriating or domesticating the buildings they work and live in? These themes are discussed in sections 2.3 and 2.4. First, I turn to STS-approaches, to find out more about the mutual development of technology and society in relation to buildings.

2.2.2 STS-approaches to the built environment

The reciprocal relationship of technological and social phenomena is studied by science and technology studies (STS), so to position this thesis against the background of STS-literature I will now discuss a selection of STS-contributions to our understanding of the built environment. Beforehand, I have to mention that the STS-literature on the built environment in general, or buildings in particular, is not very substantial. Indeed, it is surprisingly limited, as signalled by other writers (Coutard & Guy, 2007; Hommels, 2005a). However, we can find a number of studies of the built environment that rely on STS-approaches, such as Social Construction of Technology (SCOT), Large Technical Structures (LTS), and Actor-Network Theory (ANT).

Social Construction of Technology (SCOT): Social Construction of Technology has been applied to city planning in a paper on the Cerdà Plan for Barcelona by Aibar and Bijker (Aibar & Bijker, 1997), who argue that towns and cities form 'enormous socio-technical artifacts', that pose rich and complex research sites. The struggle for the design of this plan took place between 1854 and 1860, while the implementation and major modifications extended to 1907. The protagonists in the development and implementation of the plan for the extension of the city belong to different social groups, such as engineers, hygienists, architects, local politicians, property owners, national ministries, and the upcoming working-class movement. Coalitions of these social groups use different technological frames that contain goals, purposes, knowledge and expectations of the new city extension. Aibar and Bijker identify three frames in relation to the extension of Barcelona: Engineers' frame, Architects' frame and the (later emerging) Working Class' frame. In the end, the aristocratic elite and the nouveaux riches reached a consensus over a modified extension, which however was broken up quite literally by the working-class movement in the 'tragic week' in 1907. The barricades effectively stalled further development of the reformed plan (Aibar & Bijker, 1997).

Large technical systems (LTS): Large technical systems, such as the electricity system, have early on attracted the attention of STS-scholars. Thomas Hughes analysed the development of the electricity system in his seminal work *Networks of Power* (T.P. Hughes, 1983). This study is of course a huge endeavour that cannot be summarized in a mere paragraph. However, what interests me most in relation to my own research, is that Hughes studied the contribution of the people that were involved in the creation of electricity networks in the USA, Germany and the UK. He shows the different development paths in these three countries, caused by differences in regulation and culture. He describes the gathering of momentum in the development of new technology systems, which includes the foundation of educational programmes and university faculties, the creation or fostering of research facilities by leading companies and the influence of professional associations of electricity engineers (T.P. Hughes, 1983, pp. 15; 140). In this way, technology becomes more entrenched in society over time. Another relevant concept is the military metaphor of reverse salients that hamper progress in the development of a system. Furthermore, the importance of research directed at finding solutions for 'critical problems' is underscored (T.P. Hughes, 1983, pp. 14; 79).

The rather linear development path that Hughes proposed is extended by Sovacool et al. (2018), adding phases of reconfiguration, contestation, stagnation and decline. Reconfiguration can be brought on by changing cultural values, consumer behaviour, environmental effects or indeed a combination of the three. Sovacool identifies 'drift' as one of the mechanisms that provoke contestation, which refers to the challenge of control of the system. The response of the incumbents is an important factor of the way the system will develop. For example, in my literature study of community energy, it shows that regulation systems, which are heavily influenced by the energy incumbents, have a pervasive influence on the level of success of community energy initiatives.

A central theme in community energy is (de-)centralisation. As Hughes shows, the electricity system has been set up as a central system from its early beginnings, growing from neighbourhood to city to national networks. He mentions that companies that produced their own electricity were actively targeted to give up their self-supply and join the network. Centralisation processes have increased considerably since the liberalisation of the energy market in the 1990s. In Europe, the production of electricity is now in the hands of a small amount of large international companies. Centrally produced electricity is delivered to households, workplaces and industry by a largely one-way distribution system. Therefore, the recent phenomenon of community and prosumer production of electricity, with a view of delivering this to the network, is a rather new and alien phenomenon. Decentralisation poses a challenge to both the technical and organisational layout of the electricity system. It also involves new roles for users. Earlier, Devine Wright identified ten new roles for consumers (2006), and Sovacool (2018, p. 22) points to new typologies acknowledging the influence of users on sociotechnical change. In my study, users are involved in the role of citizens, prosumers, contesters or challengers, but also as intermediaries, and probably as new 'system builders'.

Actor-Network Theory (ANT): Actor-Network Theory is an approach to the social study of technology developed by Latour (Latour, 1990, 2005), Callon (Law & Callon, 1992) and Law (Law, 1990). The basic tenet of ANT is to 'follow the actors' to identify processes of world-making on the micro-level, emphasizing negotiations and controversies related to both technical details and social relationships (Jolivet & Heiskanen, 2010, p. 6748). ANT allows to examine both individual buildings, districts, or infrastructures. Blok (2013, p. 12) identifies two ANT approaches to the built environment, which take different scales as their starting point. Assemblage urbanism aims to rethink the city in urban studies, emphasising that cities are 'relentlessly being assembled at concrete sites of human practice' (Farias & Bender, 2010, p. 2). The second approach Blok mentions are ethnographic studies of architecture (Blok, 2013, p. 12). This approach is applied by Latour and Yaneva (2008), who devise a so-called 'ANT's view on architecture' and interpret buildings as moving projects which develop over time. The changes in buildings go very slowly, but with 'time-lapse photography' it is possible to see the movements. In a 'still' one can for example zoom in on the period before the actual building of a structure, when worldviews, ideas, and regulations are turned into building designs. Furthermore, in an analysis of the renovation process of the Alte Aula in Vienna, Yaneva conceptualized buildings as a network that should be studied as a 'non-stabilised entity' (Yaneva, 2008). In this 17th century building an unexpected fresco was discovered, which sent the restoration architect back to the archives, and generated a prolonged discourse on the appropriate actions regarding the fresco. As such, the building made the workers 'do more, engage with, and reassess the building history, materiality, and technicality' (Yaneva, 2008, p. 25). Central in Yaneva's argument is that buildings are not an obedient passive object, but instead have agency themselves, and can surprise the renovator. The Alte Aula in Vienna thus is a 'building-in-becoming', capable of challenging the renovators' views of the history or the building. This example is used to demonstrate how non-human actors such as buildings have agency and that instead of static objects, buildings should be seen as moving projects.

The obduracy of built structures can also be analysed with ANT. For example, in 'Technology is society made durable', Latour proposes a set of concepts to analyse the question of the durability of domination and power (Latour, 1990). Durability of power relates to the creation of buildings and infrastructures, because elites and national states have historically used architecture as a primary means to express power and wealth. Building types also play a role in territorial strategies to affect or control the actions of users (Kärrholm, 2013, p. 112).

2.2.3 The double reality of buildings

STS in general takes the mutual constitution of technology and society as its departure point. Gieryn applies this approach to the built environment. In the paper 'What buildings do' (Gieryn, 2002) he examines sociological thoughts about buildings and how they alternate their emphasis on agency or structure. Gieryn combines Bourdieu's notion of the influence of structure on social life with the emphasis on human agency by Giddens. Bourdieu describes how the domestic organisation of space in the Kabyle house reproduces and organises the way of life of the Berbers, especially drawing attention to gender divisions (Bourdieu, 1970). Gieryn (2002, p. 40) argues that Bourdieu understands buildings as autonomous forces, influencing social life without incorporating human agency. The purposeful design of the house and its interior is not considered by Bourdieu, nor are the possibilities of new interpretations by human actors (2002, p. 41).

In contrast with the structuralist approach of Bourdieu, Gieryn (2002, p. 40) positions Giddens as a sociologist who gives precedence to human agency. As said in Chapter 1, structuration theory maintains that social structure is both the medium and the outcome of social actions or practices. The issue of structure and agency thus is not a simple dichotomy, they presuppose each other. Furthermore, structures in society must be reinforced and reproduced daily (Giddens, 1984; Giddens & Gregory, 1984). The duality of structure implicates that agents draw upon structures to perform social actions. These social practices are reproduced, but also changed by agents. Agents fulfil multiple roles, depending on the theoretical stance of the author they can be referred to as human actors, moral agents, consumers, users, or citizens. In such a role, they relate to other actors on the scene.

However, for Giddens, structure primarily refers to social institutions, to rules – meaning and norms- and resources- power – not to material artefacts. Giddens interprets space as situatedness and observes that action inevitably must take place somewhere in time and space. When it does, this situated action intersects with institutions that are present before and will remain in place (perhaps somewhat changed) after the action. This 'situated action (..) is the 'materiality' of all social life' (Giddens & Gregory, 1984). Giddens does not further go into materiality or the 'physical milieus of action'(1984, p. 126). Thus, although he draws our attention to the 'fixity' that locations add to social life, for Giddens, buildings are what people actively do with them. However, although buildings are the outcome of social actions, they are surely more than memory traces; they contain materiality. At the same time, this material structure is strongly bound to or intertwined with social structure. By connecting material and social structure the built environment carries meanings and social practices through large 'stretches' of time-space, comparable to the social institutions that Giddens refers to (1984, p. 127).

Gieryn argues that for a sociology of buildings we need both Giddens and Bourdieu (2002, p. 41) and states that *Analysis must respect the double reality of buildings, as structures structuring agency, but never beyond the potential restructuring by human agents* (2002, p. 41). Thus, buildings stabilise social life, but can always be reconfigured. Gieryn further argues that design is heterogeneous, firstly because it must cater for the needs of both material and human actors, and secondly because a design produces its users as well as a society in which the design can thrive. Gieryn thus extends and combines Giddens and Bourdieu, recognizing both the structuring role of buildings and the agency of human actors in the production and restructuring of the built environment. Furthermore, he recognises two types of reconfiguration: discursive and material. Discursive reconfiguration refers to 'interpretative flexibility', meaning that an artefact or structure can mean different things to different people. Material reconfiguration is heterogeneous, because it 'the artefact is undone both materially and socially' (Gieryn, 2002, p. 45).

Gieryn suggests three ways in which material artefacts structure social action: 1. by becoming an obligatory point of passage; 2. by concealing politics and interests behind interpretative registers of costs or aesthetics; 3. by increasing costs of subsequent innovative use (Gieryn, 2002). In subsection 2.4, the theme of 'structures structuring agency' will be further elaborated.

In Chapter 1, I outlined the 'cycle of reconfiguration' to visualize the alternating processes of agency and structure in relation to the built environment. This cycle is based on the concept of the 'duality of structure' as developed by Giddens' in structuration theory, but extends this concept with material structure. It aims to reflect the double reality of buildings as described by Gieryn but positioned in the context of energy reconfigurations. This cyclic model also applies to infrastructures, as Sovacool et al. argue, reconfiguration in infrastructural systems is a 'constant didactic process of decay and renewal' (Sovacool et al., 2018, p. 13). Reconfiguration cycles can have differing temporalities and scales, ranging from daily maintenance to major restorations or neighbourhood renewal. To quote Gieryn, 'buildings are halfway between structure and agency', they are continuously being reconfigured.

2.2.4 Buildings, architecture and heritage

We all live our everyday lives in and between buildings and infrastructures, but what characterizes buildings? How can we differentiate buildings-as-technology from other technological artefacts and how can we differentiate architecture-as-art from other arts?

The first salient characteristic of the built environment is its materiality. Compared to other technological artefacts, buildings contain a large volume of material. Therefore, buildings are not easily disposed of, as smaller consumer goods are. Secondly, buildings are durable, they last on average fifty years, but often much longer. Obviously, the quantity and quality of the materials used in buildings influences durability. But other factors are important as well, as I will show in the next chapters.

Architecture is distinguished from other arts, such as painting or music, by certain features, says Scruton. First of all, buildings have a function, or uses, 'they are places for human beings to live, work and worship' (Scruton, 1979, p. 5). Secondly, buildings are localized, or situated, they replace what was before them and then stay put. Buildings and their environment thus co-constitute each other. This also means that architecture is vulnerable to changes in its surroundings (Scruton, 1979, p. 11). Furthermore, buildings are territorial, they influence the use and users of the space they inhabit (Sack, 1986).

Architecture is public, it imposes itself upon everyone. Users cannot choose the design of their cities and neighbourhoods, although in some urban planning projects citizens are involved in choosing designs for specific buildings. Architecture is also a political art, as Ruskin already said: 'it imposes a vision of man and his aims independently of any personal agreement on the part of those who live with it' (Scruton, 1979, pp. 13, 15).

These place-based, material and political characteristics contribute to other properties of buildings, for example that they are obdurate or resistant to change, they are created with values in mind, and that these values are embedded in the buildings as scripts or use-programs. These concepts will return in sections 2.3 and 2.4.

Historical buildings possess important cultural-historical and aesthetic values; they largely define the historic structure of cities and towns. Ever since Roman times architectural professionals and city governments have valued the qualities of historical buildings and created practices and policies to protect them (Jokilehto, 2002). International codes for heritage conservation have evolved in international meetings organized by the International Council on Monuments and Sites (ICOMOS), an international body created in Venice in 1964 based on a resolution put forward by UNESCO, the cultural organisation of the UN. The Venice charter was followed by many others, treating specific building types, archaeological sites, etc. (Fredheim & Khalaf, 2016; Pickard, 1996; Vecco, 2010).

The 20th century saw several approaches to the conservation and management of the historical built environment, described by Ashworth (Ashworth, 2012) as respectively the preservation, conservation and heritage paradigm. Although these three approaches followed each other in time, they did not replace each other, but rather continue to coexist in heritage conservation discourse and management (Ashworth, 2012; Janssen, Luiten, Renes, &

Stegmeijer, 2017). Janssen et al. (2017) christened the approaches as sector, factor and vector approach and argue that they constitute different, but parallel ways of treating the past in the present. The sector approach treats heritage as an isolated part of the built environment, the factor approach appreciates heritage primarily as a stimulus to urban regeneration, and the vector-approach understands heritage as a carrier for sustainable area development. Moreover, the vector approach acknowledges the different ways in which different people and groups identify with the heritage and attach value to it. The roles and knowledges of different groups of experts and stakeholders shift over time and between approaches. For example, Janssen et al. contend that in the vector-approach the traditional hierarchies between experts and non-experts fade away (2017, p. 1665). I will come back to this increased role of different stakeholders in chapters 6 and 7.

2.3. Shaping buildings (agency)

2.3.1 The social production of building form

The sociology of architecture understands buildings as an expression of the norms and arrangements of society. In terms of the reconfiguration cycle, it stresses the top half: the role of agency. In the 1970s and 1980s 'culture' is often used as a variable to explain building form. See for example the study of the Berber House by Bourdieu (Bourdieu, 1970), and the studies of houses and culture by Rapoport (Rapoport, 1970, 1980). In the 70s and 80s 'new urban studies' broadens the scope of enquiry to the larger economic, social and political context of cities, especially exploring the critical role of the economic system in shaping urban form. For example, Anthony D. King has extensively published on the social production of the built environment (King et al., 1980). He argues that urban and architectural form represents and contains the ideology and life-styles of the time of building and aims to relate the production of architecture with economic and social relations. Furthermore, King asks what function, purpose and meaning the built environment performs, and what implications it has for the maintenance and reproduction of the larger economy, society, polity, and culture (King, 1984).

However, King notes that in new urbanism the physical and spatial realities of the built environment tend to be neglected. In *The social production of building form*, King briefly describes and explains the meaning and significance of one particular item in the built environment, namely the bungalow, as a specialised building form. In his framework, social organisation can be examined in relation to a variety of building (or settlement) types, as well as the social organisation within a building type (King, 1984). Drawing on the perspective of King we can identify cultural and ideological patterns in designing domestic space. Issues such as the role of the nuclear family, division of space according to class and gender, display of wealth and power, as well as economic interests of industrial production and the energy sector can be analysed within this framework.

The actual construction of design can be analysed with the 'Design by society' approach (Woodhouse & Patton, 2004), which considers the complex network of people that is participating in the design process. It is argued that there is no clear boundary that delineates a design and who engages in it. Not only architects or (building) engineers, but also other technical specialists developing materials, building parts or computer infrastructures are influencing the design. Furthermore, managers and government officials are involved in shaping designs of the built world. This approach also asks how societal norms are built into the world by design. They contend that social norms, values and assumptions are reproduced – often unintended – in the products of design; and thirdly to the challenge of moving design into public debate, in order to take account of social and other costs of innovation in an early stage. Lastly, they ask how social design might take place, who shall participate in making decisions about (re) design initiatives, and how the benefits of design shall be distributed.

This critical perspective on design as social practice can also help with the analysis of the steep increase of energy use in the home in the 20th century. A considerable part of this energy use is due to appliances, the acquisition of which is laid on the doorstep of the consumer. However, the electrical apparatus we use in the household are not an accidental assortment, but they are the result of decades of shifting work and energy from the producer to the household, as Ruth Schwartz-Cowan has shown. She conceptualizes the household as a system and analyses the energy, resources and working hours that women have invested in their households in the course of the 20th century (Schwartz Cowan, 1987, 1989). The same applies to the dwellings themselves; energy use for heating to a large extent reflects the priorities and politics of different periods.

The design and configuration of buildings goes on after they are built, which means that users have an active role. Users can also be seen as co-designers, that actively shape or 'domesticate' technologies in their daily practices (Berker, Hartman, Punie, & Ward, 2006; Silverstone & Haddon, 1996). Furthermore, the word 'users' itself is not neutral, but is analysed as stemming from a specific view of architecture and urban planning, as Forty shows (2000, pp. 312–315). The term is often seen as unsatisfactory, as the user is a 'person unknown', a fiction. However, it can also be used in an emancipatory way, to study user needs which then can be taken up in building design. Expectations of users' needs, and behaviours thus become embedded in the design (see also subsection 2.3.3).

Not only buildings and appliances, also infrastructures are socially produced. Hughes showed how political, cultural, material and economic structures in society influenced the design and development of energy infrastructures (T.P. Hughes, 1983). Now, the centralized large-scale structure of the energy sector is challenged by the community energy movement. The community energy movement is driven by values of democracy, sustainability and localism. These values become visible in the type of activities that community energy initiatives perform. The community energy movement aims to democratize the governance structure of the energy system. Howe et al. argue that infrastructures, although they appear strictly utilitarian, always embody 'larger structures of power and direction' (Howe et al., 2015). In this perspective community energy activists can become new system builders, comparable to the engineers, scientists, regulators, and politicians that Hughes described in Networks of Power. According to Sovacool (2018), the intermediaries in the energy movement (Parag, Hamilton, White, & Hogan, 2013) would qualify for the label of system builders, but on a smaller scale even prosumers can contribute to the development of a new system. In recent years, the roles that users can play in relation to energy production has expanded considerably. No longer restricted to being a captive user, citizens can for example choose to be a prosumer, technology host, protestor, investor or beneficiary (Devine-wright, 2006).

The built environment is thus a social product, influenced by political, cultural, material and economic factors. To quote Hillier, 'the built environment is not simply a background to our social behaviour - it is itself a social behaviour' (Hillier, 2007, p. 300). In the next section I will discuss how social values and cultural-political worldviews are incorporated in the design of the built environment.

2.3.2 Values and reconfiguration processes

In reconfiguration processes, actors can be said to hold specific values that form the ideological basis of their activities. In this way, values are important motives to change or alternatively to protect built structures. But what are values and what types of value are relevant for the built environment? Philosophically speaking, values are 'things worth striving for' (Van de Poel, 2015). Furthermore, we can distinguish values that we hold, such as liberty, and values we attach to artefacts, such as beauty. Van de Poel (2009, pp. 980-985) identifies four value types: instrumental, economic, moral, and finally cultural and aesthetic values. Under moral value the side-effects of technological artefacts are discussed, touching upon unintentional effects such as car-accidents and chemical pollution, as well as intentional effects (See also 2.4.3). Cultural and aesthetic values are presented as values that are not intrinsic to technological artefacts, but open to interpretation. However, cultural or aesthetic value 'depends not only on the extrinsic, relational properties of the artefacts, but also partly on their material intrinsic properties'

(Van de Poel, 2009, p. 984). The function of the artefact gives an extra layer of beauty to the object: '... our sense of the beauty in architectural forms cannot be divorced from our conception of buildings and of the functions they fulfil' (Scruton, 1979, p. 10).

Landscapes and buildings are connected to stories and memories, moreover, they are imbued with several types of values, including cultural-historical values, community values, social values, and spiritual values, which can be tangible or intangible (Vecco, 2010). These values can be identified in many ways, from expert value assessments by architectural historians to the gathering of values in community sessions (Stephenson, 2008). In a restoration process, it is important to assess the cultural-historical values that are attached to the historic building under consideration. Values can be related to historical events, historical figures, specific architectural styles, building types, but also local memories, social histories or other events can make buildings meaningful. In chapters 6, 7 and 8 cultural values that are embedded in or attached to buildings are examined to understand how cultural and sustainability values play a role in restoration practices.

Design for Values is a method to incorporate values in design (Van de Poel, 2009, 2015; Van de Poel & Verbeek, 2006). Here, Van de Poel discusses four challenges. First is the choice of the values that are aspired to. Importantly, not only chosen values but also worldviews, ideologies and interests of actors are relevant for the design process. Furthermore, as Van de Poel also mentions, 'technologies have all kinds of effects, desirable and undesirable, beyond the goals for which they are designed or used' (Van de Poel, 2009, p. 983). The second challenge is how to make the chosen (or identified) values bear on the design process. How to translate abstract values into material designs? To this end, van der Poel introduces a values hierarchy. Based on the chosen value, norms are specified, which subsequently are translated in design requirements. This method 'makes the translation of values into design more systematic, but also explicit, debatable and transparent' (Van de Poel, 2015).

Could the method of design for values be extended to the design of energy systems? We found that the community energy movement strongly adheres to values such as sustainability, democracy and local economic development. In the design of new organisations and structures these values can be identified, as is shown in Chapter 4. The Design for values-approach thus can help to design and evaluate sociotechnical arrangements for community energy projects that are consistent with the values that this movement holds.

In practice, values often come into conflict, so choices and trade-offs between have to be made, which is the third challenge Van de Poel describes (2009). A value conflict exists if different options are favoured as the best outcome of a design project. Values can also be incommensurable, which means that 'they cannot be expressed or measured on a common scale or in terms of a common value measure' (ibid. 2009, p. 977). In that case, trade-offs are not possible. Value conflicts or value incommensurability can be dealt with using a range of approaches, including calculative approaches, reasoning and judgment, innovation and diversity, genre and value holism (ibid. 2009, p. 1002). The issues of value conflicts and commensuration is taken up in two main chapters. Chapter 6 focuses on different types of strategies used for the reconciliation of sustainability and cultural values in restoration practice. In Chapter 7, the problem of value conflicts in restoration processes is studied by analysing commensuration processes, relying on the approach of Espeland et al. (Espeland & Sauder, 2007; Espeland & Stevens, 1998, 2008).

According to Van de Poel, the final challenge in Design-for-Value is to verify if the chosen values are successfully embedded in the design. I suggest that this approach can also be used the other way around, to uncover norms and values embedded in existing technological products or the configuration of the energy system. Here, the start is so to speak at the bottom of the value hierarchy, because the features are already known, and the goal is to uncover the higher values that lay behind it. This idea is further elaborated in Chapter 8, which examines energy scripts in buildings on the basis of (historical) texts and layouts. A good starting point for such an analysis could be to investigate the texts that speak of buildings. This is the subject of the next section.

Summarizing, values play an important role in reconfiguration processes. Actors in the community energy movement are driven by political and sustainability values, and the existing built environment is in imbued with societal and cultural-historical values, which constrain as well as motivate our actions. Commensuration of values is a social process to align different values and perspectives and to achieve reconciliation of conflicting values.

2.3.3 Translating ideas into buildings: the role of texts

For the analysis of the built environment we can of course study the buildings themselves, but it could also be very fruitful to examine texts, such as architectural theory and history, building regulations, briefs, or architectural criticism. Architects translate these written ideas, norms and requirements into designs, which then (can) get build. Such an analysis can help to uncover the expectations and ideas that play a role in the design of the built environment.

But doesn't architecture itself 'speak' to us? Indeed, it the past the linguistic analogy has been very popular. It was argued that buildings can be 'read like texts' (Lefaivre & Tzonis, 1990; Sewell, 1992). Popular titles such as 'How to read buildings', or 'The language of buildings' of Summerton speak volumes in this respect. However, the metaphor that architecture is a language is no longer fashionable. Umberto Eco says: 'architectural objects do not communicate, but function' (Eco, 1986; Markus & Cameron, 2002). Scruton (1979, pp. 160–178) critically discusses the analogy of architecture to language. Architectural expressions can follow 'grammatical' rules but can also break them; it combines elements in wholly new forms without being 'wrong'. Although some symbolic forms may mean something, make information available, Scruton argues that 'the linguistic analogy (..) is an obscure and uncertain analogy' (1979, p. 178). Forty (2000) discusses the use of words in relation to buildings. He links the rise of the linguistic analogy with the development of new views on language, for example the essay of Herder on the origin of language (1770), and the decline by the 1920s with the desire of modernist architects to emphasise the autonomy of architecture. In the 1950s and 1960s semiotic analysis of architecture, both of buildings and cities, again became popular among both semioticians and architects, while in the 1970s a strong reaction followed that condemned all linguistic analogies. Forty however finds this excessive and concludes 'even if architecture is not a language, it does not lessen the value of language as a metaphor for talking about architecture' (Forty, 2000, p. 84).

So, although architecture thus may not be a language in itself, there certainly is a vast library written about it, which could inform our investigations. However, as King (1984) argues, this written history of architecture is useless for the purpose of social studies, because it is all about the rather superficial aspect of style. This challenge is taken up by Lefaivre and Tzonis (1990), who discuss the social history of architecture in a collection of architectural theoretical texts. They argue that the consequences of built objects for human relations and societies deserve to be taken up by architectural history, rather than limiting historical research to architectural styles7.

Moreover, although we may dismiss the claim that architecture is a language, the study of the design of buildings can deliver useful information regarding the social values behind them. According to Sewell, buildings can be read to discover the schemas or mental structures that are built into them. 'A factory is not an inert pile of bricks, wood, and metal. It incorporates or actualizes schemas, and this means that the schemas can be inferred from the material form of the factory. The factory gate, the punching-in station, the design of the assembly line: all of these features of the factory teach and validate the rules of the capitalist labor contract' (Sewell, 1992, p. 13). Thus, for Sewell, buildings reveal, their material form can be analysed to uncover the ideas that are built into them. To speak of 'reading' an architectural drawing is itself a metaphor, what people actually do is 'projecting imagined bodily movement around a drawn plan or section, and describing what they would encounter; they are performing a language-like act of interpretation of an image' (Forty, 2000, p. 39). What is encountered is subsequently compared with the analyst's knowledge of social processes, social theory, historical knowledge or other theoretical or disciplinary approaches.

However, as Gieryn (2002) argues, buildings also conceal. That is, once built they hide the possibilities that did not get built, and the politics and choices that were made in the process of their design and production. After a design gets built, it becomes stabilised, and attains power over subsequent users.

Architects do not work independently, but instead have to comply with commissions, building codes, and regulations (Markus & Cameron, 2002). Therefore, instead of studying architectural history, sociologists could focus on the texts accompanying buildings, such as briefs, design guides, and legal acts, which can reveal much about the materialised worldviews, norms and values. These texts can be taken as intermediaries that for example translate norms to building instructions.

This approach is taken by Markus and Cameron, in *The words between the spaces*. They argue that 'the language used to speak and write about the built environment plays a significant role in shaping that environment, and our responses to it.' (Markus & Cameron, 2002). For example, the (British) 1779 Penitentiary Act included a detailed specification of the design and daily programme of prisons. Here, 'the political and punitive objectives were seamlessly woven into a web that contained all the building and material minutiae' (Markus & Cameron, 2002, p. 37). Indeed, the regulation and ordering of civic life through planning law goes back to antiquity. An example of the way building regulations influence society is the Amsterdam Building Ordnance of 1533 which formed the basis under of 'The plan of the three canals' (Mumford, 1961, p. 444). In fact, 'legal texts actually design cities and buildings and they, in turn, 'design' society' (Markus & Cameron, 2002, pp. 38–40).

So, how can we use this for the analysis of buildings? Markus and Cameron (2002, pp. 44–45) identify five steps from language to the actual experience and use of a building, from the description of a general vision, through the identification of categories of people and activities, to the actual design and production of the building. The building's programme, use-pattern and behaviour of the occupants are subsequently managed by implicit or explicit rules.

These steps provide a clear method for the analysis of buildings, emphasizing the influence of commissioners, regulators and users. The architect interprets the brief and materializes the requirements in a concrete design. However, buildings are not always successful in their intended program; users can behave rather differently from the designers' intentions. Conflicts can arise between the discourses, the classification, the design and the actual human behaviour in the finished buildings. Furthermore, they argue that in order to create new social relations (with buildings) we need new categories and labels to accommodate new forms of behaviour based on these changed relations. A complete rethinking of, for example, domestic life, is necessary to be able to design buildings that cater for new visions of a specific social activity (Markus & Cameron, 2002, p. 47).

Summarizing, it is clear that the built environment is socially produced. Furthermore, human values are translated in the materiality and layout of buildings, mediated by the texts accompanying the building and design process. Buildings can be fruitfully analysed by the study of texts and layouts, because both texts and designs reveal much of the values, expectations, scripts and schemas that are embedded in them. Regarding the reconfiguration cycle, I will now reflect on the way that structure influences agency, or, how buildings constitute social life.

2.4 Buildings shaping us (structure)

2.4.1 Structuring agency with place

Buildings both are tied to and influence the place where they are built. Exceptions notwithstanding, buildings are not moved. Only in very special circumstances, such as when vernacular dwellings are re-created in a folk museum, are buildings taken down and rebuilt somewhere else. This situatedness of buildings means that they can define a place for long stretches of time, indeed some buildings are iconic, landmarks, and belong to a specified location. 'A place is remarkable, and what makes it so is an unwindable spiral of material form and interpretive understandings or experiences' (Gieryn 2006 p. 472). People attribute meanings and values to places, which build up over time (Stephenson, 2008). Place is also connected to power,'(it) enables power to travel, to extend its reach over people and territory' (Gieryn 2006 p. 476).

The control of people in geographic places, such as landscapes, cities, or buildings, is often analysed using concepts of territoriality. Territoriality is a strategy or process, where human and non-human actors aim to control or influence people by delimiting or asserting control of a geographic area (Kärrholm, 2013; Sack, 1986). Sack describes the history of the RC Church to illustrate the uses of territoriality, not only regarding access to areas, by confining priests or monks to their area of origin, but also in the design of buildings, the 'visible church'. Just like Greek or Roman temples, churches are 'internally subdivided to mark off degrees of the sacred' (1986, p. 93), reserving special areas for the bishop, the priests, deacons, laymen, and women. In modernity, neighbourhoods become increasingly 'thinned out', activities more and more occur in separate places and streets are for transport purposes only (Sack, 1986, p. 89).

Mukerji analyses the relation between territoriality, state power and landscape design. She shows that the design of the royal gardens at

Versailles is related to growing national power, 'written on the land'. Military design practices and forms were used in the design of the Versailles gardens to impress visiting foreign rulers and courtly underlings alike. For one, this shows that appearances can be deceptive, meanings of historical structures and designs possess more layers than immediately visible to us. Objects have hidden properties which may surprise us, even after hundreds of years (Kärrholm, 2007; Mukerji, 1994; Yaneva & Guy, 2008).

So, one of the limits to agency (Kirkman, 2009) is the limit posed upon actors by territoriality. However, not all place-related limits are territorial. The energy infrastructure is not only a social structure but is situated in material things like cables and transformers. These structure the possibilities for decentralized power production. In Chapter 4 I describe the cooperative energy movement, which challenges the obduracy of both the social and the physical energy structures.

Division of the home, delimiting access and use by different members of the household, is described by (Bourdieu, 1970). Sack (1986) however stresses the flexibility of dwellings, particularly in the United States, and connects the efficient kitchen design with rational design of the factory. In Chapter 8, I further elaborate on the development of kitchens in relation with social views on gender roles. In the following section I first discuss the influence that building types exercise on social life.

2.4.2 Structuring agency with building types

There is a strong conviction in architectural discourse that buildings structure or guide the behaviour of users (Lipman, 1969). So, how are buildings supposed to do perform that feat, or in other words, how do buildings structure agency? One of the means of disciplining users is building typologisation, as analysed for the 18th and 19th century by Markus (Markus, 1987, 1993; Sack, 1986). A building is usually designed for a specific function, which to a certain extent determines its usage. Building types express the status and power structures in society and aim to impress on the users or passers-by how they should relate to the building and its owners. Buildings structure and reproduce social relations, discipline, division of labour, and the expression of wealth and power. When studying a specific building type, such as the prison, a sociological perspective could for example focus on the relationship between the outer façade and interior organisation of a prison on the one hand, and social theories about criminology in a certain period on the other (Tomlinson, 1980). Foucault also links buildings and their specific architectural form with the disciplining of bodies in society (Foucault, 1979). For the 20th century the design of building types continues to be relevant, because 'The modernist architects of the 20th century also took a great interest in building types as a way of trying to secure certain social outcomes'

(Kärrholm, 2013, p. 1110). For example, the designs for the 'Wohnung für das Existenzminimum' displays modernist ideas about 'proper' housing for workers (Grassi, 1997; Porotto, 2018), but also transmit ideological views, such as that parents as well as children of different sexes should sleep in different rooms and that parents should keep an eye on their -playing- children. These ideas are rather different from social practices only some decades before, when children had to work from an early age and many families had to live in just one room. The layouts also can be studied to decipher gender roles and the use and provision energy. Reading these texts and examining the typologies thus can reveal much of the ideological worldviews behind them.

Furthermore, building types are territorial, because they are used to control people in geographical locations, as can be observed in practices of zoning or the development of neighbourhoods for specific target groups. The development of offices, factories, prisons, asylums, schools and hospitals from the 18th century show an increasing compartmentalisation of rooms, specifying activities and categorising inhabitants. Not much later, houses also develop separate rooms for all kinds of functions, starting with Victorian 'grand houses' but soon expanding to more modest dwellings up till the social housing types designed by Ernst May and others (Grassi, 1997; Sack, 1986).

The flexible factory building, for example as designed by Kahn, facilitate an impersonal hold on the workers and provide 'emptiable' space that can be used for any production line. Modern offices no longer use compartmentalized 'cells' but tie the workers to their desk, while the territorial effects of open plan offices on aspects such as privacy, job performance, or social cohesion, are debated (Sack, 1986, pp. 213–215).

Consequently, Kärrholm (2013) re-conceptualises building types as territorial sorts, which describe a set of related territories associated with the same activity, such as a library, museum, or a pedestrian precinct. They choreograph or configure the actions displayed by users. Territorial sorts are territorial stabilisations by actor-networks. An example is the McDonald restaurant, which is a building type characterised by 'network stabilisation', where all actors or actants are blackboxed. However, even then it remains open to territorial production, as can be seen in the example of the child that sees a hopscotch place in the floor tiles of a McDonald restaurant. Network stabilization is only temporary, so Kärrholm uses the concept of 'fluid stabilisation' (2013, p. 1110) for these processes. Importantly, territorial production is a process that can in principle be performed anywhere by anyone, as is shown in the example of the hopscotch. So, buildings are more than the sum of their parts, they have hidden qualities or dormant aspects that lend themselves to reinterpretation or can surprise us.

2.4.3 Structuring agency with scripts

Views on how buildings should influence their users are intentionally taken up in architectural designs. For example, influencing the behaviour of prisoners is the purpose of Jeremy Bentham's Panopticon. Similarly, Foucault shows how power relations are materialized in institutional buildings, such as schools, hospitals and dwellings. (Hirst 1993; Foucault 1979). Moses' bridge to Long Island is a famous example of politically motivated architectural design (Winner 1980). Allegedly, this bridge was intentionally so low that buses could not pass, thus preventing low-income bus passengers to go to the beach in Long Island.

Designers, says Bourdieu (1984), are 'cultural intermediaries', that anticipate the interests, skills, motives, and behaviour of future users. These representations of users become materialized in the design, development and marketing of products (Woolgar, 1998). Woolgar further argues that technology development can be understood as a process of configuring the user, teaching them what to want (Woolgar, 1990, pp. 58–99, 1998, p. 445).

A range of similar terms used in the literature for such materialized representations are schemas (Sewell, 1992, p. 13), scenarios (Akrich, 1992; Oudshoorn & Pinch, 2007, p. 549) or 'use programs' (Radder, 2009). Akrich and Latour (1992) specifically use the concept of scripts to describe actor roles and qualities of devices. A device thus contains 'prescriptions' or affordances: 'What a device forbids or allows from the actors that it anticipates' (Akrich & Latour, 1992, p. 261).

Buildings thus materialize the cultural expectations of user' behaviour. However, this does not answer the question if the artefact, in this case the building, is successful in teaching or guiding the user. Indeed, determination by artefacts is never complete, users always retain agency to behave differently. Akrich and Latour (1992, p. 261) propose specific terms to describe the different reactions of users to the intended action program. For example, an actor that goes along with the action program is performing 'subscription', while an actor that purposefully deviates from this program performs 'de-inscription'. How actors can misunderstand, ignore, discard, or reject the 'instruction manual' is demonstrated by Wyatt et al. (2002). Additionally, actors can be excluded or expelled from a script (Wyatt et al., 2002). In the built environment, users always retain the possibility to reinterpret or reconfigure buildings (Gieryn, 2002; Kärrholm, 2013), and a significant potential for contestation of technologies remains (Coutard & Guy, 2007).

While the notion of script tends to be related to how singular artefacts invite, guide and coordinate action, it can, in principle, also be related to encompassing systems or infrastructures (Blok, 2013; J. Evans & Karvonen, 2014; Kirkman, 2009). On the scale of infrastructures, the importance of overarching ideas or values such as centralisation and liberalisation for the design of the energy system is well documented (Bolton & Foxon, 2015; Jacobsson & Lauber, 2006; Jørgensen, 2012; van Rooijen & van Wees, 2006; Verbong & Geels, 2007). Furthermore, expectations of grid-users are shown to influence the design of electricity grids and the allocated roles for different types of users. For example, Schick and Winthereik study visualisations of smart grids, which show how new subject positions for future electricity consumers are constructed (Schick & Winthereik, 2013), while Skjølsvold et al. demonstrate how different types of users of the electricity grid are 'orchestrated' by designers. New roles of users as drivers of change in the energy system are increasingly recognized in the literature (Devine-wright, 2006; Ornetzeder & Rohracher, 2006; Sovacool et al., 2018, p. 22).These studies show that societal values and representations give rise to expectations of behaviours of energy companies as well as end-users and subsequently get embedded in material infrastructures, ways of organizing and regulations. Therefore, I argue that it makes sense to view the existing energy system as scripted according to values and expectations of behaviour. Innovation is therefore required on the level of the system itself; an example of this will be examined in the next chapter.

How technologies invite or inhibit specific performances of their users can be illustrated by the analysis of gendered artefacts, accompanied with instructions and advertisements (Oudshoorn & Pinch, 2003; Oudshoorn, Saetnan, & Lie, 2002). A 'genderscript' specifically refers to the way that gender roles are embedded in artefacts. Gendered artifacts subsequently play an active role, they 'can contribute to the maintenance of gendered social relations, especially relations of power' (ibid. 2002, p. 472) and 'objects can attribute and delegate specific roles, actions and responsibilities to their users.' (ibid. 2002, p. 473). For example, Marit Hubak (1996) investigated how the identities of certain car models were sought, constructed, and conveyed through newspaper advertisements.

According to Akrich, 'de-scription is the opposite movement of the in-scription by the engineer, inventor, manufacturer or designer' (Akrich & Latour, 1992, p. 1). A building is usually designed for a specific function, thereby co-constructing cultural relations, discipline of users, division of labour, or the expression of wealth and power. To this end, Fallan (2008) aims to study how products transport and transform meaning, in order to better understand the interaction between product and user. 'The aim of the academic written analysis of a setting is to put on paper the text of what the various actors in the settings are doing to one another. The description, usually by the analyst, is the opposite movement of the inscription by the engineer, inventor, manufacturer, or designer.'(Fallan, 2008, pp. 61–75). Thus, script analysis can be used to understand how architects interpret the needs and behaviours of users and how 'building networks' negotiate and construct a sphere of action and meaning. Here, scripts or schemas are used as a tool to 'describe' things back to words. Furthermore, Moore & Karvonen (2008) use this approach to expose the societal preferences that are embedded in concrete buildings.

Summarizing, script analysis can be a useful tool to investigate how utilitarian functions, aesthetic expressions, social meanings, and cultural identities are constructed. This approach is applied in Chapter 8.

2.4.4 Never beyond reconfiguration: obduracy

Buildings tend to survive for relatively long periods; durability is one of the main characteristics of buildings. A typical lifetime of dwellings is fifty years, but many houses in the existing building stock date from the first decades of the 20th century. With proper retrofit they can be reconfigured to function effortlessly for another half century. Historical buildings can be much older, from several centuries to millennia. For example, many churches in Europe date from the 12th or 13th century, while a considerable amount of structures from Roman times still exist in countries that two millennia ago belonged to the Roman empire.

The durability of historical buildings is partly due to material qualities. Some materials are more resistant than others, for example wood is much more vulnerable than stone. Ancient buildings that have survived the ages are therefore most often made of stone. The layout and structure of the buildings also influence the resistance to weathering, fire and storm. Multiple non-human actors invade buildings, ranging from mould to mice, from moss to trees. These plants and animals also reconfigure the building to better suit their needs. However, maintenance and repair are decisive in keeping natural threats at bay. Durability relates not only to the buildings themselves, but also to the urban plan as a whole, including infrastructures such as roads, energy, and communication. A mixture of past and present worldviews and technologies is reflected in historic town centres, all influencing present usage.

When we want to change things, durability is labeled as *obduracy*, and is considered a barrier instead of an asset. Actors thus encounter obduracy, which refers to the resistance to change that buildings possess. Obduracy is produced by material properties as well as by human actors and networks. In *Unbuilding Cities*, Hommels examines obduracy in urban sociotechnical change (Hommels, 2005b). She presents an analysis of large projects in three main cities in the Netherlands. Moreover, she carefully unpacks the way obduracy is conceptualized in four theoretical approaches. The first (deterministic) conception primarily highlights the material aspects of obduracy. In the second conception, dominant ways of thinking are central. Hommels connects this conception with technological frames, a prominent concept in SCOT. The third conception explains obduracy by the connections of social and technical elements, stressing the heterogeneous nature of the built environment. This approach is primarily connected to ANT. The fourth conception that Hommels identifies sees obduracy as the result of the persistence of traditions, this idea is for example used in LTS (2005b, p. 46). Hommels links 'unbuilding strategies' as identified in three case studies to these four conceptions (2005b, p. 150). Furthermore, she briefly goes into identified strategies to preserve obduracy. The first strategy is 'to establish continuity with the past by stressing the importance of ideas originally embedded in the design. The second strategy is to stress the 'age' of a particular urban design and the third strategy is to refer to the social and financial investments that are at stake (2005b, pp. 152–153). In Chapter 6 I built upon and expand this preliminary list in a case study of historical buildings.

Regulations, such as building codes, strengthen the obduracy of buildings in several ways. For example, the Dutch building code of 1920 prescribed the organisation of domestic space in such a way that a small kitchen was provided for the housewife. It took half a century before citizens started to reverse this divisive layout by breaking down the walls between the kitchen and the living room (2005b, p. 153). Discursive re-interpretation apparently was not satisfactory; to re-integrate functions of cooking, child caring and family life a material reinterpretation was needed.

In the case of historical buildings, the allowed reconfigurations are regulated by conservation principles, building codes and international agreements (Jokilehto, 2002; Pickard, 1996; Taylor & Cassar, 2008). Conservation codes have been in place since Roman times, as Jokiletho (2002) demonstrates, so in the course of the centuries these codes have contributed in an important way to the durability of historic buildings.

Social norms and rules also govern energy production and consumption. The energy system is heavily regulated on a national level, where prices, taxes and license structures are decided upon. Past choices in infrastructure and sector organisation continue to influence development of energy production facilities, be it individual installations or large community solar parks. Obduracy of large technical systems is continually reproduced by the incumbents, by resisting change in regulations or by using various strategies to delay or resist new technologies. Hughes maintains that it takes massive contingencies such as war to disrupt such systems. However, the Community Energy movement challenges the governance, organisation and values of the present energy system.

Human made threats to buildings are individual demands for space, comfort or fashion, new city plans, acquisition of new funds or alternatively, the lack of funds to finance these demands. Buildings contain sunk investments, which inhibit (costly) reconfigurations.

Because buildings are not infinitely flexible, therefore, it is relevant to investigate the limits of flexibility or obduracy of the built environment (Kirkman, 2009). The obduracy of the built environment is thus based on the characteristics of the materials themselves as well as the dynamics of social norms, rules, challenges and contestations.

However, obduracy should not only be seen as an obstacle to change, there is a positive side of obduracy. It allows buildings and cities to retain stories and memories, to provide identity. Because of the obdurate nature of the built environment we can enjoy the many cultural-historical values in buildings and cities. The built environment stabilizes social life; it can only do that when it is – to a certain extent – obdurate.

2.5. Summary

The double reality of buildings, shaped by us and subsequently shaping us, is the underlying logic of the cycle of reconfiguration. Reconfigurations are generated by the continuous interplay of agency and structure. This reciprocal relationship is the particular focus of science and technology studies, which I briefly discussed in 2.2.1. This reciprocity is also the underlying notion in the empirical chapters that follow. In the preceding chapter I concentrated on the two sides of the reconfiguration cycle, first discussing the role of agency in the built environment, in other words how we shape our buildings and secondly following the influence of structure, or how our buildings shape us. In relation to this reconfiguration cycle, I focus on three concepts in particular, obduracy, values and scripts.

Obduracy, or resistance to change, is 'produced' by the network of materials, values and regulations that are present in the built environment. In the course of the energy transition, numerous changes to these obdurate networks are necessary, to increase renewable energy production and decrease energy demand. In chapters 4 and 5 the attempts of the community energy movement to challenge the obduracy of the energy system are studied, as well as how this movement is actively building new social and material structures. The difficulties to realise a reduction of energy demand in historical buildings are further discussed in chapters 6, 7 and 8.

Values are strived for both in relation to community energy and historical buildings. They motivate and guide community energy groups in their endeavours to realise a sustainable energy system. Goals of sustainability, democratization, and localism are the values that underlie the designs of new organisation and governance structures. Values are also paramount in the efforts to conserve and protect historical values in the built environment. In chapters 5 and 6 I will zoom in to the building scale and examines how sustainability and cultural values are negotiated in restoration practice.

Scripts connect designers and users in multiple ways and are instrumental in configuring the user by inhibiting or promoting envisaged ways of use of an artifact. It is possible to interpret the whole of the energy system as a scripted system, guided by leading values, such as centralisation or liberalisation. These values then become embedded in the design of the numerous artifacts and regulations that make up the system. Expectations of the user are also related to these values and although actions by users that do not fit the overarching vision are possible, they require more strength and endurance for successful realisation, as is investigated in Chapter 4. That script analysis can be a useful tool to study the design of buildings in relation to energy efficiency, is further taken up in Chapter 8. Table 1. sketches the empirical tasks related to the three guiding concepts.

Table 1. Situations and concepts of energy reconfiguration

Situations	Concepts		
	Obduracy	**Values**	**Scripts**
Community energy	What obduracies are encountered by community energy initiatives and how is this obduracy challenged by innovators (Ch. 4)	What values are important for the community energy movement and how are they implemented in activities (Ch. 4 and 5)	The energy system is geared to centralised production. How are 'centralist expectations' embedded in the design of infrastructures and governance, hindering decentralised developments. (Ch.4)
Historical buildings	How can we relate obduracy to historical buildings and in what way can obduracy be an asset instead of an obstacle (Ch. 6)	What values are relevant in historical buildings and how are competing values reconciled (Ch. 7)	Can we identify scripts in buildings and what are the effects of these scripts regarding energy efficiency (Ch. 8)

3.

Strategies of community energy: a literature review

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Keywords: community energy; renewable energy; local energy; energy transition; distributed generation; literature review

Appendix A contains a list of the corpus of 263 articles, including authors, title, journal, publication year, country of study, used keywords and theoretical approaches

Appendix B contains a list of keywords provided by the authors of the articles in the corpus

Abbreviations: In the text, corpus articles are indicated with the prefix c, within brackets (c..), articles that are used in the main text and also appear in our corpus are indicated with both the usual reference and a corpus number: (..)/c. For example: Seyfang et al. (2014)/c208

3.1. Introduction

Renewable energy is on the rise in most of the European Union (EU) member states. In 2015, the share of energy from renewable sources in gross final consumption of energy reached 16.7% in the EU; nearly double 2004 (8.5%), the first year for which the data are available.[5] The International Energy Agency in its World Energy Outlook expects it to become the largest source of electricity generation in the EU by 2030[6] (IEA, 2016). In several European countries, an increasing part of the production of renewable energy is generated by citizen-owned production units. These units are installed and managed individually or by local communities, and the number of local energy initiatives, who aim to increase local energy production, is rising rapidly. This has resulted in a new research area we label as community energy. In our study, we use community energy to encompass several terms that have been used so far in the literature, such as citizen's power, grassroots energy, and local governance of energy production. In this respect, we highlight the role of the individual, acting as consumer, prosumer or citizen. Throughout this paper, community energy is defined as local production of renewable energy, governed by citizens, with a view to contribute to the transition to a sustainable energy system. Our aim is to identify the key issues and concepts covered in the community energy literature so far and to reflect on how it is studied.

5. Eurostat Newsrelease 43/2017 – March 14, 2017.
6. Source: International Energy Agency (IEA). 2016. World Energy Outlook. Paris: IEA.

The community perspective is highly relevant for energy policy, especially regarding the transformation to an energy system that relies on non-fossil and renewable energy sources. Traditionally energy policy is a top-down approach, which relies on taxes, subsidies and regulations. These policies for sure will affect the start-up and success of local initiatives. But community energy is a bottom-up and grassroots phenomenon that is difficult to integrate with conventional policy. The main reason is because it is local and highly context specific. At the local level, municipalities may try to mitigate or stimulate the community initiatives. Given the importance of the local context, it is likely that community energy has ramifications that go beyond the production and distribution of energy only. Community energy is in the frontline of acceptance of alternative ways of energy generation and the energy system transformation. It also highlights the importance of community sense and the role of small and medium-sized enterprises in the transformation. Community energy is a focal point which brings together a wide array of perspectives regarding how to organize a society, specifically at the local level. Therefore, it does not come as a surprise that within and between countries we witness very different experiences and approaches with community energy and policies to stimulate, integrate and mitigate it. Of course, it should be mentioned that community energy is unlikely to be the sole or main driver of the transformation of the energy system. As there is a very skewed distribution of both the production and consumption of energy, it is unlikely to play a dominant role at the national level. However, at the local or regional level, it may result in a very substantial contribution to the supply of renewable energy. Therefore, it is of interest to both national and local policy makers.

In academia, the community lens has been used for analytical purposes before. For example, Howard Jones addresses the (potential) role of community action in a democracy in the Annals of the American Academy of Political and Social Sciences in 1938. It shows that the contribution of communities to the energy transition has attracted attention in the literature (Araújo, 2014; Hauber & Ruppert-Winkel, 2012; Hielscher, Seyfang, & Smith, 2013). Local transitions to energy-neutral or low-carbon communities especially have been studied by analysing national or regional cases and policy (Alexander, Hope, & Degg, 2007; Chmutina & Goodier, 2013; Emelianoff, 2013; Forrest & Wiek, 2014; Hauber & Ruppert-Winkel, 2012; K. Hughes, 2009; Trutnevyte, Stauffacher, & Scholz, 2011). Other studies focus on the emergence of social networks in relation to renewable distributed power generation (Berkhout & Westerhoff, 2013; Parag et al., 2013). We investigate the developments, focus and highlights of the community energy literature by critically reviewing the recent studies that appeared in academic journals.

In this respect, we found that there already are some studies, which investigate a particular aspect of this emergent energy literature. For example, Yildiz et al. (2015) compare energy cooperatives in Germany with investor-oriented firms, using insights from diverse strands of the economic literature, with the aim of setting a research agenda. Furthermore, they review literature from the social sciences on the topic of participation and civic engagement, as well as highlighting intra-cooperative dynamics concerning conflict and trust. Fast (2013) reports on a literature study into social acceptance of renewable energy and investigates the possible role of geography in this discussion. He follows Wüstenhagen et al. (2007) in distinguishing between socio-political, market and community acceptance. Fast finds that the level of acceptance is generally higher if the public has a role as investor or co-owner of the facility. De Boer et al. (2015) study the literature regarding the spatial impacts of renewable energy, in particular direct land use impacts, aesthetic impacts, recreational and ecological impacts. De Boer et al. zoom in on the structural conditions of renewable energy, in particular biophysical conditions, while the aesthetic impacts relate to the community acceptance discourse, as also investigated by Fast (2013) and Wüstenhagen et al. (2007). Van den Bergh et al. (2011) focus on theoretical approaches used in the sustainability transition literature. They identify four broad systems approaches, namely innovation systems, multi-level perspective, complex systems, and evolutionary systems and organize the literature accordingly. We depart from their framework regarding the community energy literature and try to account for the existing approaches.

Other studies that are closely related are Ribeiro et al. (2011), who reviewed nineteen studies regarding the impact of social sustainability on electricity planning. They find 101 social, economic or environmental impacts of electricity plants in this study, for example referring to employment, health, noise, visual effects, land cover (although a quarter of the reviewed studies are literature reviews themselves, which probably adds to the number of impacts found). One of the emerging impacts identified in this study is social acceptance, including NIMBY-ism. Rae and Bradley (2012) reflect on energy autonomy and identify a list of key issues. Their contribution is that they explore the characteristics of sustainable communities. They identify four key issues on the basis of their study of the literature: 1. The degree and scale of energy autonomy; 2. Matching demand with supply; 3. The importance of socio-economic and political factors; 4. Energy autonomy in island and remote communities. Community energy is discussed under key issue 3, including community ownership and stakeholder's engagement, the role of policy and the impact of economics and project finance. We study these issues in section 3.4, where we discuss the theoretical approaches to community energy. Another take on the subject is provided by Wolsink (2012a), who focuses primarily on the social aspects of smart grids. He treats renewable energy grids as a 'common pool resource' (CPR). According to Ostrom and others, 'collaborative planning and community involvement are key for effective implementation by and community support for renewable energy projects' (Wolsink, 2012a, p. 830). Wolsink proposes a research agenda and recommends ensuring that social acceptance is taken up in the design of smart grid policies. Further, we refer to the study of Beynaghi et al. (2015), who executed a search in Scopus with the search terms sustainability and sustainable development in two separate years: 2000 and 2013. They show the texts of the top 5% of the resulting articles in a word cloud. Comparison of these word clouds leads them to conclude that a large increase in studies relating to energy has taken place from 2000 to 2013. Within energy studies, a shift to renewable energy is evident. Key issues and trends regarding integrated community energy systems (ICESs) are outlined by Koirala et al. (2016) in a broad literature review on the basis of a total of 1285 studies derived from Scopus. They highlight technical, environmental and institutional issues that apply to local systems. Lastly, Klein & Coffey (2016) review the theoretical basis for community energy as well as a literature overview of technological options and geographical focus of 70 community energy studies.

As to the research method and philosophy, we want to point out that transdisciplinary research is increasingly seen as crucial in the implementation of sustainable development (Pouw & Gupta, 2017). Such approaches open up new ways for 'sustainability learning' (Cornell et al., 2013) in relation to energy transition. Therefore, building on Hirsch Hadorn et al. (2006), we will position community energy between academic disciplines on one side, and the perspectives of non-academic stakeholders on the other. Inspired by Turnheim & Geels (2012), we further cluster the nine approaches into four societal domains: sociotechnical studies, social-economic studies, governance and planning studies, and socio-psychological studies. This shows the interconnectedness of community energy activities with global and local networks of human actors and technologies. The right-hand side of Figure 3. depicts the different categories of stakeholders, the left-hand side has the nine different theoretical approaches we will be studying, grouped under four more generic headings. The approaches are detailed in section 3.4.2, where we will also use them in the analysis as the different approaches arrive at different views about and recommendations for energy policy.

Figure 3. Academic domains and stakeholders of community energy research

Our aim is to complement these studies by providing a more encompassing and systematic approach of the community energy literature. Further, we want to perform a critical review of this literature and to draw conclusions on what theoretical perspectives are used, to what extent commonalities and differences can be found between the main countries about which community energy studies have been undertaken, and how to proceed to better understand patterns of local energy transitions. To this extent, we first provide an overview of the timeline of appearance of community energy studies in the literature, the geographical orientation of more than 250 studies, and the journals that published the articles. We also provide an encompassing overview of their characteristics and about the theoretical perspectives employed. We then analyse these approaches in relation to the keywords used to assess these approaches as well as the focus and research design of the studies. Lastly, we relate the different approaches to the country specifics of the case studies. In the conclusion, we reflect on the state of the literature about community energy and identify topics for further research. As such, we provide an encompassing overview of the what (keywords), where (countries), when (years), by whom (journals) and why community energy is studied.

3.2. Research design

In order to evaluate the contribution of community energy to the energy transition, we perform a literature search in Scopus for the period 1997 to 2018 (for this end year, we have data for January-February only). We start in 1997, which saw the Kyoto Protocol that gave rise to new energy policies in most of the countries involved with this international agreement about greenhouse gas emissions (Bagozzi, 2015). At the same time, the liberalisation of the energy sector created opportunities for citizens in their choice of their energy provider (Smil, 2005). Moreover, prices of solar panels dropped considerably, bringing solar technology within the reach of individual house owners.

The phenomenon of community energy not only relates to a technological transformation of the energy system into a system based on renewables, but also to a more diversified and decentralized system where communities aim at considerable control of their own energy generation and provision. The latter is central in the community energy studies. For our literature search, we proceeded as follows. We initially used the search terms 'community energy' and 'renewable'. However, it showed that the terminology used to describe community energy activities appeared to be very varied. Therefore, we extended our search with the search terms decentralized energy, community engagement and local energy. Furthermore, we used keywords found in these articles that directly relate to our subject as a further search term: low carbon communities, local energy governance, community action, decentralised energy, grassroots innovations, renewable energy, sustainable energy, and energy autonomy. In addition, we fine-tuned the corpus to studies concerning citizens, local and regional projects. We included articles focusing on local governments, if citizens were involved in a meaningful way. We excluded papers that do not account for an active role of citizens. In order to limit our material to peer-reviewed articles, we excluded working papers, proceedings and book chapters. As a result, we ended up with 263 studies, which is the corpus of studies on which we will perform the review. These sample studies are all listed in Appendix A, which displays authors, title, journal, publication year, country of study, used keywords and theoretical approaches. Corpus-articles that are discussed in the text are indicated with the usual reference and a number according to Appendix A. Corpus articles that are referred to in the main article are included in the reference list.

We analysed the resulting list of research articles with Atlas.ti, which allowed us to identify keywords and search for theoretical frameworks and geographical names in the articles as a whole. Our findings provide an overview of the literature about community energy initiatives, both initiated by citizens and municipalities. We focused on keywords, theoretical approaches and country distribution.

3.3. Characteristics of the community energy studies

This section gives an overview of the descriptive characteristics of the studies regarding community energy that resulted from our screening process as described in the previous section. The key characteristics of the 263 studies investigated are the time of appearance in the literature, the geographical orientation of the studies, and the journals that publish community energy studies.

Figure 4. shows the development regarding the publication of the articles of interest in our review. Please note that the data for 2018 is only for the first two months. The first paper in our literature review appears in 1997 written by Jaccard et al. (1997)/c136 in Energy Policy, regarding community energy management. Since then, there has been published at least one article every year that fulfils our criteria, with the exception of 2002. Figure shows that the topic of community energy took off in 2007. This is the first year when more than five articles did appear. This has been the case since then. Until 2007, for a period of 10 years, which constitutes almost half of our sampling period, only six percent of the studies did appear. The other 94 percent saw publication in the remaining twelve years. Further, it shows that most studies have been published in the last four years, with 2016 being the year with the largest number of publications: more than one out of six studies in our sample was published in this year. The studies published in 2014-2017 make up almost 50% of our total sample (i.e., the corpus of 263 articles).

Selection of the studies is based on the following search terms: community energy, renewable, decentralized energy, community engagement, local energy, low carbon communities, local energy governance, community action, decentralised energy, grassroots innovations, renewable energy, sustainable energy, energy autonomy, and local government.

The majority of the papers in the community energy literature rely on the case study approach and focus on one or more specific countries. More specifically, we encountered 308 cases. The geographical distribution of the cases studied shows in Figure 5. This number (i.e., 308) is more than the total number of studies (i.e., 263) due to the fact there are several case studies that make a comparison between two or more countries. Figure 5. shows that most case studies, namely almost one third, are about community energy in the UK. Germany, the Netherlands and the US rank second, third and fourth in this respect. Combined, more than two thirds of all case studies investigate community energy in one of these four countries. This reveals there is a substantial geographic bias in the community energy studies. The focus on these four countries is a bit of a surprise as only Germany produces a substantial part of its energy consumption with renewables. Further, Germany is the only country of the four where community

Figure 4. Year of publication of studies on community energy and number of studies published (vertical axis).

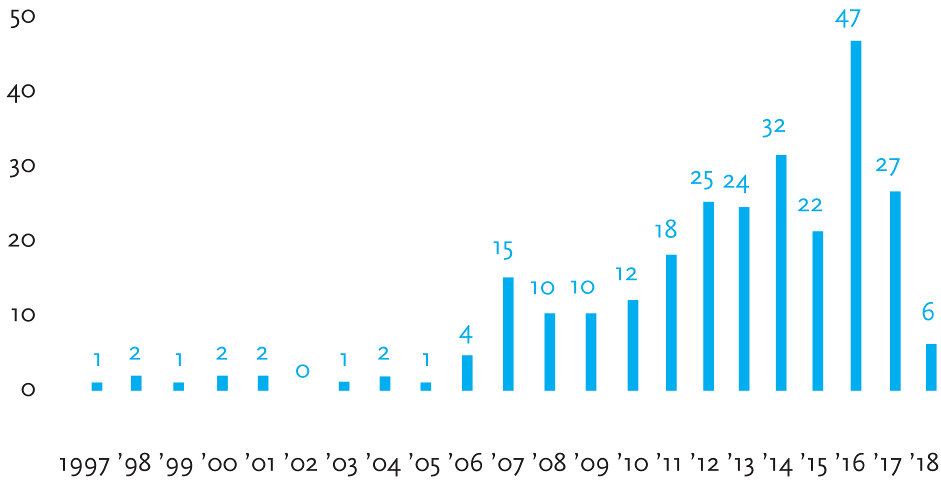
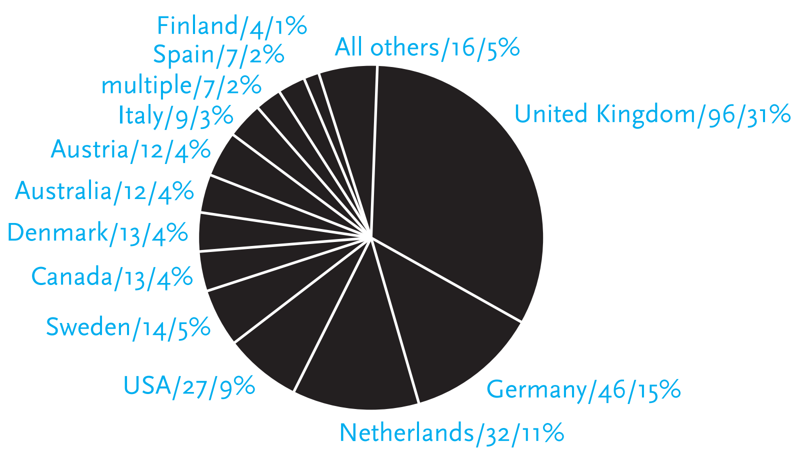


Figure 5. Geographical distribution of the 308 case studies (countries/number of studies/percentage of total sample).



initiatives are responsible for a considerable part of the renewable energy generated. Lastly, it is remarkable that Denmark, which is often quoted as an example of successful policies for implementing renewable energy hardly turns up in our searches.

The 263 studies appeared in 82 journals, which implies that the average journal has 3.2 articles. However, of course, their appearance is very skewed: There are 51 journals that published just one single study on community energy, and there are 14 journals that published two studies. Together, these 65 journals with either one or two studies published 30% of all studies on community energy in our sample. Table is an overview of the journals that published studies on community energy. It reveals that most studies appeared in Energy Policy (namely one out of every six studies published). The journal ranking second (Local Environment) published 9.5% of the studies, and the third (Energy Research and Social Sciences) 8.4. Thus, combined these three journals published 25% of all articles on community energy in the period studied. The runners-up are Sustainability, Energy, Sustainability and Society, and Renewable and Sustainable Energy Reviews, which together published 40 community energy articles or 15,2% combined. These characteristics reveal that the community energy debate is taking place in only a small number of journals. This is a typical characteristic of emergent fields of study.

Table 2.(The first column gives the number of publications in a journal. The second column gives the number of journals that held this number of publications. The third column gives the names for the journals that published three articles or more on community energy in 1997-2018; for the sake of brevity, we do not provide the names of the 51 journals with one article and for the 14 journals with two articles, please see Appendix A.
The fourth column shows the total number of articles that appeared in these journals. The fifth column shows the percentage of the articles in these journals in relation to the total number of articles (i.e., 263). The last column is the cumulative percentage of the articles published in the journals.)

Table 2. Frequency of publications about community energy and journal.

Number of community energy articles published	Number of journals	Journals	Number of articles (column 1* column 2)	% of articles in relation to total sample	Cumulative % of articles published
(1)	(2)	(3)	(4)	(5)	(6)
1	51	Not disclosed, see Appendix A	51	19.39	19.39
2	14	Not disclosed, see Appendix A	28	10.65	30.04
3	4	Futures; Geography Compass; Global Environmental Change; Research Policy	12	4.56	34.60
4	2	Environment and Planning C; Local Economy	8	3.04	37.64
5	1	Bulletin of Science, Technology	5	1.90	39.54
6	1	Geoforum	6	2.28	41.83
7	2	Environment and Planning A; Journal of Cleaner Production	14	5.32	47.15
9	1	Environmental Innovation and Societal Transitions	9	3.42	50.57
10	1	Renewable and Sustainable Energy Review	10	3.80	54.37
12	1	Energy, Sustainability and Society	12	4.56	58.94
18	1	Sustainability	18	6.84	65.78
22	1	Energy Research and Social Sciences	22	8.37	74.14
25	1	Local Environment	25	9.51	83.65
43	1	Energy Policy	43	16.35	
	82		263	100%	100%

3.4. Results

Here, we report and discuss the analysis regarding the focus and the scientific scope of the community energy studies. To this extent, we first provide an inventory of the keywords. Then, we provide an inventory of the different theoretical approaches assess their use. Next, we relate the approaches to the keywords. Last is that we investigate which approaches are used regarding the country case studies.

3.4.1 Keywords in the community energy literature

In this section, we show the keywords used. To this extent, we investigated the keywords provided with the studies. Not all articles did do so as this might be journal specific. Hence, only studies with keywords are included in this analysis.

Most studies provide two or three keywords, but there can be up to six keywords. Please do realize that there are no strict guidelines about what should be a keyword. This means that different authors will have different ideas in mind when they do provide their keywords. Further, journal practices regarding keywords differ too. Some limit them two three, others to five. Some journals provide a list of keywords from which authors have to choose, whereas others do not limit the number keywords. Nevertheless, we feel that investigating keywords helps us to specify what the literature does and where it is actually interested in.

In total, we encountered 670 different keywords in the sample of 263 studies. Appendix B lists all keywords encountered in this literature. We provide a summary of frequency and occurrence in Table . This table shows that the number of keywords used is very skewed indeed. We identified the usage 1090 keywords in total. This implies that on average a keyword is used in 1.6 cases only. There are five keywords (renewable energy, community energy, energy transition, climate change) that together account for 12% of the occurrences. There are 530 keywords that only appear once. This shows that of the 670 keywords, 79% appears just in one instance. These keywords make up almost half (namely 49%) of the total keyword occurrence.

The emergence of the study of energy communities can be held responsible for the extremely wide dispersion as 49% of the keywords provided is only used on one occasion in the literature. This implies that about half of the keywords is used in more than one article. But the distribution is very skewed: 83 keywords are used in two articles, which mean they occur in 166 occasions; 21 keywords are used in three articles, etc. The keyword used most ('renewable energy') was used in 52 articles. The keyword ranking second in this respect is 'community energy' and the third keyword is 'energy transition'. This leads us to conclude together these three dominant keywords qualify the main topic of this research domain. If the permutations with these keywords, as in 'community renewable energy' or 'sustainable energy', are grouped in clusters of similar keywords, this trend is even stronger. Worth mentioning are the keywords denoting theoretical outlooks, such as grassroots innovations, multi-level perspective, or niche management (each used in 9 articles).

In our view, the large number of keywords is very interesting as it shows that community energy studies relate to widely different issues. The lack of a clearly identifiable list of keywords in most studies also suggests that community energy studies is a field in progress and by far a coherent sub-discipline yet.

Table 3. (page 74) Occurrence of the number and percentage of keywords (The first column gives the frequency (F) of the keyword. The second column gives the keyword(s) used with this frequency in case it is at least five. In order to have a concise table, we did not include the keywords that were used less than five times, as this would result in 545 keywords. The third column has the number of keywords that appear with frequency F. The fourth column is the product of columns 1 and 3 and shows the occurrence of keyword(s) with frequency F. Column 5 relates this product to the overall number of keyword(s) with frequency F that occur in the literature (i.e. 1,090) as gives the percentage of occurrence of this keyword. The last column cumulates these percentages.)

3.4.2 Theoretical approaches

Community energy studies show a wide variety of theoretical approaches and is studied within social science disciplines such as sociology, social-psychology, economics, and social geography. Community energy organisations are examined from various angles. Local initiatives make use of existing technologies, adapt them to their needs and/or stimulate the development of new (variants) of technologies. Local energy initiatives are interpreted as a firm, organisation, an ad-hoc grouping of individuals, or as nodes in a regional network. Further, the individual members or initiators of community energy organisations are seen as moral agents, as end-users, as prosumers, entrepreneurs or voluntary workers. In addition, it has to be acknowledged that national and local policies can be an important incentive, but also a serious obstacle for community energy action. In several cities and regions, examples of energy and spatial planning are investigated. Van den Bergh et al. (2011) detected four main approaches in transition studies and encouraged researchers to elaborate on this. We did so for community energy and arrive at nine approaches being employed. Inspired by Turnheim & Geels (2012), we further cluster the nine approaches into

Table 3. Occurrence of the number and percentage of keywords.

Frequency of keywords (F)	Keywords (>5)	Number of keywords with frequency F	Occurrence of keywords with frequency F (column 1* column 3)	% occurrence of keywords with freq.F	Cumulative % of occurrence
(1)	(2)	(3)	(4)	(5)	(6)
1	530 words	530	530	48.62	48.62
2	83 words	83	166	15.23	63.85
3	21 words	21	63	5.78	69.63
4	11 words	11	44	4.04	73.67
5	Cities; energy efficiency; Germany; justice	4	20	1.83	75.50
6	Civil society; energy policy; local government; policy; sustainability; transition	6	36	3.30	78.81
7	Energy cooperatives; sustainable energy	2	14	1.28	80.09
8	Participation; sustainable development	2	16	1.47	81.56
9	Community renewable energy; energy; governance; grassroots innovations; multi-level perspective; strategic niche management	6	54	4.95	86.51
17	climate change	1	17	1.56	88.07
18	community	1	18	1.65	89.72
27	energy transition	1	27	2.48	92.20
33	community energy	1	33	3.03	95.23
52	renewable energy	1	52	4.77	100.00
		670	1090		

Table 4. Approaches in the community energy literature.
(Column 1 is the label of the approach. Column 2 reports the articles that are using this approach (number refers to number in corpus, Appendix A). Column 3 shows the number of articles that use this approach. Column 4 reports this number as a percentage of the total number of studies.)

Approach	Articles with the approach (numbers refer to the article in the corpus – see Appendix A)	Frequency (number of articles)	% of total sample
(1)	(2)	(3)	(4)
Transition	28, 30, 37, 44, 45, 73, 80, 82, 83, 86, 89, 90, 106, 107, 109, 115, 116, 129, 131, 140, 159, 160, 164, 174, 188, 207, 209, 210, 212, 219, 220, 221, 226, 239, 241, 242, 243, 244, 260	39	14.8
Science and Technology	11, 65, 110, 139, 175, 177, 178, 203, 206, 227, 245, 247, 248, 251	14	5.3
Economic	21, 23, 26, 27, 34, 49, 51, 53, 54, 56, 67, 68, 74, 88, 96, 104, 105, 113, 138, 147, 154, 166, 195, 198, 199, 225, 240, 261, 262	29	11.0
Acceptance	6, 17, 50, 58, 60, 69, 71, 77, 169, 183, 189, 191, 205, 211, 213, 217, 259, 263	18	6.8
Sociology	4, 5, 7, 9, 22, 24, 36, 63, 81, 94, 102, 108, 114, 120, 121, 122, 123, 124, 142, 146, 149, 153, 162, 163, 167, 173, 179, 181, 193, 194, 197, 204, 208, 222, 229, 232, 235, 238, 246, 249, 257, 258	42	16.0
Governance	8, 10, 14, 25, 29, 32, 33, 40, 41, 42, 43, 47, 76, 84, 85, 87, 97, 98, 103, 112, 117, 125, 127, 130, 143, 150, 151, 156, 157, 158, 161, 165, 170, 172, 176, 186, 187, 190, 201, 214, 218, 228, 236, 252, 253, 254	46	17.5
Planning	1, 13, 15, 19, 31, 46, 48, 55, 78, 79, 92, 95, 99, 101, 111, 128, 132, 134, 135, 136, 141, 144, 145, 152, 168, 171, 182, 185, 202, 223, 224, 230, 231, 233, 234, 256	36	13.7
Spatial	18, 39, 57, 61, 64, 66, 72, 196, 237	9	3.4
Norms	2, 3, 12, 16, 20, 35, 38, 52, 59, 62, 70, 75, 91, 93, 100, 118, 119, 126, 133, 137, 148, 155, 180, 184, 192, 200, 215, 216, 250, 255	30	11.4
		263	100.0

four societal domains: Sociotechnical arrangements, social-economic studies, political and planning studies, and socio-psychological motivations. This shows the interconnectedness of community energy organisations with global and local networks of human actors and technologies. In Figure 3, the nine identified approaches are divided over four societal domains. Here, we first investigate the theoretical and disciplinary approaches. Then, in section 3.4.3, we will connect these approaches to the keywords employed in community energy. In section 3.4.4, we will investigate which approaches are used to study community energy in the main countries of interest in the literature (i.e. UK, US, Germany, the Netherlands).
Our paper highlights frameworks that are used by more than five studies; smaller groups are clustered as will be described below. For each approach, we identify important studies, specific topics and typical keywords. Table lists the approaches, refers to the sample articles and shows the absolute and relative frequency of the approaches employed in the sample period. This table shows that most studies fall in the categories of Governance and Sociological studies. Together, they make up one third of all studies. Together with studies on Transition and Energy Planning, they make up almost two thirds of all 263 studies.

Transition studies (39 studies)

The community energy movement aims at the transition to a sustainable energy system. Therefore, we will start our categorization of approaches with Van den Bergh et al. (2011), who identifies four broad clusters of systemic approaches: innovation systems, multi-level perspective (MLP), complex systems and evolutionary systems. These approaches use specific key concepts and have a related policy view. However, Van den Bergh also recognizes that the boundary between approaches is not very sharp and that there is considerable overlap in concepts. The group 'Transition studies' combines studies drawing on Evolutionary systems (3 studies), Grassroots Innovation (6 studies), Innovation systems (3 studies), Multilevel perspective (17 studies) and Strategic Niche management (12 studies). The group contains 39 articles. It appears that the phenomenon of community energy so far does not attract much interest from researchers using Innovation systems and Complex systems as a framework, while Evolutionary systems also is used scarcely to analyse community energy. A much more popular systemic approach in this respect is the multi-level perspective (MLP), which was grounded by Geels (2002, 2011). From this approach strategic niche management (SNM) was derived, to apply MLP in policy development (Schot & Geels, 2008). In our sample, several authors conceptualize local communities as a niche, a protected space that according to the MLP scheme will influence the current regime. Seyfang et al. (2014)/c208 position communities as a specific niche:

‘grassroots’. The grassroots metaphor has attracted new followers, for example Martiskainen et al. (2017)/c159 study leadership in community energy, and in (Martiskainen, Heiskanen, & Speciale, 2018)(c160) they position grassroots innovations as forms of political engagement. Yalcin-Roillet studies grassroots initiatives in France. Furthermore, Fudge et al. (2016)/c86 focus on local governments and their activities in the role of niche actors. The second level in MLP is called ‘regime’, consisting of clusters of incumbent actors, institutions and policies that protect the status quo. Berlo et al. (2017)/c30 take this perspective in a study of the German Energy regime. An attempt to combine Social Practice Theory with MLP is performed by Hargreaves et al. (2013)/c107.

Science and Technology studies (14 studies)

Studies focusing in particular on the interaction between technology and human actors or users are listed as a separate group, namely Science and Technology studies (STS). They typically take socio-technical configurations as their starting point. This group contains 14 articles. For example, Palm (2006)/c177 investigates municipalities, focusing on power in the policy process of energy systems, understood as a Large Technical System. Palm et al. (2016)/c178 use the concept of the ‘system builder’ to study municipally owned energy companies in Sweden. Strunz (2014)/c227 studies the German energy transition as a regime shift from a fossil-nuclear – to a renewables-based energy system, setting the resilience framework as an alternative (non-linear and non-hierarchical) for the MLP. Hauber & Ruppert-Winkel (2012)/c110 study socio-technical change and identify three phases of regional energy transformations: pioneer phase, pivotal network phase and extended network and emerging market dynamic phase.

Socio-technical configurations also are the departing point for Walker & Cass (2007)/c249 in their study of the multiple roles of ‘the public’ in renewable energy implementation. Energy technology ‘hardware’ comes in different sizes and can be categorized in five ‘modes of implementation’: public utility, private supplier, community, household and business. They relate these modes and technologies with underlying discourses, size, management and infrastructural aspects. The meanings of community renewables are further explored by Walker & Devine-Wright (2008)/c250, evaluating how we can understand dimensions of process and outcome of community renewable energy projects. Van der Schoor & Scholtens (2015)/c203 investigate 13 cases of local community energy initiatives, evaluating their activities against dimensions of relations with outside networks and commitment of local actors as proposed by Law & Callon (1992). Ornetzeder & Rohracher (2013)/c175 explore the possibilities of user participation in the development of sustainable energy technologies. They investigate cases where local user groups were instrumental in both development and dissemination of solar collectors and biomass heating systems. Viitanen et al. (2015)/c245 report on two low-carbon communities, where ICT systems are used to facilitate community-based governance of energy, involving users as active agents in design of the systems.

Economic studies (29 studies)

The third group we identify consists of 'Economic studies', which take the economic aspects of community energy as their starting point. These studies usually focus on the economic, social and financial viability of community energy projects and go into the market share of renewable energy in relation to the domestic power or primary energy markets (e.g Blokhuis et al. (2012)/c34, Del Rio & Burguillo (2008)/c67, Steenhuisen & de Bruijne (2015)/c225. Topics that are investigated include energy network companies and utilities (Blokhuis et al., 2012)/c34, (Heiman & Solomon, 2004)/c113, (Graichen, Requate, & Dijkstra, 2001)/c96), economic benefits (Hanley & Nevin, 1999)/c105, (del Río & Burguillo, 2009)/c68, (Callaghan & Williams, 2014)/c49, organizational design (Kunze & Busch, 2011)/c147), business studies (Chen, Duic, Manuel Alves, & da Graça Carvalho, 2007)/c56), and economic-sociological analysis (Rydin et al., 2015)/c198. Investigating the type of 'firm' community energy initiatives constitute, Yildiz et al. (2015)/c262 compare local cooperatives with investor-oriented firms. Becker et al. (2017)/c23 interpret community energy initiatives as social entrepreneurs, analysing ownership and organisation types, while Magnani et al. (2017)/c154 study the initiatives as 'ecopreneurs'. Lastly, Sagebiel et al. (2014) /c199 investigates if consumers are willing to pay for energy produced by community cooperatives. This group combines economic studies and business analysis (27) and studies based on alternative economic views e.g. localism (2). The group contains 29 articles.

Acceptance perspective (19 studies)

Studies from environmental psychology have investigated specific behavioural aspects and drawn our attention to the acceptance of renewables. In our view, this approach is not only a research topic, but is used to categorize phenomena primarily on the dimensions of acceptance and resistance as well. In relation to community energy, the main question in this acceptance perspective is if community engagement increases acceptance of renewable energy projects. The influence of community benefits on acceptance is investigated by Wüstenhagen (2007), Wolsink (2012a) and others. Simpson (2018)/c217 compares two communities in Australia, analysing the role of champions in social acceptance of solar energy. Reusswig et al. (2016)/c191 investigate local opposition in the small town of Engelsbrand in Germany, using discourse analysis to study local conflict dynamics. In this group we combine studies into acceptance (14) as well as resistance/ NIMBY studies (5), which fit our criteria listed above. The group contains 19 articles.

Sociological approaches (42 studies)

Topics that are investigated in the sociological studies are capacities of local actors Middlemiss & Parrish (2010)/c162, development of community initiatives, organisation, and social networks. Van Veelen (2017)/c238 develops a community energy typology to position the Scottish community energy sector. Bauwens et al. (2016)/(c22) examines factors that foster community participation, relying on Ostrom's socio-ecological system framework. Some studies start from 'grounded theory', forming their own theoretical views on the basis of qualitative methods (Hielscher et al., 2013). Kunze & Busch (2011)/c147 investigate seven rural energy projects and identify nine ideal types of technology application, according to their technical, financial and social complexity. Wüste & Schmuck (2012)/c258 perform a qualitative interview study, looking for the success factors for the implementation of bioenergy villages. Still others draw on future studies (1), social movement studies (3) or perform evaluation research (5). Another relevant theoretical framework in this group is Social Practice Theory (SPT), which looks how social practices, such as cooking, driving or showering, evolve over time. SPT is applied to community energy by Shove et al. (2010) and Hargreaves et al. (2013)/c107. We group these social studies under the heading of 'Sociological approaches'. This somewhat eclectic group of studies contains 42 articles.

Governance studies (46 studies)

Policy and governance on the municipal or regional level is another important strand within the community energy literature. Many studies pose the question about how to govern the new relations and opportunities that come with the transition to a renewable energy system, especially when this also entails the shift to a decentralized system. Major themes in this literature are the new roles of local government, relations with private actors and the existing energy sector, relations between different levels of governance, and the participation of citizens in municipal governance. It shows that with 46 studies in the corpus, governance is the approach used most in the community energy literature.

The (new) role of local governments is the subject of for example Fudge & Peters (2009)/c85, who report on a study of local government, who encourages community led sustainable development objectives, following several national policy frameworks. This study investigates the problems in relation to the increasing responsibilities of local governments in this respect. It remains problematic for local governments to foster an effective level of civic engagement. It turns out that key players, such as mayors, can be of great importance for local energy policies (Busch & McCormick, 2014)/c47. Practical renewable energy policies are more relevant to mayors than abstract considerations of climate change or national power supply. According to Monstadt (2007)/c165 new policy approaches and institutional reforms are needed to reshape the local energy system in order to provide for local and regional sustainability needs. To this end, Mårtensson & Westerberg (2007)/c158 identify three strategy models in their study of municipalities (see also Berkhout & Westerhoff (2013)/c29, who identify a lack of integration across scales, which leads to legislative barriers at the local scale). Should municipalities take back ownership and control of local energy provision? In this respect, Becker et al. (2015)/c25 report on this trend of so-called remunicipalisation, which could lead to new forms of urban and energy governance. How energy governance should be organized in the case of collaboration with private sector organisations is investigated by Heldeweg et al. (2015)/c117 in a study of a biogas grid. Safeguarding of public standards and interests is important in these kind of projects, while retaining the advantages of collaboration with private parties. Institutional space of community initiatives is investigated by Oteman et al. (2014)/c176. National configurations of the energy sector strongly influence the institutional space for community initiatives. In Canada, although there certainly is potential for community energy, macro-level politics pose significant challenges, according to MacArthur (2017)/c151. Alignment of discourses between government levels and actors shows to be an important factor in creating opportunities for community initiatives. Higher-level government support is deemed necessary for further development of community energy in Australia, see Mey et al. (2016)/c161. However, Arentsen & Bellekom (2014)/(c10) predict that local initiatives will remain small-scale niches and will have no major impact on the energy system as a whole. National policies in relation to local energy transitions are investigated by Granberg and Elander (2007)/c97, Poupeau (2014)/c187, Hall et al. (2016)/c103, and Bulkeley & Betsill (2013)/c43.

Energy planning (36 studies)

In this approach, we have grouped 36 articles which investigate municipal or citizen-led energy plans in cities, regions or smaller communities. Jaccard et al. (1997)/c136 explain that the concept of community energy planning (or energy management) combines urban planning concepts with energy management concepts. For example, the design of liveable cities (see also Tozer (2012)/c233 and Krupa et al. (2013)/c145. Ivner et al. (2010)/c135 describe the application of a decision-making model for energy planning. Gustafsson et al. (2015)/c101 report on experiences of 60 participants in a municipalities program initiated by a national agency, concentrating on energy plans and strategies (see also Nilsson & Mårtensson (2003)/c171 and Sperling et al. (2011)/c223. Community energy planning is a complex and time-consuming process, argues Petersen (2016)/c182, which can be supported by methodologies that help to develop energy system variants. Collaborative approaches to energy planning, involving both municipalities and community organisations, are compared for UK and US by Pitt & Congreve (2017)/c185.

Planning for energy autarky is analysed by Madlener (2007)/c152 in a study into wood fuel utilisation for district heating, describing diffusion of biomass heating systems. Schmidt et al. (2012) couple regional energy data with land use information to model energy demand and potentials for biomass supply, striving for energy autarky (see also Abegg (2011)/c1 and Müller et al. (2011)/c168. Further, it shows that multi-criteria Decision Analysis (MCDA) is often used for energy policy analysis to compare renewable energy systems. For example, Wilkens & Schmuck (2012)/c256 study the creation of a bioenergy village (see also Trutnevyte et al. (2011)/c234), Burton & Hubacek (2007)/c46.

Spatial design studies (10 studies)

Spatial planning and design has landscape design and land use as its primary focus. It shows that there are 10 articles in this category.

According to Crawford and French (2008)/c61 spatial planning involves governance, policy and organisation issues, as well as technical analysis and design. Coenen et al. (2012)/c57 contributes an economic geography perspective to sustainability transitions. Socio-technical developments are embedded within territorial spaces of multiple scales. The geographies of the energy transition in relation to the low-carbon economy are also examined by Bridge et al. (2013)/c39, who discusses the spaces and places of a low carbon future. They suggest six concepts: location, landscape, territoriality, spatial differentiation, scaling and spatial embeddedness. Van den Dobbelsteen (2011)/c72 uses Energy Potential Mapping for developing spatial plans to develop an energy-productive area. This study uses insights from energy planning for spatial design. Barton (1998)/c18 reviews projects that aim to develop self-sufficient (eco-)neighbourhoods. His conclusions are that community-led projects show the best results, in comparison with municipally led plans, while market-led plans have achieved only limited success. De Waal and Stremke (2014)/c66 explore the challenges and opportunities that the energy transition poses to landscape architects, and how landscape architecture can contribute to the energy transition. They propose the integrative concept of 'sustainable energy landscapes' as a meeting ground for landscape architecture, other disciplines ad local communities. Spatial impacts of small-scale renewable energy are investigated by De Boer et al. (2015)/c64.

Norms and values (30 studies)

What meanings, discourses and values are important in the community energy discourse? How are problems framed and how are justice and equity safeguarded in community energy developments? These are the issues studied by a group of articles which is called 'Norms and values' and contains 30 articles. This group is closely related to the studies in Table belonging to 4. Acceptance and to 5. Sociological approaches. However, the focus on concepts and meanings sets these studies apart.

Especially aspects of justice are investigated in this literature, such as recognitional and distributive justice. Energy and justice is the subject of Catney et al. (2013)/c51, who investigate knowledge networks, and argue for affording greater 'recognitional justice' to different social groups. Costello et al. (2011)/c59 highlight that -next to sustainability principles- also procedural and distributive justice are important principles that should guide an effective governance process. Equal opportunities for communities presently lack policy attention with community energy projects, is argued by Park (2015)/c180. Adams & Bell (2014)/c2 assess equity and risks in local energy generation projects, testing an energy equity assessment tool in two villages. Simcock (2013)/c215 explores how the justice principle of 'those affected' was utilised to make claims about the fairness of boundaries of two community wind projects. The environmental justice framework is applied by Breukers et al. (2017)/c38 in a study of participation in deprived neighbourhoods. Especially on the topic of justice there is some overlap with the Acceptance approach, where it is expected that better attention to justice will increase public acceptance.

The concept of 'carbon capability', which refers to the meanings, knowledge and skills associated with energy and climate, is explored by Whitmarsh et al. (2011)/c255. This survey shows that carbon capability in the general public is limited, both in individual day-to-day decision-making and in civic and community engagement. The concept of community, its narratives and rhetoric, is examined by Aiken (2012)/c3 and Bailey et al. (2010)/c12. Mälgand et al. (2014)/c155 study how the transition movement ideology created the 'constructed landscape' of a transition initiative. Environmental concern and place attachment are important for similar grass-root initiatives. Phillips & Dickie (2015)/c184 investigate carbon dependency, awareness and actions in four villages, focusing on the way that narratives account for the gap between awareness and action. They find five narratives of non-transition or stasis, and three narratives of transition. Eaton et al. (2014)/c75 study sociotechnical imaginaries of bioenergy, with empirical material from four northern Michigan communities. Collective action frames are developed to account for differing meanings and interpretations of woody biomass usage. Bomberg & McEwen (2012)/c35 did a qualitative study of 100 community energy groups and apply resource mobilization theory to energy studies, and identify two sets of resources: structural and symbolic. The motives of individual consumers to generate their own electricity are investigated by Leenheer et al. (2011)/c148); environmental concerns prove to be the main driver, next to affinity with technology and energy and the reputation of electricity companies.

Public values are the subject of a study by Hoffman et al. (2013)/c124. Community energy programmes often generates a lot of local debate about the development process, the choice of technology, and the spatial siting of the project. Findings include that a bottom-up approach is likely to foster community dialogue, while a top-down approach can reach behavioural impact.

3.4.3 Keyword identifiers and theoretical approaches

For each of the nine approaches discussed in section 3.4.2, we investigate what typical keywords are used. Of course, the more general keywords and identifiers appear in all approaches, but here we want to investigate what makes a particular approach special. This helps us to identify the focus of the respective approach. To this extent, in Table 5. we list typical keywords that refer to specific theoretical concepts related to the identified approaches. Please do realize that these are not the keywords that are used most, because the most frequent keywords tend to be connected to the dimensions of our topic, i.e. climate change, community and renewable energy.

The keywords of Transition studies (group 1 in Table 5.) show a strong connection to its related theoretical frameworks and accompanying concepts, such as multilevel perspective, niches and regimes. The Science and Technology group (2) favours socio-technical configurations, technology assessment and user-led innovations, reflecting less deterministic and more bottom-up concepts. The Economics group (3) relates to keywords related to topics such as ownership, companies, utilities, but also critique on neo-liberalism. The Acceptance approach (4) has acceptance, resistance, but also public awareness, public opinion as keywords. Sociological approaches (5) show keywords related to organisation and process, while participation and agency also refers to the bottom-up actions of citizens. Governance (6) keywords show the institutional and governmental aspects, for example in citizenship, authorities and governance. Energy planning (7) has a strong systematic perspective and includes concrete technology choices and calculations. Spatial design (8) has typical keywords relating to landscape, urbanism and spatial and urban planning. Norms and values (9) relate to public values, public sphere, and trust. In addition, justice related keywords such as justice, equity are typical for this group.

This analysis shows that the approaches are quite distinct indeed, as the keywords reflect specific research interests and perspectives in the study of community energy. The variety of perspectives contributes to the richness of the literature.

Table 5. Typical keywords used in theoretical approaches

Approach	Typical keywords
Transition studies	Energy transition, grassroots innovation, niches, regime, path dependence, energy innovation systems, socio-technical transitions, multilevel perspective, strategic niche management, innovation
Science and Technology	Socio-technical configurations, socio-technical change, constructive technology assessment, user-led innovations
Economic	Economics, markets, neoliberalism, economic development, impact, utilities, companies, ownership
Acceptance	Social acceptance, engagement, environmental awareness, public opinion, resistance, justice
Sociology	Social capital, participation, processual analysis, social resilience, change, environmental awareness, agency and capacity, organisation
Governance	Governance, institutional arrangements, environmental citizenship, local authorities, local government, collaborative planning, interactive governance
Planning	Energy planning, energy strategy, public participation, energy management, energy policy, community energy planning, municipal energy plans
Spatial	Spatial planning, landscape architecture, urban planning, eco-urbanism, resilience, regional development, sustainable urban development, geography
Norms	Justice, equity, public values, public sphere, procedural and distributive justice, trust, risk, social impacts

3.4.4 Country perspectives and theoretical approaches

We also want to find out whether studies after community energy in different countries investigate different topics or use different approaches. This pertains to the role of country specifics. This might be relevant because of the role of communities. In particular, their degrees of freedom to engage in energy transition, the role of renewable energy, and institutional settings differ among the countries studied. To find out, we grouped the literature according to theoretical approaches by country. We first discuss the literature regarding the countries studied most, and then we provide a comparative assessment. In this respect, we focus on four countries: UK, Germany, US, and the Netherlands. Please recall that almost 70% of the case studies investigate community energy in at least one of these four countries (see Section 3.3, Figure 5).

The *United Kingdom* (UK) is by far the country studied most; no less than 99 studies investigate community energy in the UK. The MLP approach is used in eight studies after the UK. Especially the concept of niches engenders several studies (for example (Seyfang et al., 2014)/c208). Here, local energy initiatives are conceptualized as niches, which according to MLP theory can eventually influence the energy system. This niches approach is challenged by Middlemiss & Parrish (2010)/c162, pointing to the need for communities to have resources and power to adequately influence the energy regime. North (2011)/c173 further investigates the power of 'green niches' in his study after social movements and climate activism. Linked to the niche approach is the concept of grassroots, which is however almost exclusively used by Seyfang et al. (2007)/c210. Walker & Cass (2007)/c249 critically reflect on the rigidity of the concepts of niches and regimes, proposing the term 'mode' instead, allowing for a greater heterogeneity. The impacts of community energy for the local economy is investigated for Scotland (Callaghan & Williams, 2014)/c49 and compared to the economic impacts in other countries (Kunze & Becker, 2015)/c146 and (Rydin et al., 2015)/c198. Sociological studies are developed quite well with investigations of a range of cases throughout the UK (Alexander et al., 2007)/c7, (Gormally, Pooley, Whyatt, & Timmis, 2013)/c94, studies of the capacities of local initiatives (Middlemiss & Parrish, 2010)c162) as well as specific studies into networks or support organisations (Parag & Janda, 2014)/c179. Other studies deepen our understanding of the concept of community (Parkhill et al., 2015)/c181, (Walker, 2011)/c248, (Walker, Devine-Wright, Hunter, High, & Evans, 2010)/c251). Saintier (2017)/c200 argues that to achieve energy justice prosumers and community actors should receive more recognition and policy support in the UK as well as the EU. In projects of shared ownership community actors and companies experience a lack of trust, as Goedkoop & Devine Wright (2016)/c93 show. They conclude that trust-building mechanisms are required for shared ownership to become conventional practice.

In *Germany*, the phenomenon of community energy is studied from a wide variety of angles. Especially the Energiewende, in relation to local initiatives, is a growing research niche (Timothy Moss, Becker, & Naumann, 2014)/c167,/c228). Beveridge & Kern (Beveridge & Kern, 2013)/c32 outline the development, policies and future challenges of the Energiewende. Several sociological studies used a grounded theory approach (Hauber & Ruppert-Winkel, 2012)/c110, (Kunze & Busch, 2011)/c147, c259. Some studies after the German energy communities, such as Hauber et. Al (2012)/c110, are critically reflecting on MLP as a framework. For example, Strunz (2014)/(c227) contrasts MLP with a resilience framework, thus highlighting aspects of interrelations between scales that have been underrated in the literature due to MLP dominance. Sühlsen & Hisschemöller (2014)/c228 use an MLP-perspective to study the 'big four', the incumbents' lobbying activities. They argue that the renewable energy sector in Germany is no longer a niche, but is incorporated in the energy regime. Others are using Strategic Niche Management or MLP as theoretical approach ((Hoppe, Graf, Warbroek, Lammers, & Lepping, 2015)/c129, (Koehrsen, 2015)/c140, (Viétor, Hoppe, & Clancy, 2015)/c244. A relatively large proportion of papers in Germany is devoted to economic aspects of community energy. Hall et al. (2016)/c104 discuss the role of financing institutions in relation to community energy, comparing Germany and UK. Doci & Gotchev (Dóci & Gotchev, 2016)/c74 research energy communities as new investors. They compare the risks, opportunities and support structures in Germany and the Netherlands. The economy of renewable energy cooperatives is investigated by Yildiz et al. (2015)/c262) and Kunze & Becker (2015)/c146. Sagebiel et al. (2014)/c199 examines if consumers are willing to pay for energy produced by local cooperatives. Perspectives on community energy projects as (social) entrepreneurs are used by Lastly, the acceptance of local renewables in relation to environmental justice is investigated by Schweitzer-Ries, et al. (2008)/c205 and Zoellner et al. (2008)/c263.

In the *United States*, renewable energy plays only a minor role, according to Heiman & Solomon (2004)/c113. Klein & Coffey (2016)/c138 compiled a database of community energy projects in the US and propose a classification scheme based on financial model. Federal government policies to promote energy efficiency and renewable energy use have been limited (Pitt & Congreve, 2017, p. 281)/c186), and, as a result, local approaches to clean energy are particularly important. This is reflected in the division over theoretical approaches, where energy planning and governance issues are studied most. Citizen participation is an important strand in the literature from the US. Hoffman & High-Pippert (2010)/c126 focus on the ways to recruit members for local initiatives and sustaining their participation.

They further explore civic culture in a collection of case studies in Minnesota, with a view to develop a social architecture for community management of renewable energy technologies (Hoffman, High-Pippert, Peters, & Fudge, 2005)/c125. Furthermore, Hoffman et al. (2013)/c124 study cases in the UK and the USA focusing on public values and public participation, comparing institutionally-directed programmes with citizen-led initiatives. Berry (2013)/c31 extensively studies the energy programs of community organizations in Arizona, focusing on organisational capabilities. Morris (2013)/c166 analyses emerging energy initiatives in Washington DC, focusing on the elements of ownership, governance and sustainable urban place making, which she connects to the theme of 'localism'. Collaboration between local governments and citizens is investigated by Hawkins & Wang (2012)/c112, relating citizen participation with municipal management and support networks. Pitt & Bassett (2014)/c186 executed a survey of 381 small to mid-sized cities in the US, in order to investigate clean energy policies. Another study after cities, investigating Climate Action Plans (CAPS) is executed by Bassett & Shandas (2010)/c19. Specific local case studies are undertaken across the US in Pennsylvania (Feder, 2004)/c78, California (Weil, 2013)/c253, Illinois (Gasteyer & Carrera, 2013)/c88, Texas (K. Hughes, 2009)/c132 and Michigan (Eaton et al., 2014)/c75. Feliciano & Prosperi (2011)/c79 reflect on low carbon cities, especially focusing on the role of different levels of government, with Broward County, Florida, as empirical case study. Electricity utilities are responsible for 41% of CO_2 emissions in the US. So, how can utilities integrate renewable energy and consumer's choices in their policies? The incumbent electricity utility industry is investigated by Heiman & Solomon (2004)/c113. They compare state policies for renewable sources and discusses green demand and the role of non-profit publicly owned utilities. Byrne et al. (2009)/c48 investigate ideas for a Sustainable Energy Utility (SEU) as a new institutional and community strategy.

In *The Netherlands*, where the MLP approach originated (Verbong & Geels, 2007)/c242), Doci et al. (2015)/c73 investigates the contribution of local energy initiatives as to energy transition. These initiatives are niches, defined as protected spaces for innovation. They stress that these cooperatives are not aiming at technological innovation, but introduce social innovations and new energy production practices. Bosman et al. (2014)/c37 analyse discourses in the energy regime, concluding that there are conflicting storylines within the incumbent regime, which might indicate regime dynamics. The storyline relating to decentralized energy for example is varying widely between regime actors, indicating uncertainty within the regime. Social Practices Theory is used as perspective by Van Vliet et al. (2012)/c239, studying the influence of the Smart Meter on energy related practices in the household. The effects of varying regional policies are investigated by

Warbroek & Hoppe (2017)/c252, who compare two Dutch provinces. Socio-technological studies include De Vries et al. (2016)/c65, who focus on user innovations in civic energy communities. If the share of prosumers continues to grow, how will this effect local grids and network management? Bellekom et al. (2016)/c26 suggest that DSOs and energy communities could cooperate in the development of new business models.

To wrap up, regarding the countries studied, the high amount of studies executed in the UK is striking, although Germany is catching up quickly with a host of studies investigating the Energiewende. As the development and impacts of community energy undertakings are quite dependent on local cultural and political conditions and policies, it seems to us that it is important to replicate studies outside the UK. Furthermore, the phenomenon of community energy as such is not equally prevalent in all countries in our sample.

Regarding the country division of the approaches, it is remarkable that the Transitions approach is rather popular in the UK and NL, while in Germany (GER) a broader group of frameworks is used. In Figure 5, the geographical distribution for our corpus showed that the majority of studies investigated the UK, with NL and GER coming after that. In the US, the majority of articles involves case studies with a governance or energy planning perspective, which relates to the relative absence of federal energy policies.

Table 6 shows the use of the approaches at the country level. We report for the four countries studied most (UK, Germany, the Netherlands, US) and group all remaining studies as Other. The last two columns show the total use of each approach and are identical with Table 3. Table 6 shows there are remarkable differences at the country level though. With studies for the UK, it shows that the sociological perspective is used most, and the norms perspective is second. Together, these two approaches are used for 40% of the studies for the UK. In contrast, studies on the US mainly relate to Energy Planning and Governance. Combined, these make up more than 55% of the US studies. For Germany, the Economic approach is used most, followed by the Governance approach. Together, these two are used in almost half of all studies on Germany. For the Netherlands, it is Transition Studies and Governance which is used most; together almost 50%. For the other countries, it shows Energy Planning and Governance combined make up about almost 40% of the studies.

3.5. Conclusion

The community energy literature studies the production and distribution of especially renewable and sustainable energy at the level of neighbourhoods, small communities and municipalities and specifically accounts for the contribution of these entities. This sets this literature apart from the

Table 6. Approaches by country

(This table reports the theoretical approaches at the country level. In bold it features which approach is used most within this country (respectively other and total). The numbers under the heading # relate to the number of studies that use the particular approach. The numbers under the heading % relate to the percentage of the studies using a particular approach in relation to the total number of studies after this country (respectively other countries and total).

	Approach	UK		GER		US		NL		Other		Total	
		#	%	#	%	#	%	#	%	#	%	#	%
1.	Transition st.	12	15,0	6	15,0	1	4,3	6	24,0	14	14,7	39	14,8
2.	Sci and Tech.	5	6,3	3	7,5	0	0,0	2	8,0	4	4,2	14	5,3
3.	Economics	3	3,8	11	27,5	4	17,4	3	12,0	8	8,4	29	11,0
4.	Acceptance	7	8,8	4	10,0	0	0,0	0	0,0	7	7,4	18	6,8
5.	Sociology	18	22,5	5	12,5	3	13,0	2	8,0	14	14,7	42	16,0
6.	Governance	9	11,3	8	20,0	6	26,1	6	24,0	17	17,9	46	17,5
7.	Energy plan.	8	10,0	2	5,0	7	30,4	1	4,0	18	18,9	36	13,7
8.	Spatial sci.	4	5,0	0	0,0	0	0,0	2	8,0	3	3,2	9	3,4
9.	Norm	14	17,5	1	2,5	2	8,7	3	12,0	10	10,5	30	11,4
		80	100	40	100	23	100	25	100	95	100	263	100

technological studies after the transformation of the energy system (Bagozzi, 2015). The community energy literature relies on a wide array of approaches and studies communities in a wide range of countries and regions. This literature has taken off about ten years ago and focuses on the interchange between power generation and distribution, social networks and local institutions. In this paper, we analyse this literature regarding community energy. Based on relevant criteria, we ended up with 263 studies, which appeared in academic journals in the period 1997-2018. The majority of the studies on community energy were published from 2012 to 2017, which proves that it is a relatively new area of research. This is also witnessed by the huge dispersion of keywords. Of the 530 keywords listed with the articles by the authors themselves, it shows that half of them are used only once in the 263 articles. We observed that the articles appeared in 82 academic journals. But the outlets of the articles were highly concentrated with Energy Policy publishing one fifth of all the articles. And 51 journals so far published just one single article on community energy in the period under review. We focused on case studies and establish that most of them investigate the UK, namely one out of three studies. Together with studies about the US, Germany, and the Netherlands, they make up almost 70% of all cases. We also relate the articles to the theoretical approaches employed. Here, it shows that there is a wide variety in approaches used to study community energy. However, four out of nine approaches, governance studies, energy planning, transition studies, and sociological approaches, make up two thirds of all the studies.

We conclude that the study of community energy is still in its infancy as there is little commonality in the terminology and key concepts used Moreover, the topic lacks consensus about appropriate theories and common methodologies. Further, the number of outlets is very limited at this stage and the debate is concentrated in a limited number of journals. As mentioned in the introduction, our study is not the first to reflect on the community energy literature (Beynaghi et al., 2015; de Boer et al., 2015; Fast, 2013; Rae & Bradley, 2012; Van Den Bergh et al., 2011; Wolsink, 2012a; Yildiz et al., 2015). However, we add value by offering a much more encompassing perspective by systematically analyzing the development of this literature from its beginnings to 2018. Further, we contribute to the existing reviews by interacting the approaches used in the literature to the key interests of the studies as revealed by the keywords. We also relate the approaches used to the main countries studied. This leads to novel and interesting insights from which future research may depart.

The expected or conceivable quantitative contribution of community energy to the energy transition is another topic that is lacking attention from social research. Similarly, the many case studies of municipalities and specific community projects could be supplemented with investigations of the interrelations between local and national policies. Correlation between national energy policies (or the relative absence thereof) and the breadth and impact of community energy is apparent. Therefore, comparative country studies, such as the study of Oteman et al. (2014), regarding the effects of national policy and institutions on the opportunities for community energy, merit more attention in the literature. Also, studies after community energy in non-developed countries would be very welcome as these are not included in the corpus.

Community energy is studied from a variety of perspectives, delivering insights that range from individual motivations of members to join these groups, the organisation of local community initiatives, their relations with local governments, regional support organisations and networks, to national policies that aim to stimulate decentralized community owned energy production. Studies using MLP have opened significant avenues of studies, conceptualizing community energy as a niche phenomenon. However, MLP as well as the other approaches will have to specify and develop in order to understand and explain community energy. Further, we feel there is room to further reflect on the agency that is employed by local communities and how bottom-up changes in the energy structure occur. We argue that the study and practice of community energy could benefit from a transdisciplinary research approach, which integrates perspectives of multiple academic disciplines and non-academic stakeholders. Moreover, this could lead to policy development that is science-based and practice oriented.


energy
renewable
community
local
transition
governance
climate
development
change
sustainable
social
policy
planning
lowcarbon
management
electricity
public
grassroots
systems
niche
network
system
strategic
multilevel
decentralised
research
regional
analysis
production
rural
District
identity
green
United
supply
impact
solar
behaviour
mitigation
organic
leadership
theory
longterm
geographies
norms
economics
assessment
equity
design
civil
citizen
trust
plan
agency
risk
land
bottomup
civic
activism
actors
business
space
model
growth
dynamic
urban
groups
processes
state
power
work
scale
UK
conflict
cities
wind
user
biogas
heat
carbon
smart
utility
grids
service
Action
conservation
small
water
peak
autarky

Part II
Energy communities

4. Challenging obduracy : how local communities transform the energy system

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Abstract
Arguably, the transformation from the current energy system to a decentralized renewable energy system requires the transformation of communities into energy neutral or even energy producing communities. Increasingly, citizens become 'prosumers' and pool their resources to start a local energy initiative. In this paper, we present an in-depth study of networks that recently developed, which challenge the established way of centralized decision-making on energy resources.

Many local communities are eager to promote sustainable energy production, to use local financial resources for the local community and to employ democratic governance of energy production and supply. Furthermore, we study how these co-operations are linked to local, regional and national networks for community energy.
We use both Actor-Network Theory (ANT) and Social Movement Theory (SMT) to investigate the initiatives, as this allows a dynamic analysis of collective strategies.

We discuss the obduracy of the energy system and how this system is challenged by new connections between communities and global networks and by new types of energy providers that are rooted in social networks. Furthermore, we draw attention to the way community energy networks provide a social innovation while realizing a decentralized and decarbonized energy system.

Keywords: community energy, cooperatives, renewable energy. energy transition

4.1. Introduction

The transition to a sustainable energy system entails the mobilisation of local communities and local production of renewable energy. This is a technical challenge, but also, and in particular, requires new social, economic, financial, cultural and political arrangements (Hargreaves, Longhurst, et al., 2013; Walker & Cass, 2007). Many cities, towns and villages have already put together ambitious visions about how to become 'energy neutral', 'zero-emission' or 'low carbon'. In several European countries, such as the Netherlands, Germany and the UK, we observe a rapidly growing number of local citizens groups that aim to stimulate local energy production capacity on an individual as well as cooperative basis (Musall & Kuik, 2011; Walker, 2008). On top of this ambition, many citizens try to organize the governance of energy production on a more democratic basis; they contend that the future energy system should not only be sustainable, but also decentralized and democratically governed. Citizens want to have democratic control over energy investment decisions, in order to ensure that these investments are made into renewable energy production. According to some observers, this signals a trend contrary to developments in the past few decades, where governance of energy production has gone in the opposite direction, from the hands of local and regional governing bodies to international companies (Wolsink, 2012b). This combination of developments raises questions about how local initiatives are able to connect vis-à-vis the countervailing forces of established parties and arrangements.

In a European perspective the Netherlands is very much in the rear-guard with only 4% of electricity production coming from renewable sources.[7] Domestic heating is primarily based on the use of natural gas from the Groningen field, in the North of the Netherlands. However, extraction of these gas resources increasingly leads to earthquakes in the region, necessitating the quest for alternatives. Hence, especially the Dutch energy system will have to face a substantial transformation.

In this paper we investigate the recent attempts of local Dutch communities to challenge the present energy system and to find new ways of organising and governing energy production. Recent developments in the Netherlands show signs that local initiatives are forming new regional clusters, which could contribute to the scaling up of local attempts and thus to mainstreaming renewable energy. In this process they have to overcome economical, technological, political and physical constraints or 'obduracies'.

This paper builds on recent claims that local energy cooperatives provide an alternative model for the governance of energy resources (Hargreaves, Hielscher, Seyfang, & Smith, 2013; Hielscher et al., 2013). We argue that the described new regional networks are an understudied, yet crucial element to organize the production and distribution of energy in a democratic and sustainable way, and as such contribute to the wider process of grassroots innovation, as defined by Hargreaves et al. (2013). Our theoretical contribution is the combination of SMT and ANT in the

7 http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Share_of_renewables_in_gross_final_energy_consumption,_2012_and_2020_(%25)_YB14.png

analysis of recent attempts to decentralize and decarbonize the energy system. In this way, we also contribute to the existing literature focusing on local energy initiatives as well as to the critical reflections regarding the conventional energy system.

The remainder of this paper is organized as follows. First, we discuss the studies of local energy initiatives (section 4.2). The theoretical section (4.3) will introduce the concepts from ANT and SMT and present the theoretical backbone of our approach. In section 4.4 we introduce our research design and methodology, and describe our case, especially the background, formation and goals of the newly formed regional energy co-operations. Furthermore, we investigate the linkages of local initiatives to existing regional and national networks, including environmental movement organisations and village support organisations. In section 4.5, we analyse the new intermediary energy networks, and their relation to local and global networks. In section 4.6 we discuss the findings of our case study and relate them to the literature.

4.2. Studies of energy communities

Increasingly the varying roles of citizens regarding energy consumption and production have caught the attention of researchers (Arentsen & Bellekom, 2014; Devine-Wright, 2006; Hielscher et al., 2013; Musall & Kuik, 2011; Oteman et al., 2014; Schweizer-Ries, 2008; Van Der Schoor & Scholtens, 2015). Basically, these roles range from passive consumers to active creators of new energy systems. Here, we give a short overview of preceding research into this spectrum of roles.

The literature shows that citizens are often framed according to their acceptance of or resistance to renewable energy (Musall & Kuik, 2011; R.P.J.M. Raven, Mourik, Feenstra, & Heiskanen, 2009; Sardianou & Genoudi, 2013). It especially investigates whether citizens are willing to take part in government programmes for energy efficiency, to install new equipment in or on their houses, or to choose renewable energy when their provider offers this option (Perlaviciute & Steg, 2014). Stern (2014) argues that citizens can influence government policies through acceptance, acquiescence, or resistance of changes in the energy system. Furthermore, he calls for more research into households as energy producers. Resistance to sustainable energy, i.e. in the case of the siting of windmills is another widely studied phenomenon, where concepts such as procedural justice (Schweizer-Ries, 2008; Zoellner et al., 2008) and NIMBY are being discussed (Jolivet & Heiskanen, 2010).

Some studies contend that in the current energy system the possible roles of consumer-citizens are extended. Already in 2007, Walker and Cass (2007) presented ten roles, where the traditional passive consumer is only one of the options for engaged citizens. Active consumers can select their own provider and choose their preferred energy source, such as fossil or renewable. With the installation of PV-panels they become co-producers or 'prosumers' of energy. Prosumers appear to share a pro-environment attitude (Lavrijssen, 2014; Leijten et al., 2014). The German Energiewende increasingly shows the enormous social changes brought about by a large number of individual and small PV installations, in a relatively short period of time (Beveridge & Kern, 2013). Furthermore, small biomass installations, heat pumps and solar thermal installations are appropriate technologies for the individual prosumer who wants to become more independent from centralized energy supply. Not surprisingly, the existing power companies are reacting on this development in several ways; in order to influence policies according to their interests, as argued by Kungl (2014, 2015) and Sühlsen and Hischemöller (2014). Kungl's analysis of the actions of four leading energy companies in Germany in the first period of the Energiewende shows that these incumbents engage in activities such as lobbying to limit the effects of the ECC to their own advantage, while Sühlsen and

Hischemöller show that the 'big four' spend ample resources to lobby for their interests, and concludes that lobbying fosters the status quo. Also Geels (2014) points to the resistance of the incumbent fossil fuel industries.

Another new role for citizens is to set up or become a participant of a community energy initiative. Such bottom-up activities show that citizens have started to take control of the production and distribution of energy. Araujo (2014) points to the relevance of researching bottom-up change in the area of (energy) policy and governance, so as to expand on studies after market-based and regulatory approaches. Seyfang, Walker and others have researched community energy for the UK (Hargreaves, Longhurst, et al., 2013; Hielscher et al., 2013; Seyfang & Haxeltine, 2012; Seyfang et al., 2014). In Germany more than 700 cooperative companies were registered in 2012 (Holstenkamp & Müller, 2013). These cooperatives are embedded in communities, and are active traders in renewable electricity. Sagebiel et.al. (2014), who carried out an online Choice Experiment in Germany, report that transparency, share of renewable energy and (to a lesser extent) democratic control are important aspects for consumers, who on the whole exhibit a considerable Willingness-to-Pay for renewable energy. Since 2010 a wave of energy initiatives has emerged in the Netherlands, following examples in Germany and the UK. In 2014, 500 of such initiatives have been counted in the Netherland, according to an inventory by the provincial 'Federations for Nature and Environment'.[8] These initiatives are actively engaged in promoting decentralized sustainable production (Arentsen & Bellekom, 2014; Hoppe et al., 2015; Van Der Schoor & Scholtens, 2015). It is the view of Arentsen (2014) that, although these initiatives form a 'seedbed of innovations', they will be limited to a niche existence. Comparative case studies have been executed by Oteman et. Al. (2014), who draw our attention to the constraining or enabling influence of institutional arrangements in Germany, Denmark and the Netherlands for the success of community energy initiatives. North (2013) investigates climate activism in the UK, analysing demonstrations as well as grassroots activities to highlight the social conflicts inherent to such forms of activism. What transpires from this literature is the abundance of local initiatives that organize and explore new forms of sustainable energy provision at the local level. A key question in this regard seems to be whether such local initiatives will (and should) be able to scale and contribute to a wider transition towards an energy efficient society.

To support each other local initiatives increasingly unite in networks on varying geographical scales. For example, in Germany there are several countrywide networks on community energy, such as '100% Nachhaltige

8 www.hieropgewekt.nl

Energie Regionen' (Beveridge & Kern, 2013; Timothy Moss et al., 2014). Regional networks and middle actors in the energy system in the UK are discussed by Parag et al. (2013) and Parag & Janda (2014), while Moss (2009) reports on the role of intermediaries in Germany. How local initiatives support each other in various ways in the region of Oxfordshire is investigated by Parag et al. (2013), who identified a broad range of supportive relationships between organisations both formally and informally connected to each other. Parag and Janda (2014) further describe the important role of middle actors for socio-technical change, with three case studies in the UK 36 . Hargreaves et al. (2013) discuss the role of intermediaries in the support and development of community energy initiatives. Furthermore, they argue that these local initiatives are producing 'grassroots innovations', which they define as innovations 'that challenge and often attempt to replace existing and unsustainable sociotechnical systems' (2013, p. 868). Grassroots innovations, thus, provide a research field that could be further developed. In the literature, the communities' own attempts to realize scale and combine their resources in order to influence the wider sociotechnical system have not received much attention.

We are interested in the aggregation of local initiatives, the creation of regional energy networks and especially in the role of the middle actors and intermediaries. In this article we examine the situation in the Netherlands, where the creation of regional networks is developing at a fast pace; in the past two years many new regional networks have been set up and existing national networks are merging. These networks not only connect local initiatives with each other but also act as an interface with the more traditional energy system. Given the diversity of networks that support community initiatives, we are particularly interested in the goals, organisation structure and activities of network organisations in the Netherlands. We compare if and how these network organisations act as intermediaries with and for local energy initiatives.

Our principal question is how the various roles of citizens as mentioned above are connected in networks and how networks challenge the existing energy system. Do these networks attempt to provide an alternative and thus try to alter the present energy system? How do these networks contribute to the process of grassroots innovation as defined by Hargreaves et al. beyond the local energy literature, several studies take Actor Network Theory as a starting point, such as (Devine-Wright, 2006; Walker, 2008; Walker, Cass, Burningham, & Barnett, 2010; Walker & Devine-Wright, 2008; Walker, Hunter, Devine-Wright, Evans, & Fay, 2007b) (Dufays & Huybrechts, 2014; M. Evans, Marsh, & Stoker, 2013). Actor-network theory allows to follow the moves of actors and posits a flat ontology as explained by Jörgensen (2012), a perspective that differs from the popular multi-level perspective that is often used in the field of energy transitions. The role of technology in these socio-technical assemblages is part of an ANT approach, as it gives due attention to the non-human actors in a network.

The novelty of this paper is to combine Social Movement Theory (SMT) with with Actor Network Theory (ANT) to allow a rich description of the formation of regional and local networks, including the role of technology and of collective action. As such, this study deviates from but also complements similar studies, like those of Seyfang et.al (2014), Hargreaves et. Al. (2013), and Parag and Janda (2014).

4.3. Theoretical approaches: SMT and ANT

To allow a dynamic analysis of collective strategies we combine two theoretical perspectives: Actor-Network Theory (ANT) and Social Movement Theory (SMT). ANT is particularly suited to describe interlinked networks consisting of human actors as well as institutions, buildings, energy technologies and infrastructures (ref)., thus highlighting obduracy and change as grounded in socio-technical networks/assemblages. With SMT we are able to include collective action and social conflict over the governance of energy resources in our analysis. In this section we first introduce relevant ANT-concepts, then reflect on the benefits of complementing ANT with SMT, and subsequently explain important SMT-concepts relating to the energy movement.

An important concept when attempting to change an existing system is obduracy, or resistance to change. In general, technical objects and human actors mutually shape each other as they interact, or in the words of Michel Callon: *'the stability and form of artifacts should be seen as a function of the interaction of heterogeneous elements as these are shaped and assimilated into a network.'* (Callon, 1980). In the literature we find several studies using ANT in the analysis of changes in the built environment. Latour and Yaneva (2008) focus on buildings as actants in a network. Aibar & Bijker (1997) look at cities as 'enormous socio-technical artefacts', while Hommels (2005a, 2005b) and Kirkman (2009) draw our attention to the causes of obduracy of buildings. These studies have shown that the built environment and the energy system are socially and technically intertwined; a large part of energy consumption takes place in the home, and the energy infrastructure is part and parcel of the layout of villages, towns and cities. Furthermore, decentralized production of renewable energy is also related to households and communities. With an ANT perspective, the obduracy of the energy system can be investigated by following network actors, aiming to understand their activities in the large socio-technical artefact that makes up the energy system at different levels of scale, as intertwined with the built environment.

A common criticism of ANT is that it is primarily suited for micro studies, producing 'lots of little stories' (Law, 1997), forgetting patterns and declining to search for explanation, as Geels (2007) notes. However, this seems to be a consequence of empirical operationalization, with many ANT studies meticulously following details at the micro level, rather than a consequence of Actor Network Theory itself (Peine & Herrmann, 2012). In our view, ANT remains suitable and productive to describe larger networks, linking 'local' and 'global' networks. We have elaborated upon this point in van der Schoor & Scholtens (2015), where we use ANT, as discussed by Law and Callon (1992), to show that local energy initiatives are situated along two dimensions: *Attachments to outside networks and Commitment of members*. Findings suggest that a high level of commitment and a broad range of attachments help initiatives to reach their goals.

ANT theory does not take a normative position but follows actors in the creation of networks that interlink normativities with the socio-technical assemblages in which they are constituted and which they give rise. As such, it is a highly suitable theory to analyse how normative projects contribute to alter existing socio-technical arrangements, give rise to new arrangements and are spelled out in the process. The energy transition is a normative project; actors express clear goals and opinions about the desired future governance of energy resources. They want a better energy system than the present fossil fuel based one, with all its related ills such as climate change and air pollution. Moreover, they face considerable social conflicts when they struggle to establish their vision of sustainable energy provision in the context of an already existing wider infrastructure with its associated vested interests. Social Movement Theory (SMT) sheds light on how such social conflicts play out in the fight for control about dominant patterns of actions in societal domains.

Following main SMT theorists like Touraine and Melucci, we argue that local energy initiatives are social movements. Indeed, Touraine maintained that the *study of social action* rather than the *study of society* should be the main subject for sociology; therefore, the concept of social movement should in his view have central importance. This concept acts as a *'bridge between the observation of new technologies and the ideas of new forms of political life.'* He continues to define a social movement as a special type of social conflict, which presupposes a clear definition of competing actors and of the resources they are fighting for or negotiating to take control of. Furthermore, he refers to conflicts around *'the social control of main cultural patterns, (..) through which our relationships with the environment are normatively organized.'* (Ruggiero & Montagna, 2008, p. 213).

To reveal the complex nature of new social conflicts, Touraine analysed the actions against nuclear energy, i.e., against 'decision makers who have the power to shape national life for a longer period of time in a 'technocratic' way. This action tries to foster a grass-roots democracy.' (Ruggiero &

Montagna, 2008, p. 217). This resembles recent work on grassroots innovation, where these innovations are conceptualized and analysed as ‘bottom-up civil society-led initiatives for sustainability’ (Seyfang et al., 2014, p. 22). Melucci argues that ‘Conflicts are carried forward by temporary actors who bring to light the crucial dilemmas of a society. These (..) processes generate both new forms of power and new forms of opposition.’ (Ruggiero & Montagna, 2008, p. 219). Drawing on Touraine and Melucci, we argue that local energy initiatives can be understood as such temporary actors that bring to light a fundamental dilemma of our society: the normative organisation of the production and appropriation of energy resources. SMT positions conflicts about such a normative organisation as the kernel for a wider transition towards new normative and cultural patterns. That is, we contend that local energy initiatives, and their activities, represent a social conflict about the production and appropriation of energy resources, with the potential to eventually foster new forms of organisation and governance of sustainable energy production. Ultimately, this conflict represents a struggle about how modern societies should provide energy in a more sustainable way.

Regarding network dynamics Melucci emphasises that a social movement is a ‘field of social relationships’ where a collective identity is structured. In these fields, individuals are linked together, forming ‘solidarity networks’ (Ruggiero & Montagna, 2008, p. 224). The networks that are formed in the community energy movement can be fruitfully analysed as an emergent social movement and thus a conflict about normative orientations towards energy provision. In our case studies, we will apply methods from ANT to follow the variety of human and non-human actors in the formation of new energy networks, as well as the materialities and normativities associated with them. We thus propose to use SMT in combination with ANT to better understand the dynamics of the community energy movement. More specifically, we trace the emerging heterogeneous network around a normative project that challenges the existing energy system. With Social Movement Theory it is possible to position the emergence of energy co-operatives as a new phase in the history of the energy movement.

4.4. Case description: new energy networks in the North of the Netherlands

In the Netherlands more than 500 local initiatives[9] seek to reshape the energy system in the face of constraints embedded in technical, cultural, economic and political traditions. The goals of local energy initiatives are to accelerate sustainable energy production, to foster self-governing communities, to stimulate local entrepreneurship, to enhance local social cohesion and employment, and to reinvest profits of energy sales to the local community

9 www.hieropgewekt.nl (accessed july 7th 2015)

(E-Decentraal, 2013). In many cases, it boils down to that they want to 'fight the power'. Furthermore, many initiatives have formulated visions about the transformation of their village, town or neighbourhood to a low carbon community. The majority of local initiatives are organised on a democratic basis, with cooperatives as the preferred organisation model. Activities organized by local initiatives include cooperative projects to buy PV-panels, organisation of information markets on renewable energy, stimulating homeowners to insulate their property, etc.

We detect a tendency to cluster into regional networks as part of the development of the local energy movement, without diminishing the local autonomy of local energy initiatives. In the region under study we find three networks, organized along the lines (boundaries) of provinces. Together, these three Northern networks founded their own co-operative energy provider. This will be further detailed and analysed below.

We use a case study (Stake, 2013) to understand the development and activities of regional networks from an inside perspective. 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, cited by Thomas (Thomas, 2011, p. 21). Following Yin (1994), we used our case study to search for conceptual patterns and categories.

For this qualitative case study (Stake, 2013), we observed the regional networks that have been formed since 2012. In particular, we investigate the formation of three regional networks (Us Kooperaasje, GREK and Drentse KEI) in the Netherlands, as well as the cooperative energy provider (NLD Energie) that they founded. We have undertaken qualitative interviews of initiators/ board members of these four organisations in four interviews which each lasted 1,5 hours. To gather insights in the relations between local and regional networks we interviewed initiators/ board members of two local cooperatives in the province of Groningen and Drenthe. One of these cooperatives has been active for three years and is actively involved in the regional network. The other cooperative has recently been set up and can be regarded as a newcomer in the community energy movement. In this manner we seek to include varying perspectives in our case study, as is common in case study research (Stake, 2013).

Furthermore, as a background to our analysis we draw on interviews with initiators of twelve local cooperatives and observations of public information meetings, undertaken in the course of a related research project, reported on in Van der Schoor& Scholtens (2015). This second group of materials informs our knowledge of the movement but was not explicitly used in this paper. All interviews were transcribed and analysed with Nvivo, following a grounded theory approach. In the preparation of this paper we included several quotes to support each point, in the next phase of writing we chose the quote that best expressed the opinions of the respondents.

Further information was gathered by visiting websites, Facebook pages, and documents produced by the organisation in our study, as well as blogs and policy documents regarding the Dutch Energy Covenant. These materials were also content analysed with Nvivo.

In this section we first describe the formation, organisation and goals of the new regional energy co-operations in the North of the Netherlands. Secondly, we investigate the linkages of local initiatives to other regional and national networks, including environmental movement organisations and village support organisations.

4.4.1 Development of a co-operative energy provider

Foundation

In order to actively increase the production and consumption of renewable energy, the local energy initiatives stimulate consumers to buy green electricity from their provider. Furthermore, many initiatives act as reseller and offer green energy themselves. A much-used formula to organize this is that the local initiative agrees to a reseller's arrangement with an existing sustainable energy provider, where the members of the initiative become a client of this provider. In return the local initiative gets a yearly remuneration for the clients they deliver.

Until 2014 it was possible (although not formally allowed) to sell energy through a so-called 'white label construction', which means that a local cooperative can sell energy under its own name, using the energy supply license of an existing energy provider. At the end of 2012 one of these commercial green providers, the Dutch branch of Trianel, went bankrupt. Furthermore, the Dutch Authority on Consumers and Markets (ACM) no longer allowed the white label construction. This caused a considerable stir in the world of local energy cooperatives, as the model of providing green energy as well as getting a return for their local cooperative was under threat.

'So our plans to deliver energy to our local initiatives through such an energy provider, these (plans) fell apart.' (interview C1)

Local cooperatives in the Netherlands either had to find another provider, or apply for an independent supply license. Different regions in the Netherlands chose their own paths; here we concern ourselves with developments in the North only. This is because this part of the country from a geographical perspective (esp. population density) is much more comparable with the average 'landscape' in Europe than the much denser populated other regions.

'So, we asked ourselves, are we going to look for another provider, or shall we work on the foundation of our own energy company' (interview C1)

Coincidentally, initiatives in the northern provinces were already well under way to unite in regional networks. The new organisations Drentse KEI (in Drenthe), Us Kooperaasje (in Friesland) and Groninger Energie Koepel (GREK, in Groningen) were formed. These networks-in-the-making wanted to source their energy from sustainable providers. They quickly realized that creating your own provider could have benefits.

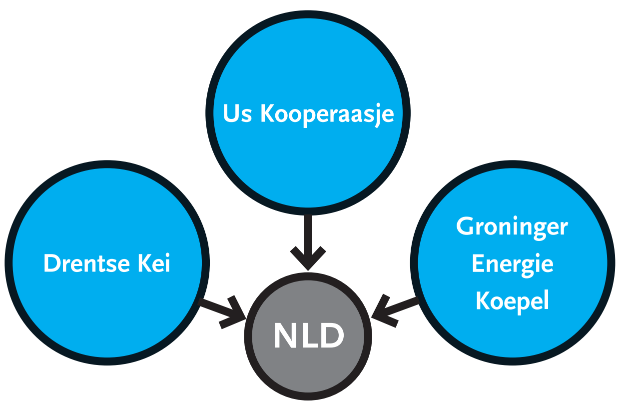
'Obviously, this has a number of benefits, being in charge of the organization yourself, but also from a financial perspective. Profits won't leak away. So this was actually even better.' (interview C1)

Thus, the bankruptcy of the existing provider, together with a change in regulation concerning the white label construction, triggered the decision to found a new energy provider, named NLD Energy.

'so when Trianel went bankrupt and the opportunity of starting our own company presented itself.' (interview C1)

The regional networks Groninger Energie Koepel, Us Kooperaasje and Drentse Kei founded NLD Energy, which got a supply license in 2014. NLD Energy is thus the 'daughter' organisation of the networks, as is illustrated in Figure 6, and is democratically governed.

Figure 6. Structure of regional energy networks



Goals

On the basis of our case study we identify three main goals of the new organisational model of local energy initiatives: realisation of sustainable goals, keeping financial means within the region and democratic governance of energy resources.

5. First goal of NLD is the promotion of local sustainable energy production and consumption. The profits are available for local cooperatives to invest in local sustainability projects.

'Goals of the local cooperation have a central place, such as an orchard, a solar park, a windmill, or a new installation for the swimming pool. With the NLD, with this concept, we can make money and this will trigger an acceleration...' (interview C1)

'It works as a flywheel for our goals, to stimulate local initiatives in Friesland.' (interview C1)

5. Initiators of NLD Energy want to keep more financial resources within the region as well as exert greater influence on the operations of the energy provider. The view of initiators is that the millions of euros consumers in the region spend on their yearly energy bills are leaking away to other countries since the publicly owned utilities were 'liberalized' and sold off to multinational companies (in the Netherlands to RWE and Vattenfall). Thus profits are not used to generate economic development in the region, and not invested in sustainable goals.

'You're talking millions, that we throw away together. Millions that are invested in German bmws or Swedish Volvo's...' (interview C2)

'Especially because it is our intention not to let money be diverted to share-holders or other people elsewhere, the whole point is to keep money fully in the Northern region.' (interview C4)

5. Governance of energy resources. Decisions to invest in local sustainability are up to the community energy co-operations themselves.

'Because the real argument, to supply your own energy and to decide yourself how your energy is produced, how it is purchased, where it is purchased, (..) furthermore, keeping profits in the region, preventing that they leak away to foreign countries, but instead are invested in your own neighbourhood, where you have a say in things.' (interview C2)

Getting started

The foundation of the new energy provider NLD was 'a hell of a job' for a network that at that time was still in the making and relied primarily on volunteers. After much voluntary work the newly founded northern sustainable energy company got its license on 1 April 2014. One of the interviewees expressed his feelings of nervousness when the license came through:

'When we got our supply permit, April 1st 2014, we did not throw a party, no champagne, no cake, because we thought, now we have to deliver! And if we mess it up, than it's spoiled for the Netherlands for the next 15 years.' (interview C2)

The NLD started its work on July 1st 2014, after three months of installing an office. Personnel include employees with extensive knowledge of and experience in the fossil energy sector. At the time of the interview the co-operation had been operational for seven months. The NLD presently has a small office with four employees, including a director. However, in order to be able to create a more resilient organisation, NLD has to grow to at least 5.000 clients.

NLD is a profit-for-purpose firm, meaning that any profits will be returned to the local cooperatives, which decide how it will be used.

'We are a profit-for-purpose company, which means that nothing remains in the central organization, all the profits are distributed over our participants, not only the saved marketing costs, but also profits at the end of the year.' (interview C4)

Under Dutch law[10] NLD has to accept every consumer that chooses to become a client of NLD. If applicable, this client can indicate which nearby cooperative the remuneration has to be paid out.

The co-operative structure of NLD is seen as unique for the Netherlands, although a comparable organisation exists in the province of North Holland, called De Unie (Duurzame Energie Unie) However, according to our interviewees De Unie is primarily a producers' organisation, uniting (cooperative) owners of solar parks or windmills, whereas NLD is a consumers network, uniting citizens who want to use their consumers' power to stimulate renewable energy. Furthermore, NLD limits itself to the three northern provinces, whereas De Unie is in principle a national organisation.

'We are focused on Friesland, Groningen and Drenthe, that's it. This is very consciously done, in order to keep the span of control limited, so that we can be the decent organization we want to be.' (interview C2)

10 Electriciteitswet (Electricity law) 1998 Art. 95b

NLD is actively trying to buy electricity produced in the region.

'Of course we try to purchase in the North. You can imagine that every village hall, which has enough room for an array of solar panels, can become a supplier of solar energy. We want to buy and sell locally. Ameland has a solar park that has enough capacity to supply the energy to all our clients on the island, so that would be brilliant, that we purchase their energy and sell it immediately to the people from Ameland themselves.' (interview C4)

'I think we have the right formula to keep finance and energy local, to close the energy loop and to close the financial loop on a local level.' (interview C2)

Future visions: a co-operative network structure

The present role of energy distribution networks is difficult to influence in the Dutch context, but it is the dream of NLD to experiment with cooperative network organisations. In their view, this has benefits for feelings of ownership, financial benefits, governance, but also for the optimization of energy exchange on the local level. Experiences in Germany are mentioned as an example, where apparently fewer obstacles for local cooperative networks exist.

'In my opinion it would be worthwhile to experiment in the Netherlands with network-cooperatives, so as to keep energy networks under governance of local cooperations.' (interview C4)

'For these experiments, rural areas are the most appropriate, because then you can offer solar parks or biomass-farmers a new perspective.' (interview C4)

4.4.2 Regional networks

Supporting local cooperatives

NLD is organized as a cooperative with three members: the regional energy networks in the three provinces, respectively called Us Kooperaasje, Groninger Energie Koepel (GREK) and Drentse NLD These provincial networks each have their own organisation structure, statutory description, members, website, and board and see themselves as quite distinct from one each other.

'It was a very clever move to create three umbrella organisations, because you have three provinces, with different dna, different political priorities, (..) who each want to make sure that money will stay within their own provincial boundaries.' (interview C2)

The role of the provincial networks is to support the local cooperatives with their activities, but also to guarantee that the money is invested in a sustainable way. The NLD has no say over local projects.

'They support the local cooperatives, they perform monitoring, policymaking, sustainability checks... Through the obligatory membership of a provincial cooperation we hope to guarantee that the local cooperation spends the money well.' (interview C4)

Lets' get started: Us Kooperaasje

The development of the regional cooperation in the province of Fryslân started with a few people who had been thinking for a longer time about ways to stimulate local energy initiatives, and who thought 'just lets' get started'. They first founded a 'foundation for the foundation of ...', which is a usual approach to get something off the ground.

'Then there were a few people who said, well, we just have to get started. So they thought about an organization structure, created a board, found a few people who were willing to invest some time and effort.' (interview C1)

The next step was to apply for provincial funds for legal procedures, a statutory description and the development of a website. In March 2013 'Us Kooperaasje', meaning 'Our Cooperation' in Frisian, was founded.

The size of the organisation is limited: a half time employee, a board with five members and a group of volunteers.

'We have a half time employee, who is the only one that get's paid, he supports local initiatives with the set up of a local cooperation. But in the end we do it all together, it is just a question who is able to free up enough time to do something.' (Interview C1)

The team is described as very active and close-knit:

'We work as a very close-knit team, where some are on the board but also very active in the field. So they visit all kinds of villages. The team consists of 10 or 12 very active people.' (interview C1)

Interviewees recognize the need to expand the organisation, which in their eyes makes paid employees a necessity. Therefore, they are actively looking for ways to generate more funds.

'But to really expand your activities, you need some income. To pay people on a sober, but decent level.' (interview C1)

There is no physical office; the board has different locations where they can meet. They are guest of several friendly organisations, who provide a temporary place to have meetings. But this is considered of low importance.

'The office is negligible, we always have a place where we can meet, in different locations. Even our postal address changes regularly, I've already forgotten which is the last one. (..) Actually, almost everything is done digitally. But you need a place to sit dry, to plug in a computer and to have meetings.' (interview C1)

Some board members are at the same time active in local initiatives. Others have a background in the energy sector. The chairperson is mayor in one of the municipalities in Fryslan and as such brings in a large network.

'The team consists of people who know the energy sector, or have lots of experience with energy cooperations, so we are all experiential experts. And there is someone who works with the municipality, but is granted one day a week to work for Us Kooperaasje.' (interview C1)

The goal of the provincial network is to support local initiatives with practical advice, to enlarge the network and to share knowledge. The co-op is founded by and works for the local initiatives.

'The goal of Us Kooperaasje is to support the local initiatives, to foster the growth of the network and to stimulate the sharing and spread of knowledge.' (interview C1)

Local cooperatives can apply as formal member of Us Kooperaasje if they have set up their local organisation, have a statutory description and a plan of work.

The local cooperatives as mentioned before work with a reseller's arrangement. Yearly they receive €75 per client. It is entirely up to them how they spend this money, although there should be a link with sustainability and energy projects.

'This money they can invest in the manner the local cooperation wishes, they decide with their own local members, we are not responsible for that. Naturally, the idea is to use the money to stimulate local sustainability projects.' (interview C1)

Drentse KEI

In the province of Drenthe, the regional network is called Drentse KEI, where KEI is used as abbreviation for Koepel Energie Initiatieven, meaning umbrella organisation of energy initiatives. In Drenthe a lot of boulders from the ice age are found, such a boulder is called a kei in Dutch, hence the name.

Drentse KEI has a board with five members; it has no office and no employees. All work is done voluntarily. As yet, Drentse KEI has fewer members than its Frisian counterpart. One of the reasons for this lies in the mentality of the people from Drenthe.

'In Drenthe we have the problem that people from Drenthe are inclined to wait and see – for a very long time. So we move very slowly.' (interview C2)

It is difficult to get the message across, interviewees tell us. Why would clients choose for NLD? The arguments include climate change as well as price and service with traditional providers. But it proves difficult to get the 'real argument' as they call it, across. This argument concerns the governance of energy resources, as discussed above in section 4.4.1.

In order to get resellers arrangement with NLD, a loco has to become a member of the Drentse KEI, for €250. In return they receive a certificate.

'Cooperatives that become a member of kei buy a membership certificate for €250. This is enough for us to pay for small things (..)' (interview C2)

It is stressed that the regional network is democratically organized. The local coops also should organize themselves on a democratic basis.

'It cannot be a foundation, because a foundation isn't democratically organized. So they need to be a union or a cooperative.' (interview C2)

The goal of the regional network is to support local initiatives. They organize instruction meetings, help the initiatives with legal procedurs and give fiscal advice.

The local cooperatives have to decide themselves how the money will be spent, in Drenthe interviewees observe that this is difficult on a scale where several villages belong to the same cooperative, for example when a cooperative is organized on the scale of a municipality.

'It is too large, here is someone from Luttingerveld, hier is someone from Een, here is someone from South- well whatever, and they don't even know how these villages look like, so they can't decide when Luttingerveld says We need something for our village hall, maybe the cooperation can pay for that? – if that is a reasonable request.' (interview C2)

Groninger Energie Koepel: 'wie doun't zulf'

In the province of Groningen the number of local energy initiatives is rising rapidly. From only five members in 2012 now there are seven full members and another eight are in preparation stage. The name simply refers to Groningen as province, but in the communication the Groninger language is regularly used, to provide a strong link to the cultural identity in Groningen. The slogan 'we doun't zulf' means 'we do it ourselves' in the local language. GREK was started somewhat later than the other two regional networks, because the existing strong cooperation Grunneger Power long tried to fulfil a coordination role themselves, which slowed down the development of a regional network.

'Then they concluded that the scale of operations was to small to create a viable organization, that they needed to scale up and to create a energy wholesale business. Then it would be possible to save profits to invest in local initiatives.' (interview C3)

The Groninger Energie Koepel has a vision where the province is able to provide for its own energy needs.

'Our vision is that in the province of Groningen local village organisations and energy cooperations work towards an independent fossil free supply of energy.' (interview C3)

In order to reach this goal local initiatives have to be supported.

'To achieve that, we try to stimulate, encourage and link local initiatives to get started.' (interview C3)

The organisation of GREK is rather low profile; so far the only employee is a full time volunteer, who is assisted by students doing their internship. Board members also fulfil many tasks, such as representing the organisation in meetings. Board members are based in different regions and bring in their own networks. Furthermore, the majority of board members are active in one of the local cooperatives.

'Increasingly, you find out that everyone has his own network in the region, so it is natural that board members are active in their own region, not only as a member of the board but also in the local cooperation.' (interview C3)

'Furthermore, you notice that every region has its own characteristics and its own mentality.' (interview C3)

In GREK several initiatives are organized as a working group under the umbrella of the village organisation. This is seen as an important asset, because the village organisation has a broad range of members, whereas a dedicated energy cooperative runs the risk of being stigmatized as a green organisation, which can lead to an isolated or marginal existence.

'We chose to align ourselves to the village organization, (..) which means that a broad range is almost guaranteed.' (interview C3)

'Whereas – as I gather from Frisian experiences – there are villages with small organisations only consisting of sustainably oriented people, this can lead to an isolated existence.' (interview C3)

Furthermore, the cooperative has to remain true to a broad definition of sustainability, where economic or social aspects are as important as environmental benefits.

'Not only look at green issues, but also take economical benefits and social aspects on board.' (interview C3)

The issue of geographical scale is mentioned as very important, comparable to the situation in Drenthe. Coops that are organized on the level of a municipality run the risk of being to far from people's needs, or even to encounter age-old conflicts between villages.

'Scale is in my view a decisive factor, it you choose a scale that is too large, it is difficult for people to identify with the club.' (interview C3)

4.4.3 Volunteering

Resellers arrangement

Local cooperatives work with a reseller's arrangement, comparable to the usual contracts with traditional energy suppliers. To get a resellers contract with NLD it is obligatory to be a member of the provincial network. A reseller gets €75,- a year for every client, which represents the marketing costs that NLD doesn't have to spend, because the local cooperatives do this work. Furthermore, local cooperatives get a percentage of the yearly profits. For an individual cooperative the total amount of yearly income can become rather substantial.

'Village cooperations are almost always dependent on small subsidies and contributions, however, we provide a model to make money, to create a substantial stream of money to the local community' (interview C3)

'For example, we have a thousand clients on Ameland, so €75.000 a year will go to the Amelander Energy Cooperation.' (interview C3)

There are differences in the number of local cooperatives and clients the regional networks bring to NLD, reflecting to the different stages of development of the respective organisations. NLD had 42 local cooperatives enlisted as resellers as of February 2015.

Time and effort

It is a rather busy existence for the active members of the community energy movement. Organisation size is very limited, only the Frisian cooperation has a temporary employee. In the interviews the constant stream of meetings is mentioned. One type of meeting is the local information meeting. Volunteers mention they visit a village information meeting twice or three times a week. Furthermore, there are meetings organised for information sharing, instruction or otherwise. Interviewees are sometimes worried about the workload for volunteers.

'People who for next to nothing work days, weekends and even nights to get things done.' (interview C1)

Although there are views that a modern organisation would be preferable, in practice board members invest a lot of time and effort.

'You just have to do it together.'

Knowledge

It is stressed that a lot of knowledge is available in the local cooperation's and the network as a whole.

'You have to realize that a lot of knowledge is available, also locally. If you think that knowledge is only in the heads of a few specialists, you are terribly mistaken.' (interview C4)

'So we depart from the strengths of the local community, (..) Then we investigate what is missing and if we can supply those things within the network, and sometimes we still need some expertise, for which we then involve other parties.' (interview C3)

Outreach

Repeatedly, concerns were voiced about the outreach of the local cooperatives to a larger part of the community.

‘We are now working to develop our marketing strategy, to increase the volume of clients.’ (interview C4)

‘What I want to know is, whom do we not reach? Why are people so difficult to convince, can we improve our arguments, our story? Because we want something, we believe in it, but we don’t succeed in selling it properly.’ (interview C2)

4.4.4 Interlinkages with pre-existing networks

The provincial bottom-up networks we just introduced in our case study have been created only recently; they entered a landscape already populated with other organisations, which also aim to support local energy cooperatives. For the outside observer an increasingly complicated pattern of networks is displayed. In this section we primarily want to position the newly created regional networks in relation to the pre-existing regional top-down networks of NGOs and provincial authorities and discuss the linkages between these types of networks. Furthermore, we briefly look at the role that relevant national energy networks play in the energy transition.

In the provinces existing support networks are organized along the lines of provinces and topic areas. In all Dutch provinces there is an environmental network organisation, uniting and supporting local environmental groups. These organisations usually have a central Dutch office with employees working on specific environmental subjects, such as transport, energy, nature conservation, waste management or spatial planning. Furthermore, they attract funds for specific projects, such as setting up a service point for local cooperatives. The environmental umbrella organisations are united on a national scale in the Stichting Natuur en Milieu.

On the other hand, there are provincial organisations that are dedicated to support organisations in (small) villages. This can range from financial advice for the exploitation of the village hall to exchange of ideas on local care, or community gardens. As many local cooperatives started out as an informal working group of a village organisation, the provincial village support organisations received many calls for support on the setup and running of an energy initiative. These are funded by the provinces and employ a handful of employees. At the national level the ‘Network Sustainable Villages’ was founded, which supplies villages with an interactive website as well as a platform for meetings. This network was funded by the province of Friesland and managed from the Frisian village support organisation.

Therefore, the landscape of intermediary energy organisations is roughly organized in two pillars, one stemming from environmental concerns and the other from village perspectives. On a provincial scale these support organisations often work together, to increase the total level of support. On the other hand, the organisations compete to attract funds for their

Table 7. : Overview of support networks in three northern provinces of the Netherlands

Regional Network	Region/ Province	Grassroots (bottom-up organisation)	Environmental organisation	Village Support organisation
GreK (Groninger Energie Koepel)	Groningen	x		
Drentse Kei	Drenthe	x		
Us Kooperaasje	Friesland	x		
NLD	Groningen, Friesland, Drenthe	x		
Milieufederatie Groningen	Groningen		x	
Milieufederatie Drenthe	Drenthe		x	
Milieufederatie Fryslan	Friesland		x	
Doarpswurk	Friesland			x
Vereniging Groninger Dorpen	Groningen			x
BOKD	Drenthe			x
Energiewerkplaats	Friesland			x

projects. An overview of the existing networks in the Northern Netherlands is presented in Table 7.

Looking at this provincial network landscape we notice that the existing networks undertook projects such as *Lokale Energie Voorwaarts* and the *Energiewerkplaats*. They also organized numerous meetings, which served as an important platform for local cooperatives to meet and share knowledge and experience. The relation of the new networks with the existing ones is geared at cooperation and profiting of reciprocal strengths. However, conflicts could arise around the provision of money to existing organisations, leaving the new networks without funds.

On a personal level we observe structural as well as incidental links between the networks. The cooperative structure of the provincial networks and the NLD means that representatives of local cooperatives can be a member of the board of the network as well as the NLD. Furthermore, some citizens from the Northern region are active in one of the national networks. For example, one of our interviewees is a member of the loco in the municipality of Noordenveld; he is also a member of the board of Drentse KEI, the provincial network in Drenthe; for Drentse KEI he is on the board of the NLD; and on top of that he is board member of E-decentraal, one of the national networks. This combination of volunteer positions links networks from local to national.

National networks have been set up at the beginning of the surge of local cooperatives, such as E-decentraal. However, at the moment the subsidies are being discontinued, so the organisation is reorienting itself. The role of the national networks is primarily geared at lobbying and organizing national conferences for information sharing. Regional networks do not spend much time on that; they are far too busy with daily concerns.

4.5. Analysis

The regional networks in the area under study have been set up by local initiatives in the three Northern provinces. Subsequently these regional networks founded the cooperative energy provider NLD-Energie (NLD). Local energy cooperatives can become a reseller for NLD. This means they get a comparable remuneration from the NLD as they used to receive from the commercial sustainable energy providers. Additionally, any profits made by NLD will be distributed along the local cooperatives. There are some differences in the approaches chosen by the respective regional organisations, partly depending on the provincial or other support the regional network was able to get. This structure of regional networks is unique for the Netherlands. In other provinces, the local cooperatives are working together on a much less formal basis. NLD is (so far) the only energy provider in the Netherlands that is founded and governed by local citizens' initiatives. A comparable provider, such as De Unie, is a producers' cooperative, organized by renewable energy producers, some of which are cooperatively owned. NLD instead is a consumers' cooperative, set up to supply renewable energy. Therefore, this structure for the regional energy network is indeed a grassroots innovation, as it challenges and aims to replace an existing socio-technical structure. In this section we further discuss and interpret the results of our case study, in particular the issues of democratic control; the existing regional and local political environment; network formation and socio-technical transitions.

4.5.1 Democratic control of energy policies

The trigger for the decision to create a new cooperative energy provider was the bankruptcy of their former provider, Trianel and the closing down of the 'white label construction' by the market authority (ACM). This development prompted the Northern groups to evaluate the model of delivering sustainable energy by means of a traditional energy provider.

To sell renewable energy under a white label or by means of a resellers' arrangement does have drawbacks, according to the local cooperatives. Firstly, energy companies have shareholders, which means that profits 'leak away' to shareholders, often located outside the region. Investments and employment therefore do not fully benefit the region. Therefore it is strongly felt that the region does not gain economically from consumer expenditures in energy, which is seen as an important missed chance in this economically relatively weak region (Macke & Arnold, 2012). Secondly, local cooperatives have no say in investment or other strategies of a traditional provider, only shareholders have a (limited) influence on decision-making. However, the initiators want to make sure the energy is produced sustainably and preferably in the region. For these reasons, the networks in the three northern Dutch provinces chose to apply for a supply license and thereby founded an independent energy provider. In this respect, NLD is put forward as an alternative to traditional energy providers. However, NLD also has to comply with existing rules and regulations regarding energy providers.

Democratic governance of energy resources according to our respondents helps to attain three main goals:

- Promotion and implementation of sustainable energy production units on both an individual and a community scale
- Keeping financial resources in the community with a view to invest profits in local sustainable goals
- Democratic influence of citizens on their energy provider

In our case study the interviewees emphasise the democratic nature of the network structure they have created. They expect democracy at the level of the provider to safeguard sustainability as well as the distribution of profits to the local cooperatives, which in their turn should be democratically organized to involve local members/ clients in their decision-making about the investment of these profits in local projects. In the terms of Melucci (Ruggiero & Montagna, 2008) we interpret this as a signal that the local energy movement is posing political demands for the democratic control of energy policies, as well as finding ways to realize their vision within the present regulatory framework. This aligns with the reasoning of Touraine and Melucci, when they claim that the basis of a social movement is a conflict over (the governance of) resources (Ruggiero & Montagna, 2008; Touraine, 1985).

The new energy initiatives aim to use other logics to structure local energy supply. This is consistent with the concept of 'grassroots innovation', which aims to replace existing socio-technical structures.

4.5.2 Regional and local political environment

In accordance with SMT we observe that initiatives *'confront political authority on specific grounds' (Melucci)*; they regularly try to influence local decision-making but emphasise that they do not take part in traditional party-politics. The relation of local cooperatives with the municipal and provincial government can be characterised by a certain degree of unease. For example, in the province of Drenthe none of the municipalities is a client of NLD, and neither are the provinces, although they expressed their sympathy and helped its foundation with a loan. Furthermore, only the municipality of Midden-Drenthe has a clear approach to local energy initiatives and has an active local energy policy, supported by instruments such as courses for homeowners. Nevertheless, there is no financial support for local projects or initiatives, and the provincial fund for energy projects in practice rules out small initiatives, because of the financial threshold of €50.000 per project. In the province of Friesland municipalities and the province have drafted lofty visions on sustainable energy, but according to our respondents they lack capacity and instruments to put these visions into practice. In the province of Groningen, the wave of local energy initiatives is just getting off the ground, the province has recently installed a fund to support local initiatives as well as a special instrument for largel projects.

It seems a difficult task for local and provincial authorities to find an appropriate way to facilitate local energy production. They have to steer between EU regulation regarding government aid, making funds available for small ventures, high costs for operating support schemes, and loss of influence over provincial funds. However, an in-depth analysis of provincial energy funds is outside the scope of this article and would merit a separate investigation.

4.5.3 Networks, commitment and attachments

From a social movement perspective (North, 2011; Ruggiero & Montagna, 2008; Touraine, 1985) we would expect personal ties between local initiatives, regional networks and national organisations. This is indeed apparent in the combination of roles that individuals take up, as the majority of board members of these organisations usually are also active in one of the local member organisations. However, only one of the respondents combines his local and regional activities with a function as board member in a national energy network. Other respondents report they are not spending much thought or time on national organisations, as they are far too busy with running their own initiative.

Based on the model of Van der Schoor & Scholtens (2015), we expect that initiatives with both strong attachments to outside networks and highly committed members achieve the most local results. In this respect we first of all notice the very high commitment of the actors in the networks. Not only is almost all work done voluntarily, involving a huge amount of time and effort, interviewees also hold outspoken views on the best way to organise the future energy system.

Secondly, for the local cooperatives the regional cooperatives and new energy provider are a means to increase the number of attachments to outside networks. This structure is set up to foster attachments between local cooperatives; the regional cooperative in fact is no more than a service organisation, governed by their members, the local cooperatives.

Thirdly, although national networks are known by the local cooperatives, and some members are themselves active in national networks, closed attachment with these organisations is not considered a high priority. According to interviewees, day-to-day work on the local level is far more important for the organisation.

Fourth, referring to local network attachments the following observation is relevant. One of the goals often expressed by local cooperatives is to enhance social cohesion in their community 55. However, the reverse is also true, in the sense that small cohesive communities have a greater chance of maintaining a successful local cooperative. If the scale of a cooperative is too large – for example if it is organized on the level of a complete municipality with several villages – it runs the risk of experiencing difficulties with involving their members, and problems can arise with decisions on the budget. Furthermore, information meetings should preferably be held in the locality or neighbourhood itself, because otherwise only the 'converted' will turn up. Even meetings only one village (two kilometres) away attract less people, and from a smaller segment of the population. It seems that commitment is immediately lessened when activities take place elsewhere. Finding the optimal scale for the local cooperative appears to be of paramount importance for the success and continuity of the organisation.

Fifth issue is the question of informal and formal organisation structures. On the basis of the interviews we notice that informal working groups, connected to a general village organisation, can reach a broad constituency, whereas specialized energy cooperatives sometimes can become isolated, missing out on this broader audience. Although such a working group has an informal appearance, in fact formal ties are derived from the membership of the provincial network organisation.

4.5.4 Sociotechnical transitions

Activities of citizens regarding the transition to a sustainable energy system can be organized along dimensions of scale, as well as the dimension of the degree to which the proposed alternative aims to replace existing socio-technical arrangements. In North's analysis of climate activism in the UK (2011) a table was presented of the active climate organisations. We adapted this table to the networks we included in our case study. As such, in Table 8, we present two dimensions regarding the grassroots innovation of the energy system: a dimension of scale (from individual to national) and an incremental-radical dimension (from incremental solutions to systemic changes).

The regional networks act as an important instrument in the upscaling of local energy supply and production. Attempts to change the logic of decision making and governance of energy resources is visible in the different activities listed under 'radical reform'. While concrete options are available for individuals, energy neutral visions are not yet realized in the region under study. On the level of regional networks ideas are developed for a regionally governed energy system, including supply to all citizens as well as cooperative management of technical energy networks.

4.6. Conclusion

We conclude our paper with a discussion of challenges to the energy system by new regional networks and cooperative energy providers. In effect, the existing system is challenged on sustainability, primarily the transition from fossil to renewable fuels; on its contribution to regional investments and employment; and on democratic procedures, especially the incorporation of preferences of its clients. Obviously, the new energy movement maintains that the existing energy system in the Netherlands is severely failing on these three accounts.

In the social movement for local energy transitions, we observe a wide diversity of interacting and overlapping networks linking together individual prosumers, regional providers and national lobbyists in our case study. The cooperative model is apparent throughout; the local cooperatives have to be democratically organized, together they constitute a regional cooperation in

Table 8. : Grassroots innovation of energy system

	Prosumers	Communities	Regional Networks	National Networks
Incremental reform within existing energy policies.	Reduce energy for heating and appliances. Produce own electricity, grid connected. Buy green energy.	Local PV-groups. Local cooperatives for supplying green energy. New social enterprises for supply and production of energy.	Regional networks for support of local cooperatives. Cooperative provider set up by regional networks.	Projects for support of local cooperatives Organisation with local cooperatives as members.
Radical reform of energy governance.	Produce own, off grid. Energy neutral, passive houses.	Autarchy, low carbon, energy neutral visions	Cooperative service for all households in the area. Experiment with cooperative network management.	

their respective provinces. The three regional cooperatives in the provinces in the north of the Netherlands in turn are the founders and only members of the cooperative energy provider (i.e. the regional energy network). We conclude that the people in the energy movement organize themselves according to an ideological vision concerning sustainability, regional economy and democracy, thereby challenging the present governance of the energy system. Therefore, the network structure as described in this paper is regarded as a grassroots innovation.
The described network structure has three goals:

1. Sustainability: profits will be invested in sustainable projects on the local level.
2. Regional economy: profits are kept in the region, while stimulating innovation.
3. Democracy: governance of energy and related financial resources is organised on a democratic basis.

As such, our analysis complements different strands of the literature. Relating this innovation to Sagebiel (2014), who points to the willingness-to-pay for sustainable energy from cooperatives, we find that there is considerable scope for these networks to be successful. Relating to Parag (2013), Hargreaves (2013) and Seyfang (2014), we observe a dynamic field of networks that are in constant development. In the described networks there is a strong and widely held common vision, which is an important factor for success, as argued in Van der Schoor and Scholtens (2015). The energy cooperatives require considerable time and effort of its volunteers. Local and provincial networks have absolute priority in their daily business. Therefore, few people can afford to spend much time on national networks, although informants do find these useful for lobbying and information sharing.

Community energy, what should it mean? Ask Walker and Devine-Wright (2008) in their article. On the basis of our study, we conclude that among other things it means a close relationship with regional culture and a specific mentality. The networks all refer to the mentality, or way of thinking, in their region as important for the best approach. In their communication all networks use regional language to connect to people living in the region. In Friesland this is quite common, as Frisian is the second official language in the Netherlands, but also in Groningen and Drenthe local expressions are used. This conveys regional pride, where people for example first see themselves as Frisians, and secondly as Dutch. Another manifestation of the desire to align with the region is that these networks are organized along provincial boundaries in the first place. This is not self-evident, because in Dutch national political circles the relevance of provinces and their boundaries are often challenged. Furthermore, the networks hold the explicit view that the energy provider NLD should be limited to the three northern provinces, to remain close to local networks and people.

It may seem quite a jump from local grassroots initiatives to an economically viable energy provider, which makes it all the more important that the NLD employs people who have background knowledge of and experience in the traditional energy sector. In combination with the democratic structure and formal contracts this should provide a basis for continuity. The network structure is rooted in the region by means of the local member cooperatives. Via their respective provincial networks these cooperatives control the activities and policies of the NLD.

The network has been put in place and, hence, the next challenge of the local cooperatives is to attract enough members and clients to the new energy provider to sustain the business model. Many local cooperatives have enough on their hands, struggling to involving enough people to continue, and fully dependent on volunteers. The outreach of local cooperatives to the wider population in the community is repeatedly voiced as a challenge.

The new networks still have to find their niche, to further develop relations with the existing networks and institutions. On the one hand, the new networks want to develop good working relations 'for the common good'. On the other hand, there are opinions that government money is now channelled to traditional organisations, which in their view not always take the best approach or have the necessary knowledge to service the local cooperatives in the best possible way.

The combination of ANT and SMT in this paper brings to light the day-to-day activities of the network actors, and helps interpret these networks as a challenge to the logic of decision-making in the energy system.

The case study presented here provides no more than a snapshot of a dynamic cluster of interlinking networks. One of the limitations of this paper is that it lacks an assessment of the possible economic impact on the regional economy of an energy system as envisaged by our interviewees. Another drawback of our approach is that a longitudinal research into the development of the organisations involved is not yet possible.

Further research into processes of transformation of the fossil energy system has to take questions of governance into account. Democratic governance of energy supply and production could act as an important lever in the quest for a sustainable energy society. Socio-economic as well as technological consequences of this development in comparison with central fossil fuel production merit further investigation.

5.
Local community initiatives and the transition to sustainable energy

This chapter is a reprint of:
Tineke van der Schoor, Bert Scholtens (2015), Power to the people, local community initiatives and the transition to sustainable energy, *Renewable and Sustainable Energy Reviews*

Abstract
The transition towards renewable and sustainable energy is being accompanied by a transformation of communities and neighbourhoods. This transition may have huge ramifications throughout society. Many cities, towns and villages are putting together ambitious visions about how to achieve 100% sustainable energy, energy neutrality, zero carbon emission or zero-impact of their communities. We investigate what is happening at the local community level towards realizing these ambitions from a social perspective. We use the case study approach to answer the following question: How do local community energy initiatives contribute to a decentralized sustainable energy system? We find that especially the development of a shared vision, the level of activities and the type of organisation are important factors of the strength of the 'local network'.

Keywords: decentralized energy production; energy initiatives; citizen groups; energy neutrality; sustainable energy; prosumers

Highlights:
- Local community energy initiatives in the Netherlands are investigated from a social science perspective.
- Actor Network Theory is used as the frame of reference.
- It appears that the development of a shared vision, the level of activities and type of organisation are critical for the strength and success of initiatives.
- Community initiatives' success depends on the quality of their networks.

5.1. Introduction

The social impact of renewable energy systems is potentially quite different from that of conventional (fossil-based) systems (Akella, Saini, & Sharma, 2009). More specifically, renewable energy production offers opportunities for the local governance of energy production, in contrast to the much more centralized conventional energy production. Many communities and regions have expressed goals to transform their community to a self-sufficient renewable energy system. Thus, the societal transition to a sustainable energy system may also lead to the social transformation of communities and neighbourhoods (Mulugetta & Urban, 2010; Roseland, 2000). This transformation of energy production towards a more sustainable and decentralized system is progressing very slowly in the Netherlands. According to Eurostat, renewable energy capacity in the EU-27 makes up 8.7 per cent of the total, but that of the Netherlands is just 3.6 per cent[11]. In Europe only the UK and Luxembourg perform worse in this respect. Hence, this makes the Netherlands a particularly interesting case, especially because the lagging position seems to be related to 'soft' issues, as the technology is already freely available. For example, Dutch fiscal policies are at present far from conducive to small producers and the national energy policy appears to be one of the major barriers to change (van Rooijen & van Wees, 2006). Large energy companies voiced the opinion that the Dutch will have to temporize renewable energy. They fear that otherwise their recent

11. Source: Eurostat (online data codes: nrg_100a, nrg_1071a and nrg_1072a)

investments in large coal and gas-fired power plants will not become economically profitable. Furthermore, they argue that an exorbitant growth of renewables will reduce necessary back up capacity (The Economist, October 12th, 2013). However, this mainly reveals that they are rather slow in adapting their business model. As a result, the value of their business has been reduced dramatically over the past couple of years. The incumbents view renewable energy resources as a threat to their business model especially because the marginal costs of the renewables are way below those of fossil fuels (Mulder & Scholtens, 2013). The opposition of energy companies to the energy transition is an example of the role of vested interests in the energy industry, as suggested by Moe (2010).

On the other hand, many cities, towns and villages in the Netherlands have put together ambitious visions about how to become energy neutral, zero-emission or low carbon communities. Almost 500 local initiatives were counted in 2014 (www.hieropgewekt.nl). Their challenge is to turn these ambitions into reality. In this paper, we will particularly focus on the bottom-up approaches to realize the local community transition to energy sustainability from a social sciences perspective. We are very well aware of the fact that this social perspective is not encompassing. There are several technological issues that play a crucial role here. Especially, the development of energy storage systems as "buffer" between demand and supply is the highest priority to make renewables grow significantly. Furthermore, distributed grid management is under development to account for any short-term intermittency. Several countries try to care for decentralized production, with an obligation of power providers to accommodate the decentralized supply in the grid. In addition, local community initiatives often face the problem of construction and operation permits, required maintenance and other aspects related to decentralized production. Furthermore, apart from community initiatives, there also are local initiatives undertaken by municipalities and NGOs.

The idea that an electricity network should rely on central production in large plants situated far from individual consumers has taken hold only in the last decades (Smil, 2005). Started out as small, municipally governed production facilities, energy producers have become ever-larger companies. At the same time, the governance of energy production has gone from the hands of local and regional governing bodies to international energy companies, like the German Rheinisch-Westfälische Elektrizitätswerke (RWE) AG and the Swedish *Vattenfall* (see also Wolsink (2012a).[12] Consequently, the influence of consumers, local and regional politics on energy generation has become virtually non-existent. Therefore, the recent mushrooming of energy co-operations on a town- or even village-scale may seem quite remarkable set against the background of the international centralized energy system. However, in part, it also reveals a 'back to basics' of energy production. Due to technological innovations in especially renewables generation, small-scale generation and individual choice for green energy has become available at almost the same

12. A thorough assessment about the changing role of some of the major European energy companies in relation to renewable and sustainable energy is provided by Kungl (2014).

moment in time (OECD, 2013). In the liberalized EU energy market, consumers can freely choose their energy provider, so they can 'vote with their wallet' (Dorsman, Montfort, & Pottuijt, 2011). Moreover, consumers can become producers or 'prosumers' by producing energy with their own combined heat and power installations, solar panels or windmills. This has become an attractive option for a growing group of consumers and small to medium sized enterprises. From these economic activities, we witness the development of social networks that relate to energy (Walker & Devine-Wright, 2008). They are involved in scaling up from the individual to the community level. In this respect, the affix 'prosumers' can be applied to this development of decentralized energy production (Lampropoulos, Vanalme, & Kling, 2010). Local community energy initiatives foster and stimulate this development (Hoffman & High-Pippert, 2010). More specifically, they engage with institutionalizing and establish energy-cooperatives and similar organizations, which distribute energy to their own community or region. This community option is becoming serious business, as is shown by the already considerable and growing amount of local community energy initiatives that are taking off in several European countries in the past few years (Walker, Cass, et al., 2010; Walker & Devine-Wright, 2008; Walker, Devine-Wright, et al., 2010). We seek to understand the drivers behind this surge of community activity. The literature suggests that the provision and promotion of green electricity, the strengthening of social cohesion and the investment of revenues in the local community are strong motivations for these initiatives (Walker, 2008). In addition, many people voice ideas about self-empowerment and autarky, wishing to become independent from large and international energy companies (Bomberg & McEwen, 2012).

We will analyse the activities of these initiatives and especially investigate the potential of their effectiveness and impacts regarding the creation of a sustainable local energy community. The key question we ask is: How do local community energy initiatives contribute to a decentralized sustainable energy production system? To this extent, we investigate the activities, motives and ambitions of local community energy initiatives, what determines their effectiveness, and the barriers they encounter. We expect that this will help us to arrive at a better understanding of the position and possibilities of local community energy initiatives.

With our study, we aim to contribute to the literature in three ways. First is that we expand the teamwork literature by investigating the hitherto uncovered local energy initiatives. So far, most research on teamwork is carried out regarding formal organizations; therefore we chose to include the model of Gartner (Brush, Manolova, & Edelman, 2008; Katz & Gartner, 1988) in our analysis, as this explicitly covers emerging organisations. Second is that we use Actor-Network Theory (Jolivet & Heiskanen, 2010; Law & Hassard, 1999) and the Pentagram model (Nijkamp & Ursem, 1998) to analyse how local energy initiatives are related to more overarching networks. So far, these two analytical frameworks have not been used to investigate these entities: Nijkamp and Ursem (1998) primarily focuses on large cities, whereas Jolivet et al. (2010) describe a commercial initiative. Third is that this is the first empirical study after local community energy initiatives in the Netherlands. The latter is of interest given the relatively small share of renewable energy in the current Dutch energy system as was mentioned before.

The remainder of this article is organized as follows. Section 5.2 provides the theoretical background for our analysis. The methodology and data used is introduced in Section 5.3. Section 5.4 presents and discusses the results. Section 5.5 concludes.

5.2. Background regarding approaches of social aspects of energy transitions

Here, we discuss different theoretical approaches of social aspects of energy transition. There are several theoretical approaches that might help explain the realities of energy policy and local activism. In this section we briefly highlight studies of local energy transformations, which respectively take social acceptance as starting point, focus on technological innovation processes, concentrate on grass-roots innovation, or investigate municipal energy plans. Theoretical lenses used in these approaches include path creation, multi-level perspective (MLP), and Actor-Network Theory. We conclude with motivating our choice for Actor-Network Theory as the basis for our empirical analysis.

Social acceptance

Individual citizens as energy users, or as homeowners, have attracted the attention of researchers. Often citizens are studied in the framework of social acceptance of renewable energy, in this literature willingness to invest in energy efficiency measures by homeowners, plays an important role (see Perlaviciute and Steg (2014) for an overview). On the other hand, citizen resistance e.g. to the siting of windmills, has attracted academic interest too. Resistance to renewable energy projects is often studied in the frame of NIMBY-ism, such as the study of CCS in the North of the Netherlands (van Os, Herber, & Scholtens, 2014). Wüstenhagen et al. (2007) conceptualize social acceptance, identifying three categories of acceptance: socio-political, community and market acceptance. According to Bidmon and Knab (2014), energy transitions could be substantially improved by including non-technological innovations, such as new business models. Their conceptual discussion underpins the importance of appropriate business models in order to further develop niches. This links to the need of market acceptance as discussed in Wüstenhagen et al. (2007).

Against this background our subject can be placed in the category of community acceptance. The cases in our sample have moved from passive acceptance to active engagement. Therefore, our paper studies the processes behind the realization of sustainable energy projects by local community initiatives.

Path creation

From innovation literature the concept of path creation seems promising to analyse barriers and incentives in the energy transition (Garud & Karnøe, 2003). This idea draws on the metaphor of a development path, which guides and restricts the development of technologies. To create a new path involves a lot of risks in investing financial, human and knowledge resources in new technologies (Verbong & Geels, 2007). How can we interpret the activities of citizens initiatives against the background of path creation? Here the concept of niches as proposed in the MLP framework could be of assistance. MLP has shown to be very productive regarding its application to technological developments, especially in the field of energy. The route for influencing the energy system according to the MLP is by protecting and managing niches. In these protected spaces technological innovation is supported by for example subsidies or tax incentives and regulations. As such, the technological innovations are set apart until the products can compete on their own. Emerging energy technologies on the local level were analysed by Raven et al. (2008). According to Hielscher et al. (2011) and Hargreaves et al. (2011; 2013), local initiatives can be seen as niches, which are set quite apart from the business-as-usual or conventional ways of operating in the economy. An in-depth analysis of the usefulness of the niche-concept for grass-roots initiatives is detailed by Seyfang and Longhurst (2013) in a study after currency initiatives.

Grass roots innovation

Studies of grass roots transformation show that grassroots or bottom up transitions have their source in local networks of engaged citizens, who are moral agents. Kirkman (2009) argues that moral agents make ethical choices, but are hindered by 'limits of agency'; barriers are present both in cultural and political traditions and in the physical layout of our built environment. Examples of barriers are shown and discussed in (H.L.F. de Groot, Verhoef, & Nijkamp, 2001; Painuly, 2001; Sardianou & Genoudi, 2013). We aim to develop an approach that accounts for the bottom up path-creation by local networks of moral agents. To this extent, we will rely on Actor-Network Theory. Here, socio-technological phenomena are interpreted as heterogeneous networks, made up of human actors and non-human actors such as technological devices. Law and Callon (1992) propose that the level of 'success' of a project is a function of the degree of mobilization of local actors and the degree of attachment of actors in the global network. For example, Hauber and Ruppert-Winkel (2012) in an in-depth study of three rural regions in Germany with strong ambitions to develop towards energy self-sufficiency, find that social, market as well as technological aspects are included. They identify three phases in the development of these regions: pioneer phase, pivotal network phase and extended network/growing market phase. Previous research on community energy particularly has been done after the UK; following the publication of a UK policy document entitled Local *Energy Communities*. Especially Walker and Devine-Wright (2008; 2008; 2010) have published on this topic. For Germany, several studies (Schweizer-Ries, 2008; Zoellner et al., 2008) relate to qualitative psychological factors regarding energy initiatives by the public. Walker et al. (2007a) argue that the level of acceptance of energy production units is stronger when the unit is more open, participatory, local and collective. An important factor in this model is 'trust'; members of the local community have to trust the local initiative in order to support, or at least not oppose, the projects that this initiative wants to undertake (Walker, Devine-Wright, et al., 2010). The absence of trust often leads to opposition to sustainable energy projects, as is shown in a number of studies into siting of windmills (Jolivet & Heiskanen, 2010; R.P.J.M. Raven et al., 2009). Then, it seems important to investigate which factors might influence 'trust'. In our cases we specifically look at internal trust, because the literature on advocacy groups – primarily undertaken for the US – suggests that teamwork and internal democracy are important factors that influence the effectiveness of these groups (Ellemers, De Gilder, & Haslam, 2004). On top of this, our research takes up findings on leadership and teamwork (Salas, Sims, Burke, & Burke, 2005), which we apply to the local community energy initiatives.

Municipal energy plans

Several case studies have investigated the role of local government in (renewable) energy planning. For example, St. Denis and Parker compared the energy plans from 10 Canadian communities, ranging in size from 500 to 956.000 inhabitants (G.S. Denis & Parker, 2009). They observe that renewable energy is not a priority in these plans, rather they focus on energy efficiency and conservation. With regard to renewables these plans primarily focus on education and awareness-raising, with a view to raise the acceptance of renewable energy technologies. A second aspect is that municipalities undertook activities to lead by example: implementing solar technologies in buildings, or using bio-fuels for municipal vehicles. Citizen participation in the formulation and implementation of these plans appear rather limited, although consultations took place. The municipal energy plans in this study apparently did not allow for active citizen engagement.

Furthermore, Nijkamp and Ursem (1998) study municipal policies to promote sustainable energy in European cities. They identified five factors that are crucial in attaining successful implementation of local energy measures: technology; communication; social conditions; financial requirements and organization. Mårtensson and Westerberg (2007) present three qualitative case studies of municipal bio-energy systems in Sweden. In their study they re-construct the local processes in order to compare strategic models for energy transformation, sub-processes problem formulation, mobilization and communication are identified. On the basis of their findings they come up with three strategic models that could be used as a tool for municipalities that want to embark on an energy transformation process. Recently, Slee (2015) investigates the roles of community ownership in on-shore wind energy in Scotland. He argues this development can empower communities as well as deliver on governmental energy goals. Furthermore, the analysis of Slee might provide a bridge between governmental policies and community initiatives.

In our study, we will apply the literature about local networks to local energy initiatives. We use a conceptual model based on Law and Callon (1992) to analyse local energy initiatives in the Netherlands. These initiatives may be 'forming new centres for change', according to Kirkman (2009, p. 254), who expects that widespread changes can occur once local networks team up on a national or global scale. Therefore, we propose to analyse the networks of moral agents as the locus of agency. We relate to our empirical research on local energy communities that is explained in the next section.

When analysing local community energy initiatives (in essence non-profit grassroots organizations) we want to find out if the non-technological challenges they face mirror the factors recognized in St. Denis and Parker (2009) and Nijkamp and Ursem (1998), who analyse at the level of municipalities and cities respectively. More specifically, these energy initiatives face financial challenges, such as finding sufficient funding. Organizational challenges include safeguarding continuity, exercising effective team leadership, and attracting membership. Furthermore, they require regular communication with their local environment and securing municipal and/or regional support. Especially legal procedures can be rather complicated for non-experts. In addition, the projects face construction and operation permits, and how to manage required maintenance. Also, the members of these initiatives have to familiarize themselves with technological options. But, as already mentioned before, the latter are not investigated in this study.

5.3. Method

5.3.1 Case study

In order to investigate local community energy initiatives in more depth we rely on a case study approach. According to Yin (1994), case studies facilitate the search for conceptual patterns and categories, which helps to understand a certain phenomenon. As defined by Simons 2009: 'case study is an indepth exploration from multiple perspectives of the complexity and uniqueness of a particular project, policy, institution, program or system in a 'real-life' context. (cited by Thomas, (2011, p. 512). The choice of cases aims at the inclusion of a wide array of qualitative aspects, to be able to study as much relevant patterns as possible. This process is called strategic selection and is introduced by Glaser and Strauss (1970), Strauss and Corbin (1990), and Flyvbjerg (2006), among others. The number of cases is usually very limited, in the literature used for this paper we find between two and ten cases. For example, case studies by Hauber and Ruppert-Winkel (2012), Martensson and Westerberg (2007), Arentsen and Bellekom (2014),

Viardot et al. (2013), as well as by (Bobinaite & Tarvydas, 2014; Centeno Brito, Lobato, Nunes, & Serra, 2014; Heras-Saizarbitoria, Zamanillo, & Laskurain, 2013; Santillán Soto, García Cueto, Ojeda Benítez, & Lambert Arista, 2014; van Os et al., 2014), while Saunders et al. (2012) study two cases of innovative finance for community energy.
Therefore, case studies do not lend themselves to statistical analyses. A case study often includes multiple methods of data gathering (Stake, 2013). In our study, information was gathered through qualitative interviews, observations during meetings and activities, small-scale surveys, mapping. We also studied websites published by the initiatives, printed material and grey literature. The interviews were transcribed, coded and analysed with Nvivo. To get an overview of the potential for energy production and energy saving, we did quick scans of the natural and built environment of the communities

5.3.2 Case setting

In the period 2010-2013, we analysed the activities of thirteen local community energy initiatives in the North of the Netherlands. All initiatives consisted of volunteering citizens. We contacted these initiatives at regional information meetings on the subject of local energy production. These community groups have diverse backgrounds, but tend to converge as to their goal of promoting local energy production. They range from political parties, commercial ventures, and energy cooperatives, to village working groups. An overview is provided in Table 9.

They are set within villages or cities that differ widely as to population size. The smallest initiative in our sample (#9 Wessinghuizen) is set in a community of only 28 inhabitants, whereas the largest one (#4 Groningen) is in a city of 200 thousand. Nine of the thirteen initiatives are set within a village of less than 2,000 inhabitants, and three in a village with a population between two and twenty thousand.

They are located in different geographical landscapes and focus on various energy technologies. Two of the initiatives (#4 Groningen and #11 Franeker; 15%) are in an urban landscape. However, most (85%) are in a rural landscape. With 54% of the cases, there is an open landscape, and the remainder is evenly split along wooded and mixed landscape. One initiative (#5 Oldehove) is set within a UNESCO heritage landscape. As to the technologies applied, we find that solar energy (mainly PV) is used in nine of the initiatives (69%). Biomass is used in four (31%). Furthermore, in six initiatives (46%) energy efficiency is a point of attention. In case #5, the sustainable use of water is part of the initiative as well.

In the remainder of this article, we primarily focus on the ambitions, activities and organisation of local energy initiatives.

Table 9. Descriptive information regarding thirteen local community energy initiatives in the Netherlands.

Nr.	Location	Population	Landscape	Technology
1.	Balinge	110	Wooded Rural	Biomass
2.	Hooghalen	940	Wooded Rural	Sun PV Efficiency
3.	Westerveld	19,176	Wooded Rural	Sun PV Efficiency
4.	Groningen	200,000	Urban Open	Sun PV
5.	Oldehove	1,659	Rural Open	SunPV Biomass Water
6.	Pekela	13,449	Rural Open	SunPV
7.	Pieterburen	375	Rural Open	SunPV Efficiency
8.	Schouwerzijl	100	Rural Open	SunPV Efficiency
9.	Wessinghuizen	28	Rural Mixed	Biomass
10.	Zuidhorn	6,816	Rural Open	SunPV SunThermal
11.	Franeker	1,214	Urban Open	Efficiency
12.	Makkinga	1,039	Rural Mixed	SunPV Biomass SunThermal
13.	Oenkerk	1,800	Rural Mixed	Sun PV Efficiency

5.3.3 Framework for analysis

In our analysis, we specifically look at two dimensions as outlined in Law and Callon (1992): relations with outside networks and commitment of members. The relations with outside networks are the channels through which multiple actors influence each other, thus co-producing the result of the undertaken project. Therefore, more and stronger attachments lead to more influence on a successful outcome of the project. Secondly, the actors have to be committed to the project to achieve the best results. This ties in with teamwork literature, which points to motivation of team members as a decisive factor in achieving team goals. Thus, we analyse how these two dimensions influence the effectiveness of local energy initiatives.

As to relations with outside networks, we investigate local energy initiatives as embedded and interlinked networks. The local network consists of the energy initiative itself, as well as its relations to other local organizations, such as schools, the municipality, sports, local economic actors (shops, restaurants, farms). The outside network consists of all existing organisations that could be related to the local initiative, such as regional intermediary organisations, national networks, governmental agencies, and incumbent companies. Hargreaves et al. (2013) and Parag et al. (2013) investigated intermediaries and the maintenance of networks for community initiative in the UK. The degree of attachments of local actors to this outside network, is expected to influence the effectiveness of the initiative. To this extent, we investigate members' individual networks, relations to relevant regional and national support systems, relations to existing energy actors (incumbents) and national policies.

As to commitments, we investigate the commitment of local actors along three dimensions: organisation development, existence of a shared vision and level of activities. Following the literature on team effectiveness, we expect a more successful initiative when the internal processes are functioning in such ways that trust and sustainable leadership are guaranteed (Salas et al., 2005). We first looked at *organisation development*, which in our cases often meant evolving from an ad hoc working group to a more formal organisation type. For a sustained participation in team activities several aspects are taken into account, such as the continuity of membership, the number of active members and the amount of time members can and will spare for common activities. Strength and clarity of vision is a second aspect of commitment. From the literature (e.g. (Salas et al., 2005; Seyfang, Park, & Smith, 2013) we derive the expectation that a strong shared vision, made concrete in practical steps, is an important factor in determining organisational success. Seyfang et. Al. (2013) also mentions the importance of a shared group vision, group structures, as well as commitment of individuals. The third aspect of organisations that we focus on is the level of activities, which we identified

Table 10. Overview of the results of the case studies

#	Dimension 1	Dimension 2		
	Global and local network links	**Organisation development**	**Shared Vision**	**Level of activities**
1.	- collaboration with nature agency - municipality - schools in nearby villages	small informal village initiative with local leaders.	Individual systems with biomass heaters and sun thermal installation.	- Collective (monthly) harvesting in nearby wood - energy education in schools
2.	- Village Hall, - municipality, - local school - regional welfare organization - Regional environment organization - energy engineering (through invididual members)	formal 'Stichting' with a board and five workgroups.	Energy neutral village in 2020	- Energy fair - Survey - Website - Social media - Courses SunPV & energy efficiency for home owners - Participation in technical research projects
3.	- CE-engineering bureau (through individual members)	A local political party, Progressief Westerveld, drives the initiative in the municipality of Westerveld.	Adopted fund and action plan on community energy actions	- Communication - Advisory role to municipality - Policy documents - Website
4.	- Cooperation with initiatives Fryslân and Drenthe - municipality - national links with e-decentraal - energy incumbents (Shell, Gasunie) through individual members)	Co-operation 'Grunneger Power' formed in organ 2011. - local initiatives can attach themselves to GP, as a local branch.	Renewable energy and local economy	- PV projects - PV advice - Establish green energy provider
5.	- Gasunie (through individual members) - Groningen (province)	- Local Sustainable Energy Firm (LDEB) on commercial basis - board with regional experts.	Supply energy in the whole of Middag-Humsterland and wider region.	- Funding from the Province of Groningen to set up an organization

6.	Municipality, province Groningen, GrEK	Formal Stichting with board.	CO_2-or energyneutral village	- PV-project - information meeting - Facebook page - press - survey
7.	- participating in Duurzaam Pieterburen, - Dorpshuis Pieterburen - municipality	Formed out of a protest group 'Pieterburen Tegengas'. - local leadership	Renewable energy-village Against underground storage of CO_2	- Information meetings
8.	- regional networks through individual members	Informal working group under aegis of Village organization (Dorpsbelangen)	Promote individual actions to reduce CO_2-emissions	- Series of meetings about home insulation, solar panels and other new options to save energy and produce your own.
9.	- funding organization (Heidemij) through individual members - nature organisation	Successful small-scale initiative plans to supply houses with from the direct environment.	Renewable energy Social cohesion	- Promotion of pellet stoves - Installation of PV
10.	- municipality	Municipal working group	Not yet determined	In preparation
11.	- municipality	Small local working group, with representation of local stakeholders	Strengthen inner city by advising owners of historic buildings on energy improvements	- Information meeting,
12.	- municipality - local private sector - school - village organization	SLIM- subsidized project for three years.	Sustainable village: economic, energy, agriculture, food production,	- building solar thermal installations, - promoting solar panels, - village kitchen garden. - Plan to incorporate energy from biomass plant on farm outside village.
13.	-municipality -province	Village initiative started in 2011, informal working group co-operation sustainable energy	Mission to become energy neutral in 2050.	- Plans include collective purchase of solar panels - promoting energy efficiency

in interviews, communications and websites. The *level of activities* is interpreted as an indicator for a high commitment of members.

Summarizing, the resulting conceptual model based on Law and Callon (1992) holds that local energy initiatives can be situated along two dimensions: Attachments to outside networks and commitment of members. On the basis of this conceptual model we have analysed our cases. The results are provided in the next section.

5.4. Results

In this section we present and discuss the findings of the thirteen case studies, developed along the lines of our conceptual model. We first discuss the attachments of the local initiative to outside networks, and then investigate if the level of attachments influences local achievements. Subsequently, we look at the degree of commitment of local actors to the project, and the possible ways in which this affects local achievements. Table gives an overview of the results of the analysis of the data for the thirteen local community energy initiatives in the Netherlands.

5.4.1 First dimension, relations with outside networks

Our first dimension, relations to outside networks, is described in this section. Table shows that with eleven initiatives (85%) there is a relationship with the local or regional government (municipality, province). Seven initiatives (54%) have a relation with other community groups (schools, village communities). With six initiatives (46%), we observe there is a direct relationship with the business community. With four initiatives (31%) there is a contact with a regional or nation non-governmental organisation. This adds up to more than 100% as the initiatives have multiple relations.

Every actor in a network is in turn also part of other networks. In the local initiatives we studied it was apparent that many members were engaged in diverse networks and brought in knowledge and opportunities that their attachment to these other actors provided. One obvious attachment members have is to their employer. Some examples of relevant job activities on regional or national level of agents in our cases are the following:

- membership of municipal board (#13),
- provincial civil servant specializing in energy policy (#13),
- director of energy advisory business (#2)
- engineer with energy research institute (#3),
- policy advisor with national gas institute (#4, #5),
- employee at regional support organisation with energy as main focus (#2).

We observe that people employed in the energy sector are voluntary engaging in local initiatives. We also find that in several instances group members have an energy related education. A similar observation is reported by Schwencke et al. (2013). Furthermore, we regularly find small locally based companies, active in the field of renewable and sustainable energy, that participate in the local initiatives (cases #2, #5, #11).

Other relevant competences that members contributed to the initiative were related to finance and communication.

Organisations in the direct vicinity form a part of the network. Members with an affiliation to local organisations can reach out to small businesses, municipal government, local farmers, or the parents of schoolchildren to join the initiative and take part in activities. In our cases there was considerable involvement from local businesses (cases #2, #4, #5, #7, #12, #13), farmers (cases #5, #12), hotels or camping sites (case #2), and schools (cases #1, #2).

Regional environmental organizations as well as provincial village organisations are increasingly active in organizing meetings for local initiatives to meet each other, to share experiences and to obtain information and advice. These meetings attract a lot of attendees from local initiatives. All initiatives in our sample regularly take part in this kind of regional activities.

On a *national level*, organisations for lobbying and networking have been set up in the Netherlands. These have been initiated by environmental organisations, by provincial village organisations and by the energy initiatives themselves. This means there are now three national networks of local energy initiatives: *HierOpgewekt, Netwerk Duurzame Dorpen, E-decentraal*. Their activities range from organizing meetings to lobbying national policy. E-decentraal played an active role in the negotiations for the national energy covenant *(Energieakkoord)*, so the influence of local initiatives on national policy is growing (North, 2011).

5.4.2 Second dimension, degree of commitment of local actors

In this subsection we focus on our second dimension, degree of commitment of local actors to the project. We subsequently discuss the results on organisation development, shared vision and level of activities.

Aspect 1: Organisation development

Teambuilding literature (Bolman & Deal, 2007; Salas et al., 2005; Taveira, 2008) shows that organisations are more successful if trust and sustainable leadership are guaranteed. Seyfang et al. (2013) show that community energy groups in general have considerable trouble to survive. Furthermore, their findings suggest that the development of more formal organisation structures could be conditional to achieve group objectives.

Table 10 shows that most initiatives are relatively small and informal (5, i.e. 39%). Table 10 gives an overview of different types of commonly used organization structures and how the thirteen cases can be mapped along these types.

Table 11. Taxonomy of the ways of organizing local community energy initiatives (from less formal to more formal)

Organisation	**Cases**
Working group with the specific purpose to promote community energy.	#1, #11, #12
Working group attached to other groups already operating at the local community level.	#7, #8
Working group attached to political party.	#3, #10
Foundation with the specific purpose to promote community energy.	#2, #6
Cooperative to produce and distribute local energy at the community level.	#4, #13
Commercial venture.	#5

Community initiatives are dynamic. For example, one of the initiatives (#2) grew in size from 5 to 25 active members in one year. Typically, they initiatives with highly committed members, stimulating leadership and multiple activities go through a formalisation process after a period of six months to two years.

The initiators in the majority of cases started with an *informal working group* in close cooperation with the local village organisation (for a review of social entrepreneurship in relation to social networks, see (Dufays & Huybrechts, 2014). In some instances, for example in case #3, the organisational route was via a local political party.

Others set up a foundation, i.e. a more formal organisation, to advance its goal of promoting renewable energy (#2, #6).

A *co-operative* is a type of organisation in which members can collectively own an energy company, however the financial risks and legal difficulties in setting up such a collective business proved a formidable barrier for many of the small initiatives in our study. The co-operations that were formed often chose to align themselves to a larger energy company with a strong inclination for sustainability, such as Greenchoice or Trianel. Recently, new regional umbrella energy co-operatives have now been formed. They provide local initiatives with the opportunity to join a strong regional cooperation, while preserving their local autonomy as well as receiving any profits from customers in their constituency.

In our sample we find only one initiative that established itself as a commercial venture. However, Walker et al. (2010) points to lack of trust when commercial interests prevail.

In addition, we find that local leadership is very important in the choice of organisation type, also consistent with the findings of Schwencke et al. (2013). The original initiators in our cases largely determined the organisational structure of the initiative.

An additional observation regards the gender aspect of the energy initiatives. In our sample, with 10 initiatives (77%) the initiator was male. In four cases (31%) the whole group consisted of men, while the other initiatives were more gender balanced. This gender aspect needs more attention, which at present is outside the scope of our research.

Aspect 2: Shared vision

A strong shared vision, made concrete in practical steps, is supposed to strengthen the commitment of members to the organisation, as outlined in teamwork literature (Salas et al., 2005), as well as Seyfang et al. (2013). Table 10. shows that in eleven cases (85%) renewable energy is a shared vision. On top of this, we observe that with six initiatives (46%) community objectives are part of the vision as well. Sustainability explicitly plays a role in three initiatives (23%). One initiative has primarily a commercial objective. And with one initiative, there also is a protest involved against the underground storage of carbon dioxide. Hence, most initiatives are of a 'please in my backyard' nature.

In our sample, the visions developed by the local initiatives differ in scope and ambition. On the one hand, the modest ambition could be to stimulate energy efficiency measures and installation of solar PV panels in the village (#7, #8). After organizing several meetings in the Village Hall about the technical and financial aspects of solar PV, often resulting in a surge of installations in the village, the ambition was considered to be fulfilled and the group was disbanded. At the other end of the spectrum, one local initiative (#2) has the ambition to become an energy neutral village in 2020, meaning that the village produces as much energy as it consumes on a yearly basis. A tentative scenario of how to reach this ambition was developed.

In the field of energy transition technical appliances and energy infrastructures are often an important component of the vision. In theory, there are many technological options to decentralize energy production. However, in (Dutch) practice, the actual choice is severely limited by policy constraints. For example regional energy policy in the North of the Netherlands does not allow local windmills (Provincie Friesland, 2012; Provincie Groningen, 2008). This means that local energy coops do not have the opportunity to invest in a cooperative village windmill. Another example concerns biomass installations, which are restricted to farmers, so again this technology is not within reach of most local initiatives. This leaves the local groups with primarily individual installations, e.g. combined heat and power installations and solar panels, as the most promising feasible ('legal') technologies. The recent fall in prices for solar PV has helped to bring 'prosumerism' within reach. Small-scale use of biomass (e.g. by using wood pellets and woodchips) is another possibility on the individual level. Visions of the initiatives in our sample reflect this limited array of possibilities. Solar PV, insulation, and similar household scale measures are paramount in these visions, whereas plans for cooperative energy production with local facilities on a village scale rarely appear.

Not only prices of the appliances matter, also facilities to share or feedback excess energy play a role in inhibiting or stimulating the choice for a certain technology. In the Netherlands, fiscal arrangements generally do not favour small-scale energy production (Wolsink, 2012b). Therefore, installations in and on private houses, combined with energy efficiency measures, turned out to be the most popular option for local initiatives. Recently, the Dutch Energy Covenant facilitates small tax deductions for community energy projects.

Aspect 3: Level of activities

Table 10. (last column) shows the initiatives display a wide spectrum of activities. With eight initiatives (62%), we witness education and information activities, such as energy markets, information meetings, house-to-house surveys. Other activities range from harvesting biomass to organizing a fair, advising the municipality, trying to get funding, and demonstration projects. Also social media, including websites, twitter accounts and Facebook pages, are used by the initiatives.

When looking at the Netherlands in general, we observe that the level of activities with local energy as a topic has grown enormously since 2010. A search in LexisNexis on Dutch words (e.g., *lokale energie coöperatie, lokale energie informatie avond*) delivered 300 news articles, after removing double and irrelevant clippings. The first information meetings mentioned in the newspapers took place in 2010, the amount of meetings grew in 2012 and 2013, and in 2014 it is possible to visit a local meeting on energy issues almost every week. The agenda of these meetings usually includes discussions regarding the installation of solar panels, collective wind energy, energy efficiency measures, and the launch of a local energy cooperative. Earlier clippings more often mention involvement of the municipality. Against this background we were present as observer at several such information meetings of the initiatives in our sample. Turnout for these meetings is relatively high; we witnessed numbers of attendees ranging from 35 to 65, in villages of less than 500 inhabitants.

Internet is an important communication tool for local organisations. The majority of the local groups in our sample created a website, and/ or a Facebook page, and often use other social media, such as Twitter. This is also the case for the initiatives mentioned in the newspaper articles, as far as could be retrieved. However, a full investigation of the impact of social media in local energy initiatives lies outside the scope of this paper.

5.4.3 Reflections

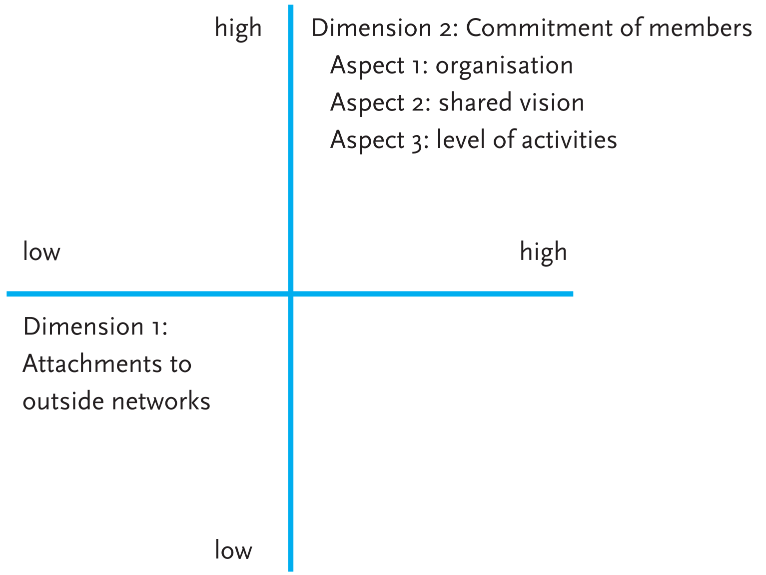
Regarding the dimension 'level of attachments to outside networks' our findings suggest that attachments to local, regional and national networks are continually developed and updated. These attachments also include informal ties, such as through the occupation of members in the energy and/or governmental sector. The community energy field is very dynamic, as is also reported by Hargreaves et al. (2011; 2013). They conclude there is as yet no 'coherent, robust and strategic community energy niche', while questioning if such a niche would be a desirable goal.

With regard to the second dimension, 'commitment of members' our findings give insights in grassroots organisation structures. A transformation from loosely connected individuals in an informal working group to a formal organisation such as a co-op is observable in multiple cases in our sample. Seyfang et al. (2013) also report this finding in their UK-wide survey.

A shared vision, put forward as an important condition for team-success, appears to have a binding role in these initiatives. The connection of organisation development and shared vision should be further researched. While in grassroots initiatives the vision is often not very detailed, in municipal energy plans the description of goals is often elaborated in more detail.

A high level of activities is interpreted here as a sign of the commitment of members to the local initiative and its goals. We saw a sharp rise of activities in the Netherlands in general, as well as in our cases. However, due to time-constraints and other competing issues, it is a challenge for citizens initiatives to continue on this high level (Hoffman & High-Pippert, 2010).

Figure 7.: Conceptual framework for the analysis of local community energy initiatives



5.5. Conclusion

In the Netherlands, we observe an active and growing number of local community energy initiatives. They increasingly cooperate on a regional and national level. New modes of organisation are developed to realize local vision and ambition. In this study, we focus on the social aspects of these initiatives and leave the technological issues aside.

Our key question 'How can local community energy initiatives contribute to a decentralized sustainable energy system' guided us in investigating local level dynamics. On the basis of a case study among thirteen local community initiatives in the northern provinces of the Netherlands in the period 2010-2013, we detect there is a wide variety of forms in which local community energy initiatives have organized themselves, ranging from very informal to quite formal. We provide the first application of Actor-Network Theory regarding how such initiatives relate to more overarching networks. We also provide the first account of local community energy initiatives in the Netherlands, a country that ranks very low within Europe regarding the role of renewable energy production. The main limitation of this study is that the type of local community initiatives studied is relatively young. As a result, a database with validated key characteristics and performance measures is missing and we cannot complement our qualitative analysis with a quantitative assessment.

We find that the creation of a committed local organization, with a shared vision and concrete goals is at the start of the change process. Many local initiatives went through a formalization process, which in turn strengthened the organization. Furthermore, the level of activities, including communication efforts, is an important indicator of local team effectiveness. To be successful, local organizations need to entertain strong and continuous relations both on the local as well as on the global level. Increasingly regional and national organizations are formed that connect and represent the local initiatives. We find that local community energy initiatives face the same non-technological challenges as those faced by initiatives from municipalities and cities. These include financial and legal challenges, but also organizational challenges, such as safeguarding continuity, exercising effective team leadership, and attracting membership. Furthermore, they require regular communication with their local environment and securing municipal and/or regional support. Also, the members of these initiatives have to familiarize themselves with technological options. The major difference with other types of local initiatives (e.g. as discussed in (H.L.F. de Groot et al., 2001; G.S. Denis & Parker, 2009; Mårtensson & Westerberg, 2007; Nijkamp & Ursem, 1998)) is that the local community energy initiatives clearly prioritize community benefits. In many respects, decentralized renewable and sustainable energy production appears to be a means to the end of improving social coherence.

Our study suggests that local community initiatives in the northern Netherlands are emergent organizations. Consistent with the expectations based on Actor-Network Theory we find that the first dimension, relations with outside networks, is important indeed. Relations on the local level determine partly the local support of local government, local economic actors, schools and other local constituencies. The embeddedness of the local organization in regional and national energy networks gives inspiration, information and support. The second dimension, commitment of the members of the local organizations, is a prerequisite for continuity and local effectiveness. A process of *organisation development*, from less to more formal, can be seen in many instances. The local emergent organization undertakes activities and uses websites and social media. This enforces its embeddedness in the community. The higher the local commitment, the higher will be the level of activities. On the second aspect of member commitment, *shared vision*: we find that members of the initiatives share rather general or superficial views on energy neutrality and the development of low-carbon village development. However, what is often lacking are more developed local visions with clear energy goals. In the municipal energy plans on the other hand the vision was more elaborate, however in those cases the active engagement of citizens was lacking (G.S. Denis & Parker, 2009). Combining these two strengths might enhance effectiveness of community energy governance. The third aspect of member commitment, the *level of activities*, is the most promising one; hundreds of activities are carried out by these initiatives. Challenges for the future are continuity of involvement, time spent on organizing activities, keeping members on board and keeping the village interested (Hoffman & High-Pippert, 2010; Walker, Devine-Wright, et al., 2010).

In all, we conclude that community energy initiatives are an emergent phenomenon that in the present stage provides a useful grassroots approach for many citizens to engage in the transition to a sustainable energy future. However, our research suggests that further development of organisation structures and viable visions for local energy governance is necessary to achieve lasting results.

Part III
Historical Buildings

6.
Restoration and energy reconfigurations

Earlier versions of this chapter have been published as conference papers:

- IST 2014, august 2014 in Utrecht. Co-authors Alexander Peine, Harro van Lente
- ERIC2013, September 2013, Groningen, in: Proceedings ERIC2013, (van der Schoor, 2015)

Abstract

Historical buildings provide local identity and a connection to our past. The energy transition therefore brings forth a dual challenge: to preserve historical buildings and simultaneously improve their energy performance. However, energy retrofit of historical buildings is fraught with problems, because of the high risk that energy measures damage historical qualities or even the building itself. In this paper, we investigate what strategies are used in energy reconfigurations of historical buildings.

Following Actor-Network Theory, we interpret a (historical) building as an actant in a heterogeneous network. Based on 14 case studies of energy efficient restorations we identify three types of strategies: design strategies; identity strategies and communication strategies. We illustrate our analysis with a case study of a restoration project in the Dutch town of Franeker.

The novelty of our paper lies in the identification of a broad range of strategies used in restoration processes. This highlights the multiple roles of technologies, values and discourses in the reconfiguration of buildings.

Keywords: redesign, strategies; cultural heritage; energy efficiency; restoration; actor-network theory, obduracy

6.1. Introduction

The ambition of a transition to a sustainable society brings forth the dual challenge to preserve historical buildings and simultaneously improve the energy performance of our built environment. However, there is a tension between preserving and improving, because energy reconfiguration entails multiple technical measures that may endanger valuable features of a building. In order to investigate how this tension is dealt with, we have studied a series of restoration projects with a high energy ambition. In this paper, we investigate what strategies are used to negotiate tensions between demands of conservation and energy performance. We illustrate these strategies with a case study of the restoration process of a Jugendstil library building in the Netherlands.

The conservation of heritage buildings is a European wide policy objective. Historical buildings are not only works of art but embody an important source of local identity and form a connection to our past. Heritage agencies aim to preserve historical qualities for future generations. Their work is guided by restoration theory, a philosophy developed and codified during the 19th and 20th century. International covenants, such as the Venice Charter and the Paris Declaration[13], express shared views on the conservation and restoration of built heritage. However, views on heritage protection change over time (Fredheim & Khalaf, 2016).

13. Chapter 6: http://www.icomos.org/venicecharter2004

Likewise, the reduction of energy use in the built environment is a EU-wide policy objective, in order to reach climate policy goals. Roughly 40% of the consumption of energy takes place in buildings, either in the production or consumption phase. However, energy efficiency is especially difficult to achieve in the case of historical buildings, because of strict regulations aimed at protecting historical values. Today, many users expect a building with modern comfort as well as a historical appearance. Moreover, new functionality is needed for building types that have outlived their original function. For example, how to re-use buildings such as old prisons, military barracks, factories, or railway stations, while protecting historical qualities? New functions and new demands pose a challenge to restoration design and practices.

Buildings in general enjoy a relatively long service-life of on average 50 years. In this period, they typically undergo both discursive and material changes, but remain recognizable as a built structure. This is referred to as the obduracy, or resistance to change, of the built environment (Hommels, 2005b). Historical buildings in particular are 'champions of obduracy', as they succeeded in surviving much longer than average buildings.

Recently, there has been growing interest in energy efficient restoration practices in the Netherlands, as is shown by the 'energy-neutral' restoration of Villa Diederichs in Utrecht, the 'Boostencomplex' in Maastricht and De Tempel in The Hague. Furthermore, the incorporation of energy efficiency when restoring historical buildings has also attracted interest in the literature (Grytli, Kværness, Rokseth, & Ygre, 2012;

Pankhurst & Harris, 2013; Røstvik, 2013). In the past years, many technical case studies have been performed, assessing the results of energy improvements in historical buildings (Ascione, de Rossi, & Vanoli, 2011; Cassar, 2011; Cluver & Randall, 2010; Fabbri, Zuppiroli, & Ambrogio, 2012; Maahsen-Milan & Fabbri, 2013). Less attention has been paid to processes, practices and strategies relevant to energy efficient restoration projects.

In this paper, we aim to investigate the strategies that are employed in energy reconfigurations of historical buildings. The following section starts with a discussion of social perspectives on the built environment and introduces the theoretical framework. Section 6.3 describes the methodology and provides an overview of the restoration projects we examined. Section 6.4 provides a description of strategies identified in our case studies. In section 6.5 we illustrate our approach with a more in-depth description of a case study. We conclude that our approach brings a broad arrangement of reconfiguration strategies to the fore. For a better understanding of energy efficient restorations, it is important to acknowledge the existence and interplay of different types of strategies in the (re)production of a historic building.

6.2. Theoretical framework

The literature on architectural sociology, the social history of architecture and philosophy draw our attention to the 'social side' of buildings. Foucault links buildings and their specific architectural form with the disciplining of bodies in society. He calls the system of relations between the elements of an ensemble an apparatus, *'a thoroughly heterogeneous ensemble consisting of discourses, institutions, architectural forms, regulatory decisions, laws, administrative measures, scientific statements, philosophical, moral and philanthropic propositions'* (Foucault, 1980, p. 194). King et al. (1984; 1980) have written extensively on the influence of economic, spatial, sociological and other factors on the social production of the built environment.. On the other hand, Lefaivre and Tzonis (1990) argue that it is important to examine the consequences of built objects for human relations and societies, instead of limiting historical research to architectural styles. A socio-technical perspective is used by Aibar & Bijker (1997) in their investigation of the Cerda plan, a 19th century extension of Barcelona. They consider cities as enormous artifacts that pose rich and complex research sites to analyse the relationship between power and technology. Hughes describes how German architects in the first decades of the 20th century adopted machine production as the leading design principle, to express modern culture as well as for technical and economic efficiency. Hughes (2004, p. 155) maintains that "architects have long argued that their buildings influence the behaviour and health of people living and working in them". The complex network of people that is participating in the design process is brought to the fore by Woodhouse and Patton (2004), who argue that design is done by society. If that is the case, this also means that social norms, values and assumptions are reproduced in the products of design. Therefore, they argue, it is important to move design into the public debate, to take account of social and other costs of innovation in an early stage.

To conceptually organize this array of humans, buildings and relations various concepts have been put forward. Murphy (2006) uses the concept of assemblages to describe the loose interacting elements of office workers, health inspection, feminists, research tools and building parts. She defines an assemblage as *'an arrangement of discourses, objects, practices and subject positions that work together within a particular discipline or knowledge tradition'* (2006, p. 12). Blok (2013) interprets the sustainable city buildings project of Nordhavn, Kopenhagen, as an 'urban green assemblage'. He uses actor-network theory (ANT) to develop an urban ontology for the city as 'heterogeneous and dynamic assemblages of humans and non-humans' (2013, p. 5).

Actor-network theory allows to position buildings as part of a heterogeneous network, consisting of human actors and non-human objects (or actants), which mutually shape each other as they interact. Latour and Yaneva (2008) argue that we should describe buildings as moving projects, as flows of transformations, instead of reducing them to flat drawings. This allows to reintroduce the actors that are usually left out of the picture, such as the multiple demands of commissioners, zoning regulations, the many models that are produced to impress viewers, and the reactions of users. A building is thus far from static; rather, we should see a building as an ecosystem.

How a heterogeneous network is stabilised is explored by Law & Callon (1988), who identify two dimensions: relations to outside networks and commitment of members. Both the stability and the form of artifacts can be related to the interactions in a heterogeneous network, as Law (1990, p. 113) states: *'the stability and form of artifacts should be seen as a function of the interaction of heterogeneous elements as these are shaped and assimilated into a network'*. Kärrholm (2007, p. 443) applies this thought to buildings, and argues that strengthening buildings involves *'network stabilizations, where connections between a set of actors or actants (e.g., rules and regulations, borders, sub territories, walls, locks, pavement, behaviours, and norms) become increasingly stable and predictable'*.

A stabilized network possesses obduracy, or resistance to change, which is encountered in processes of reconfiguration or 'unbuilding'. Kirkman (2009). is interested in the sources, degrees and limits of obduracy Hommels (2005b) investigates the obduracy of urban form in a study of three city-development projects in the Netherlands. Furthermore, Hommels (2005b, pp. 152–153) suggests three possible strategies to strengthen the obduracy of buildings that are considered valuable.

Applying these ideas on historical buildings, we interpret a (historical) building as a network of heterogeneous actors, both human and non-human (Law & Callon, 1988). Human actors in this case could be architects, owners, heritage protectors and municipalities. The building itself is a non-human object or actant, as are its constituting building parts, such as bricks and mortar, tiles or fixtures (Kärrholm, 2007). Other relevant actants are architectural drawings, models, regulations, or statements of significance. Actants influence the actions of other actors in the network, and can surprise even after hundreds of years, as Yaneva (2008) demonstrates in her study of the renovation of the Alte Aula in Vienna. The interactions of the human and non-human elements together shape the stability of the building.

Restoration is interpreted as a process of reconfiguration of heterogeneous elements, involving new actors, new demands for energy efficiency, new designs, new technologies and new interpretations of the building. One of the challenges for the reconfiguration of historical buildings is the conservation of their cultural-historical values. Reconfiguration pressures de-stabilize the heterogeneous network and can damage building features that are considered important. When the process of reconfiguration is finished, a new stabilized network emerges. Again, such a stabilized network is not static. Gieryn (2002, p. 35) argues that buildings ' sit somewhere between agency and structure', emphasizing that reconfigurations continually take place, both discursive and material. Such a halfway situation can also be called 'fluid stabilization' (Kärrholm, 2007); at this stage, many interpretations of the building are possible and the restoration process often entails material redesign. During the restoration process the involved actors mutually influence each other in the quest for a new stabilized building.

One could ask what buildings – as actants – contribute to stabilize networks. An obvious source of obduracy is the situatedness of buildings. Buildings are attached to a specific place and cannot be moved. Furthermore, the materiality of buildings adds to their obduracy; the large quantities of materials that buildings contain makes reconfiguration comparatively difficult and expensive. Obduracy not only resides in situatedness and materiality of buildings, but also in the cultural-historical features they contain. These features are valuable to the human actors in the network and thus contribute to its stabilisation.

6.3. Methodology

The empirical basis of this paper lies in the research project 'Energieke restauratie', which ran from 2013-2015. In the course of this project, in total 50 restoration projects were investigated using desk research, qualitative and walk-through interviews with restoration-architects, owners, energy advisers, users, and heritage protectors, and technical studies, such as thermography analysis and energy transmission calculations. Historical aspects of the buildings were identified using archival material and building history. Several papers were written in the course of this research project (Alberts, 2015; Alberts, Boschma, Van der Schoor, & Vieveen, 2014; A. De Groot & Vieveen, 2013; Paijmans, 2015; van der Schoor, 2015; Vieveen, 2015).

For this paper, we analysed processes and strategies in fourteen case studies, which are listed in Table 12. In total 41 interviews were conducted in these cases. The interviews were transcribed and subsequently coded and analysed with Atlas.ti. Five cases were reported earlier in a conference paper: Strategies for Energy Efficient Restorations (van der Schoor, 2015). Based on this analysis a framework of 'obduracy strengthening strategies' was developed, which identifies three categories: design strategies, identity strategies and communication strategies. This will be further introduced in the next section.

As an illustration of our approach, we describe the case study of the restoration of the youth society's building in Franeker, which has been transformed into a public library. In this case study six interviews were

Table 12. Overview of case studies Energieke Restauratie

	Location	Building	Building Type	Materials
1.	Driebergen	Villa Diederichs	Villa	Site visit, interviews (3), layouts, new design, technical information, statement of significance.
2.	Eerde	Koetshuis/ Paardestal	Horse shed	Site visit, interviews (3), layouts, new design, technical information, building history, statement of significance.
3.	Franeker	Bibliotheek	Library	Site visit, interviews (6), layouts, new design, technical information.
4.	Groningen	Parcivalcollege	School	Site visit, interviews (3), layouts, new design, technical information.
5.	Groningen	Aula Selwerderhof	Aula	Site visit, interviews (2), meeting notes, layouts, new design, technical information, statement of significance.
6.	Groningen	Suikerfabriek	Factory	Site visit, interview (1), layouts, new design, technical information, statement of significance.
7.	Kolham	Station	Railway Station	Site visit, interviews (3), technical information.
8.	Maastricht	Boostencomplex	Social housing estate	Site visit, interviews (4), survey, layouts, new design, technical information, statement of significance, heat report.
9.	Nieuweschans	Marechaussee-kazerne	Military barracks	Site visit, interviews (3), layouts, new design, technical information.
10.	Pieterburen	Dorpshuis	Village hall	Site visit, interviews (2), meeting notes, layouts, new design, technical information.
11.	Putten	Oud Groevenbeek	Castle	Site visit, walk-through (group) interview(1), layouts, new design, technical information.
12.	't Harde	Schouwenburg	House	Site visit, interview (1), technical information, installation design.
13.	Veenhuizen	Gevangenis	Prison	Site visit, interviews (2), layouts, new design, technical information, statement of significance.
14.	Winschoten	Phaff	Factory	Site visit, design workshops (2), layouts, new design, archival material.
15.	General preparation of research themes, interviews (3)			

conducted, respectively with the architects, civil servants, historical buildings board, and user representatives. We also received photographs of all stages of the restoration process, taken by the architect's team, and layouts of the reconfiguration plans. The case-description (section 6.5) follows the format of a tour through the building, highlighting important decisions, actors, and developments.

6.4. Framework of strengthening strategies

In restoration projects decisions continually have to be made regarding redesign for new uses and energy efficiency, while conserving historic fabric and features. To bridge the gap between historical values and energy values actors develop and employ strategies (Cassar, 2009). Furthermore, already in 1994 Cassar published six 'rules of thumb', emphasizing that 'good design, careful execution and competent management are required in order to realise worthwhile benefits' (cited in Cassar, 2011, p. 6). Taylor and Cassar (2008) point to the symbiotic relationship between representation and conservation. Sunikka-Blank and Galvin (2016) find that homeowners struggle to balance comfort, heritage and aesthetic concerns.

In our case studies, we were especially interested in strategies that were used in reconfiguration processes. Next, we categorized these strategies in three groups: design, identity and communication strategies.

Design strategies: New relations with materials and technologies

In a restoration plan, a building is re-designed to conserve existing values and to incorporate new demands of stakeholders. Technical design strategies to improve energy and comfort are described by Van de Ven et al. (2011; 2011) for the Dutch historic building sector. Examples are the use of original characteristic elements, such as disused rooflights; traditional materials with good insulation capacity, such as thatch; and to combine old radiators with new low-temperature heaters. Restoration architects and engineers often (have to) find creative solutions to let light in, hide ventilation ducts, use non-authentic building parts for new technology. Continual decisions have to be made on what to do with existing parts and features.

Identity strategies: Relations with cultural-historical and social values

These strategies entail emphasizing cultural-historical values to convince stakeholders of the importance of conservation of a building. Hommels (2005b) suggested that stressing original ideas, positioning the building as historical exemplar and registration as a monument could strengthen the obduracy of a building. Especially for unlisted buildings and structures these steps are necessary. The importance of acknowledging social values is suggested by Van Emstede (2008), who analyses a case where the restoration

Table 13. Framework of strengthening strategies

Strategies for strengthening historical buildings		
Design strategies – relate to reconfigurations of materials and technologies		
1.	Facilitate new functions for the building	Functional redesign Improvement of energy efficiency
2.	Technical solutions for energy efficiency	Technical designs
Identity strategies – relate to cultural-historical values		
3.	Identify Cultural-historical values	Historical-architectural values Aesthetic values Historical values (links to local historical persons or events) Characteristic building styles
4.	Identify Context value	Value of historical building for environment, and/ or vice versa Characteristic townscapes
5.	Acknowledge social value	Value of building(s) for inhabitants Collected memories
6.	Translate findings to legislation documents	Apply for registration as a (municipal) monument
Communication strategies – connections with human actors		
7.	Attract new users	Propose new functionalities
8.	Strengthen local network	Encourage active role of municipality Early involvement of heritage board Involve new stakeholders, such as local historical society, neighbourhood organisations Media approach
9.	Organisation of restoration work	Building team approach Expert advice on energy
10.	Financial instruments	Sponsors Subsidies

of a dockyard ultimately failed, because the restoration design underestimated the importance of socio-cultural values for the inhabitants of the city. Furthermore, aesthetic values and collected memories belong to the cultural capital of citizens, and are strongly related to identity (Sunikka-Blank & Galvin, 2016; Tweed & Sutherland, 2007).

Communication strategies: New relations with human actors

While design strategies relate to the materiality of a building, and identity strategies to its cultural-historical values, communication strategies are directed at the strengthening of the ties between stakeholders in a restoration project. The interests of involved actors can be contradictory and values often change over time (Howard & Pinder, 2003). Thus, in restoration projects interests and values of users, authorities, sponsors and the general public have to be aligned. In many cases new users have to be found for a historic building, as unused buildings typically deteriorate rather quickly and lack carers and sponsors. Early communication with the municipal heritage agency is important to explain the goals for conservation and energy measures. Procurement of sponsors and subsidies for financing energy as well as conservation ambitions often required the mobilization of professional networks.

The project organisation (architects, energy advisors, building companies) also has a decisive influence on the projects' results. For example, communication within the building team and early involvement of energy advisors were often mentioned as a factor that influenced the outcome of an energy efficient restoration.

6.5. Restoration in Franeker: a case of conserving identity and energy

6.5.1 The story of the R.C. Society's Building; a walk through

Franeker is a historic town in Friesland, in the north of the Netherlands, which boasts more than 300 listed buildings in the town centre. We studied the restoration of the library, housed in a building originally designed for roman catholic youth activities. We take you with us on a tour through the building, starting in the Martiniplantsoen, the former churchyard behind the Martinikerk in Franeker. The old Jugendstil building before us is returned to its former glory. The lettering says 'R.C. Vereenigings' to the left and 'Gebouw' to the right of the building, meaning 'R.C. Society's – Building'. From his recess at the first-floor Saint Anthony, the saint from Padua that looks after lost possessions, is overlooking the square. Behind him on the roof, a small shed houses the heat pump installation. The shed is not historical, but also not visible from the ground.

Local architect and carpenter Nicolaas J. Adema (1860-1946), who was an active member of the RC church, designed the building in 1907. It was meant to house the activities organized for the local Roman Catholic youth by the

Antoniusvereniging (Society of Saint Anthony). Now readers have succeeded the catholic youth that once organized their festivities in the central hall. The building is surrounded by new building parts, which house a café, a shop and several offices.

The arch like entrance, proudly announcing the year of building 1909, is now no longer used. So, we enter the building through a narrow alley. Just across once stood the Catholic church, from which the pastor was sternly overseeing the youthful activities. Since the restoration in 2003 the alley connects the square with a primary shopping street. The municipality hoped to attract more visitors to this less popular area by connecting the square with the shopping street. Entering the newly built façade in the alley we encounter a welfare café and -shop, in front of us a stair goes up to offices on the first floor. These new additions are built as annex to the south- and west side of the building, leaving the original walls intact. The main building now houses the public library.

A large breakthrough in the former southern wall takes us to the main hall of the library. This spacious reading room used to house the activities of the Catholic youth, such as plays, lectures, music and festivities. (Although dancing was prohibited by the Catholic church.) In the sixties, the building was used as dancing hall. These activities used stage lighting or modern-day disco lights, which means there was virtually no daylight in the main hall. Obviously, a reading room needs good lighting, therefore the restoration architect proposed to enlarge the windows in the east wall, bordering the alley. *'Luckily these windows could be enlarged, otherwise the functionality would not have been right for us,'* users tell us. They are quite satisfied with the result: *'a lot of natural light is coming in. The offices also have large windows, so we can do a lot without using artificial lighting.'* At the outside of the building, this intervention led to a more attractive alley, as blind walls are experienced as uninviting and socially unsafe. However, the intervention in the building was rather radical: *'these window frames were bricked for a large part, so we took a saw to a listed building and emptied the blind friezes right down to the floor...'* (interview architect)

More light is let in through the now restored skylight located above the main hall, bordered by a beautifully decorated ceiling. During the restoration, these Jugendstil decorations emerged from behind the ply board. The decorations were painstakingly restored, while behind the curving wooden panels new ventilation shafts could be incorporated. Incorporation of such new technical systems however can be difficult, as the architect tells us:
'I can tell you that in such a building there are more surprises than you care for, especially because everything is very compact. You can design what you want, but when you are set to work everything turns out to be very narrow. The space between those tubes is approximately zero.' (interview architect)

Another 19th century feature we see in the main hall are the cast-iron columns, which proved to be very rusty: 'here you see a beautiful authentic cast-iron construction, and when I came here the first time, I crashed through the floor, so it was completely rotten' (interview architect). The columns were completely removed and replaced by a modern support structure. At the appropriate places the columns were reinstated, however they now have a purely aesthetic function. 'We installed a wholly new steel construction; these things were picked apart, stored, and painted. Then a wooden framework was put into place, we used a bit of glue and put those things neatly into place. And this is what we call restoration.' (Interview architect, sarcastic tone) However, according to the architect this intervention was necessary to prevent the problems from recurring.

We now turn to the right and walk through the enlarged window frames in the former west wall of the main hall. These windows are now forming portals through which the annex at the west side of the building can be reached. An interior alley is created, which serves as demarcation as well as connection of new and old. The outside walls have been insulated; the new windows are modern double-glazed.

A little bit forgotten is the former entrance hall. This little hallway was considered especially valuable, so it could not be altered in any way. Jugendstil items, such as the tiling with floral motives were restored. Unfortunately, it is a very cold and drafty room, so it cannot be used as an office. From a highly prominent place, emphasised by the decorations of the outside arch and the decorated inside, it developed into a mere storage room for discarded paper.

Going up to the roof of the building we find a completely new shed. The old building did not have enough spare room for large heating installations, so to house the heat pump a small shed was built on the roof, hidden behind the statue of St. Antony, invisible from the street. *'The historic value has been somewhat violated here, we just built a shed around it. But no one can see it. So, we thought this was a workable compromise.'* (interview architect).

6.5.2 Struggles of restoration; a reflection on the case study

Where or when does a restoration process start? Maybe it started when the former owner sold the Society's Building to a project developer, who then indicated that he wanted to demolish the building altogether, replacing it with a new high-rise building with a supermarket in the ground floor strip. Protests came from the local historical society, from citizens reminiscing about their youth connected to the building; subsequently the building acquired a monumental (listed) status, thereby successfully preventing demolishment. The municipality wanted to buy the building and looked for a potentially useful program. Through a complicated property exchange chain, the municipality succeeded, the developer got the old library location to build a supermarket;

the library joined a consortium with other social services and eventually relocated to the Martiniplantsoen.

From a heritage viewpoint, this development was a new chance to save the building. A host of stakeholders came to be involved in the project, such as the shop owners in the neighbourhood, the board of the Catholic parish (also an earlier owner), the local housing corporation, a welfare institution, and the local historians. The municipality was very active in involving all these stakeholders in a 'sounding board' and secured funding for the project through a national subsidy scheme.

The process of restoration design has its own challenges. We see in this case (as in others) a series of small battles over specific aspects of the historical building. The important 'value-bearing' characteristics, which are described in the justifying description[14] are at stake in the struggle about the design and implementation of the restoration. Restoration designs were drawn up, adding a new layer of actors (or actants), such as plans and licenses, which will influence existing and new actors in the next stages of the process. For all listed buildings, historic values of the building are summarized in a 'justifying description'. Therefore, it is important to convince the heritage committee of the values of the new design, including measures to safeguard historic values, is critical to get a building license. To foster cooperation the municipality approached the national heritage board in a very early stage of the process. The architect backed up his design with technical arguments, to defend the sometimes-drastic interventions in the building. Approval of the design depends on the professional judgment of the heritage board members. However, restoration principles vary across time and across individuals: 'Every heritage civil servant has his own view, as well as every architect and commissioner. So, it is a kind of game, you have to choose your own route in this, and sometimes you succeed and sometimes you don't.' (Interview architect) Furthermore, practical arrangements influence the outcome of the procedure. For example, in the crucial meeting with the heritage committee a lot of time was spent on highly critical aspects of the new design. Because time ran out - other applicants were probably already waiting in the hallway - other (presumably) less controversial design interventions then were passed without much discussion.

Through the sounding board all official stakeholders in Franeker were part of the process, the only potential obstacle in this stage were citizens objecting to the building license. To prevent this, the architect used a very effective strategy, namely, to approach all neighbours, talk them through the restoration design, hoping this would convince them to refrain from taking formal steps in the licensing procedure. This was crucial, because the process was on a

14 (in Dutch: *redengevende omschrijving*, my translation)

very tight schedule due to the subsidy conditions. No one filed an objection to the building license.

How do actors evaluate the restoration of the R.C. Society's Building in Franeker? Evaluations vary according to the perspective of the actor. Heritage professionals consider the result of the restoration as excellent; and the public chose the library as the most beautiful library in Fryslan. However, the present users have some critical remarks, both on the functionality and the energy performance of the building. Noise, drafts, lack of functionality of the former hallway, difficulties with access due to multiple steps and the lack of storage space are other user criticisms. The beautifully tiled entrance hall now serves no representation function anymore; it just houses piles of cardboard boxes. Furthermore, according to the users the energy performance of the building is disappointing, primarily because of the high amount of electricity used. *'What can I expect from energy efficiency and calculations? Calculations are always wrong. We find that we have a very low use of natural gas, but due to the heat pump and the ventilation system a very high electricity use.'* (interview Users) This is partly due to problems with the heat pump installation.

6.5.3 Strengthening strategies used in Franeker

In this paper, our aim was to investigate what strategies are mobilized in energy reconfigurations of historic buildings. In section 6.4 we identified three categories of strengthening strategies: design strategies, identity strategies and network strategies (van der Schoor 2015), which we will now discuss for this particular case. We start with outlining what historic values were present in the building in the first place, according to the value statement of the *RK Vereenigingsgebouw*. The building is of cultural-historical and architectural historical importance:

- As a special expression of a social and religious development[15]
- For the history of architecture (oldest Jugendstil-building in Fryslan)
- For the oeuvre of the architect (Nicolaas J. Adema)
- Because of the aesthetic qualities of the design
- Because of the noteworthy use of material and ornaments
- Because of the coherence of exterior and interior decorations
- For the status of the urban environment[16]
- Because of the architectural wholeness of the exterior
- Because of the architectural wholeness of parts of the interior[17]
- In relation to the structural and visual wholeness of the urban environment

15 *Omschrijving Monument nr. 506244 Sint Martiniplantsoen 41 8801 LK te Franeker, downloaded from www.monumentenregister.cultureelerfgoed.nl (last accessed 27-03-2014)*

16 ibid

17 ibid

Design strategies

Design strategies include a mixture of restauration, concealment and new design. Many original details and ornaments were painstakingly restored, for example the ornaments (tiles) in the entrance hall and the decorations on the ceiling in the main hall. The cast-iron columns that were preserved but lost their load-bearing function, so they have become a mere decorative element. Out of sight, there is room for new functional design to house new functions without harming historical values. For an energy efficient design, the provision of light and heat are the main priorities.

The provision of light is of special importance in a library. Daylighting creates new attractive places and at the same time decreases the use of electricity. This includes measures to enlarge the windows, transform recesses into windows and restore the roof light. However, the exterior is drastically changed by large breakthroughs on three sides of the building.

The provision of heating is often more problematic, in this case the designers had to cope with a lack of space, underperformance of equipment and incompatibility of authenticity and comfort. The space issue was solved by careful embedding new ventilation shafts behind the ceiling in the main hall and by building a shed on the roof. Because this shed is not visible from the street, it is not considered a problem from a heritage viewpoint.

The evaluation of the energy performance by the users is rather negative. The heat pump did not perform satisfactorily, moreover it used a considerable amount of electricity, offsetting the advantage of lower gas use. The restored entrance hall is too cold and drafty to use, moreover, it generates drafts to the main hall.

The following design strategies as outlined in Van de Ven et al. (2011) have been applied in this case study: priority for minimal changes (2), use of adjacent unheated spaces as thermal buffer (8), new installations (9), insulation (10) and making use of spaces with high ceilings (13).

Identity strategies

In Franeker, the positioning of the building as the oldest Jugendstil building in Fryslan and the designation of the building as a listed monument ensured legal protection against demolishment. Earlier use of the building as dancing hall meant that many citizens had cherished memories of this building. Emphasising and strengthening the historical values of the building thus has been a powerful instrument in producing and maintaining obduracy.

- Several measures have been taken to improve the meaning of the Society's building for the urban environment. Adding the new alley at one side of the building connects the church square to the main shopping street. This creates opportunities for new attachments between parts of the urban environment.

Communication strategies

In Franeker we observed attention to communication processes in the preparation stage. For example, the municipality actively sought new users and created a sounding board with stakeholders; and in the design stage, where the architect actively sought approval by neighbours and where the municipality included the heritage board in an early stage of the project. The local historical society instigated a publication describing the history of the R.C. Society, the Society's building and its role in the Franeker community (Veldman, 2004). These strategies serve to strengthen the network that surrounds as well as includes the building.

New users were sought to give the building a new lease of life. Cooperation with the local authority and the (national) heritage board ensured financial resources and necessary building licenses. Citizens played a role in supporting the listing of the building as a monument, voicing their opinion on the new layout in the sounding board, and refraining from issuing objections against the building license.

6.6. Conclusion

The energy transition of our built environment is a complex process in which change and continuity have to be reconciled. We presented a framework of strengthening strategies and applied this framework to a case study of a restoration project in Franeker. The restoration of this building ensures the preservation of historical items and values for coming years, while daily use and regular maintenance will protect the building from damages by climatological and biological sources. In this case, several energy efficiency measures were taken, however these proved only partly successful.

The strengthening of the obduracy of historical buildings is achieved by employing various strategies, which we categorized as design strategies, identity strategies and communication strategies.

In the case study in Franeker, an important mobilizing event was the threat of the demolishment of the Society's Building by a project developer, who wanted to build a supermarket, which caused other actors to join forces to find a new function and sponsors for restoration. The identity of the town of Franeker became intertwined with the goals of a network of local actors. Identity strategies were used to identify cultural values, strengthen social values and embed the building in local regulations. Design strategies were applied to cater for new use(r)s of the building and to implement range of energy efficiency measures.

The preservation of identity and energy thus becomes part of a process of 'design by society', where a heterogeneous network of actors work together in redesigning and rebuilding the library. The restoration architect was a central actor in stabilizing the new network, not only with his design, but also by actively approaching stakeholders to reach consent with the restoration plan.

Table 14. Strategies in case study Franeker

Design strategies – relate to reconfigurations of materials and technologies		
1.	Facilitate new functions for the building	Functional redesign Improvement of energy efficiency
2.	Technical solutions for energy efficiency	New installations (heat-pump) Original elements re-installed (roof light) Careful inscription (ventilation shafts) Radical enlargements of windows in existing recesses (for daylight) Energy efficient glazing Insulation Addition of annexes (new building parts added)
Identity strategies – relate to cultural-historical values		
3.	Identify cultural-historical values	Historical-architectural values, especially as Jugendstil exemplar Aesthetic values Historical values actively researched, leading to publication of history in book and magazines Stressing original ideas, embedded in design
4.	Identify context value	Value of historical building for environment, and/ or vice versa
5.	Acknowledge social value	Value of building(s) for inhabitants Invoke collected memories
6.	Translate findings to legislation documents	Registration as a (municipal) monument
Communication strategies – connections with human actors		
7.	Attract new users	Develop new functions (library, office, social work, café)
8.	Strengthen local network	Municipality, heritage board, neighbours and historical society actively involved in 'sounding board' group Communication with heritage board in early stage Active role of municipality Involve new stakeholders Media approach, stressing historical qualities in public communication History of the Vereeniging and building published in book Insisting on lasting value of structure
9.	Financial instruments	Subsidies acquired Procure subsidies and sponsors

The building in Franeker had its surprises, such as the painted ceiling in the main hall, just like the Alte Aula in Vienna surprised its restoration team (Yaneva, 2008), and thus played its part as a non-human actor (or actant).

We conclude that energy efficient restorations of historical buildings can mobilize new actors to protect historical buildings. In this paper, we focused on strategies that are used by network actors, each pursuing their own view of the end-result. To understand reconfiguration processes, we need to be attentive to the use of different types of strategies by local actors.

7.
Instruments of valuation: the case of assessing historical buildings

This paper is submitted to *Valuation Studies* in December 2018 and is currently under review (second round).

Abstract
Valuation often comes with valuation instruments to reconcile conflicting values. In this paper we study what such instruments perform in the case of assessing historical buildings. Environmental values are becoming increasingly important in restoration of historical buildings, while the subsequent energy interventions can seriously damage historical qualities. Therefore, cultural-historical values and environmental values are often considered incommensurable, with energy engineers and heritage experts adhering to widely differing values and relating to different discourses. Instruments are devised to deal with value conflicts in restoration projects. We ask how these instruments work, i.e. how do they afford, support and guide valuation processes? Furthermore, we enquire what is achieved and what is lost in the reconciliation of values.

Theoretically, we start from the notion of commensuration, which allows comparison of values through a shared metric. Empirically, this article examines the history and use of DuMo, a valuation instrument that aims to reconcile cultural-historical and environmental values, as a case of commensuration. The instrument also provides a range of strategies to improve the sustainability of historical buildings. We find that DuMo indeed performs commensuration of these conflicting values, but also keeps the epistemic authority of the two professions intact. Our claim thus is that valuation instruments can perform commensuration and at the same time maintain incommensurability by acknowledging multiple professions.

Keywords: valuation, commensuration, cultural heritage; restoration; energy efficiency; sustainability; assessment

7.1. Introduction

Valuation processes typically contain conflicting values to be reconciled. One way to do this is to design and employ valuation instruments to afford, guide and support valuation processes. In this paper we follow a particular instrument to trace how such reconciliation is achieved and we focus on the assessment of historical buildings, where conflicting values abound. Since the beginning of this century, European and national policies put increasing pressure on building owners to perform energy performance assessments and acquire an energy label. Although this is not obligatory for historical buildings, experts nevertheless perceive this as a threat to the cultural and aesthetic values of historical buildings because the special needs of historic buildings are not considered in energy assessments (Cassar, 2009, 2011; Grytli et al., 2012; Pankhurst & Harris, 2013; RDMZ, 2001).

Environmental and cultural-historical values are indeed often considered incommensurable, that is 'they cannot be expressed or measured on a common scale or in terms of a common value measure' (Van de Poel, 2009, p. 977). As a result, trade-offs are difficult because a loss in one value cannot be compensated by a gain in the other (Van de Poel, 2009, p. 978). To put it even stronger, a gain in environmental value can cause an irreducible loss in cultural-historical value, to quote Norrström: "exhaustive refurbishments with the energy measures undertaken (can lead) to the destruction of cultural, historic and architectural values" (Norrström, 2013, p. 2624). Even stronger, energy interventions are sometimes threatening the survival of the building itself

(Schellen, 2002; Stappers, 2008). In this respect, several instruments have been proposed for a sustainable appraisal (Stubbs, 2004) of historical buildings. In these instruments, topics such as heritage, environment, economy and social issues are brought together in one valuation method.

Theoretically, valuation instruments have been characterized as 'commensuration', that is, as a social process that condenses the aspects or dimensions that are evaluated and combines them in a shared metric (Espeland & Stevens, 1998). In commensuration, claims about incommensurability are often made when identity issues are at stake: 'incommensurables can be vital expressions of core values, signaling to people how they should act toward those things' (Espeland and Stevens (1998, p. 15). Moreover, commensuration requires boundary work, to maintain the boundaries between the conflicting values and the epistemic authorities of professions. The core values in the case of architectural history are related to cultural identity, which is an important part of communal and self-identity (Stephenson, 2008). Energy performance measurements and historical value assessments are typically performed by experts from different professional groups. Heritage assessments are performed by trained assessors with a background in architectural or building history. Energy assessments are usually carried out by energy engineers.

In this paper we investigate commensuration in a particular valuation instrument, the so-called DuMo method. We investigate how the DuMo-instrument was designed and how it works. We assess what is gained and lost in the deployment of the instrument. The article is organized as follows. In the next two sections, we further elaborate on values and valuation practices in the case of assessing historical buildings. In section 7.4 we briefly discuss our methods and materials. Section 7.5 presents our case study of the DuMo-method, including its development, procedures and experts' views on its application. Clearly, the reconciliation of values is an on-going challenge, as will be discussed in section 7.6. We conclude that while the valuation instrument achieves commensuration of historical and environmental values, it also keeps the epistemic authority of the two professions intact. Our claim is that valuation instruments can perform commensuration and at the same time maintain incommensurability by acknowledging multiple professions.

7.2. Conservation and sustainability

Conservation of historic buildings connects philosophical ideas and human values with technical interventions, as Drury remarks: 'Building conservation is distinctly different from the physical processes of repair and adaptation. It is an attitude of mind, a philosophical approach, that seeks first to understand what people value about a historic building or place beyond its practical utility and then to use that understanding to ensure that any work undertaken does as little harm as possible to the characteristics that hold or express those values' (Drury, 2012, p. 1). International codes for conservation have been established in international meetings organized by the International Council on Monuments and Sites (ICOMOS), an international body under the umbrella of UNESCO, the cultural organisation of the UN. Charters have been negotiated for specific building types, archaeological sites, immaterial heritage or specific cultures (Fredheim & Khalaf, 2016; ICOMOS, 2003; Pickard, 1996). Authenticity, as affirmed in the Charter of Venice (ICOMOS, 1964) and the Nara Document (ICOMOS, 1994), is considered essential for the knowledge and protection of cultural-historical values. Based on these international charters, practical guidelines for conservation practice are described in publications of national heritage agencies (English heritage, 2008; RCE, 2009; Stovel & Smith, 1996).

Contrary to what the term itself might suggest, conservation requires constant work, i.e., constant monitoring, decision making and acting on the materials that make up the structure. Moreover, new demands regarding comfort or functionality, often prompt to change the form, material or layout of buildings. Indeed, buildings are constantly reconfigured: they need daily management, regular maintenance (J. Denis & Pontille, 2015), repair (Graham & Thrift, 2007) and sometimes restoration (Yaneva, 2008). Such reconfiguration work can be in conflict with conservation principles. Because even minor changes can seriously damage the cultural-historical qualities of historical buildings, the principle of minimal intervention is paramount when caring for such buildings. The categorization of interventions according to the negative impact on the heritage character of the building is graphically illustrated in Figure 8.

One of the new demands posed on historic buildings is the alignment of conservation with environmental values. Several methods have been proposed for the assessment and management of the sustainability of historic cities, buildings and landscapes. Integral to these assessments are environmental, social and economic aspects. For example, Stubbs (2004) has developed indicators for the sustainability appraisal of the historic environment. His framework covers four topic areas: environmental, social and cultural, economic, and generic to address the cultural significance and

Figure 8. Intervention related to impact, from FHBRO Code of Practice (Stovel & Smith, 1996)

High Intervention

(High negative impact on heritage character)

Increasing intervention ↑	replace restore repair stabilize do nothing	↓ Decreasing intervention

Low Intervention

(Low negative impact on heritage character)

sense of place. Cassar (2009) emphasizes the importance of monitoring the actual energy use and the effects of energy measures on the integrity and meaning of historic buildings. Many reports evaluate technical results of energy efficient restorations, for example Cluver and Randall (2010), Cassar (2011) and Godwin (Godwin, 2011).

Gradually, both economic benefits and local community involvement have come to take a more prominent place in assessment as well as management of heritage sites. On the basis of a careful analysis of six World Heritage Sites owned by English Heritage, Landorf (Landorf, 2009) has crafted a model for sustainable management of industrial heritage sites. The two crucial dimensions in his model are the importance of long-term holistic management and the participation and empowerment of multiple stakeholders. Liusman, Ho and Ge (Liusman, Ho, & Ge, 2013) also argue that for the assessment of heritage, environmental assessment methods are insufficient and need to be extended to include social and economic indicators. They put forward a set of 'tailor-made' indicators for the assessment of heritage, and apply this method in a case study of a heritage building in Hong Kong. Eriksson et al. (2014) developed a software tool to support decisions on energy retrofit measures. National heritage agencies have also published reports and guidelines on how to balance environment with conservation (English heritage, 2013; RCE, 2010).

Nevertheless, commensuration of historical, environmental and economic values in building reconfigurations remains a contested space. These values cannot be reconciled easily, as is recognized by Wallace et al.

(1999) and Pendlebury (2002). Moreover, Strange and Whitney (2003) argue for more research into the integration of sustainability in heritage management, especially as part of wider regeneration strategies.

Summarizing, the importance of balancing historical values with sustainability principles is increasingly recognized in the literature, but this balancing is not fully understood. While the frameworks mentioned above seek to balance historical and energy values on a theoretical level, the question remains how such instruments work in practice.

7.3. Commensuration of values

How can we understand the process of attributing values to buildings? In the cultural-historical discourse, the concept of value is considered a social construction: ´Values of heritage are not simply "found" and fixed and unchanging (..). Values are produced out of the interaction of an artifact and its contexts; they don't emanate from the artifact itself. Values can thus only be understood with reference to social, historical, and even spatial contexts through the lens of who is defining and articulating the value' (de la Torre & Mason, 2002, p. 8). According to Van de Poel (2009), values are human beliefs about important characteristics of a certain thing. Moreover, attributing values, or valuation, is performative, it concerns not only to assess what is valuable, but also how to make something valuable or to add value to something (Drury, 2012; Vatin, 2013).

To prevent negative impacts, a careful assessment of existing historical values should precede and inform reconfiguration work and restoration plans. Value assessments of historical buildings are generally performed by architectural-historical experts, that make use of predetermined categories and criteria. But assessing historical values is not straightforward, even though valuation of the qualities of historical buildings has been practiced since Roman times (Jokilehto, 2002). There is a large range of assessment methods and value typologies available (Fredheim & Khalaf, 2016). In this respect, Fredheim & Khalaf (2016) identify three steps that are commonly taken in the process of assessing value to historical buildings: first, define the valuable features of the object (what), secondly, identify what the aspects of value are (why) and thirdly, assess how valuable it is (how). For the first step, identification of values the Cultural Values Model as developed by Stephenson (2008) could be very useful. The Cultural Values Model recognizes that academic disciplines have differing perspectives on cultural values and that not all identified values belong to predetermined categories. Furthermore, Stephenson emphasises the importance of values held by people living in the context of the landscape. However, the Cultural Values Model does not provide any metric to further assess the identified values. The development of assessment methods entails negotiations about the identification and relative importance of different features, and how to bring them together in a shared framework. In this respect, Espeland & Stevens (1998) have investigated commensuration, which they define as a social process that brings various entities together in a common assessment framework. Commensuration involves first of all the simplification and reduction of information and secondly imposes a shared metric on what remains. This is often used for ranking purposes, for example of schools (Espeland & Sauder, 2007). Commensuration translates qualitative statements to quantities; in this respect Espeland & Sauder argue that numbers create authority, circulate more easily and travel more easily to other contexts (2007, p. 17). Interestingly, they note that numbers invite reflection on what these numbers represent. Furthermore, they argue that 'Commensuration presupposes that widely disparate or even idiosyncratic values can be expressed in standardized ways and that these expressions do not alter meanings relevant to decisions' (2007, p. 12). If this is contested, values can be defined as incommensurable.

Claims about incommensurables are in Espelands and Stephens' view often made when commensuration threatens cherished identity (1998), which also seems applicable to our case study. Indeed, heritage values are often referred to as constitutive and integral to our personal and communal identity (Stephenson, 2008). Creating and maintaining incommensurables requires work: 'Some party must draw boundaries around the thing whose value is to be kept, or made, distinctive and then defend the boundaries from encroachment' (Espeland & Stevens, 1998, p. 16). Examples of such 'parties' are experts, such as art critics, or organisations, such as preservation agencies. In the conservation practice, this boundary work is carried out by architectural and building historians and the Dutch Cultural Heritage Agency. As Star and Griesemer (1989) have demonstrated, incommensurabilities can be bridged with a 'boundary object', that can be understood and valued by both groups.

Heuts & Mol (2013) propose the concept of 'registers of valuing', which refer to bundles of criteria emerging out of specific practices. Registers reflect the interests and professional values of the valuator, for example a heritage expert will mobilise other registers than an energy expert, a user or a project developer. The use of registers is a partly unconscious process, enacted in practices and based on tacit knowledge acquired by education and experience. Moreover, tensions arise both between and within these registers, so in a restoration process, choices have to be made. The concept of registers of valuation can help to explain differences in value assessments between involved actors.

In general, values are fostered and transmitted in education and are strongly connected to the professional background of experts (Bluestone, 1999;

Heynen & Jonge, 2002; Saint, 2007). As we mentioned in the Introduction, the experts involved with historic buildings belong to different professional groups, categorized here as architectural-history experts and energy engineers. The two groups are characterised as two interdependent professions with more or less equal structural power and resources' (Gieryn, 1995, p. 411). Since the 19th century, conflicts over boundaries between the domains of architects and engineers have been very common (Aibar & Bijker, 1997; Bruegmann, 1978; Saint, 2007).

Professionals generally strive to gain 'epistemic authority', that is 'the legitimate power to define, describe and explain bounded domains of reality' (Gieryn, 1999, p. 1). Boundary work then has to be performed to construct and guard these professional domains, both regarding to the division of labour and to the definition and description of reality. Gieryn (1995) points to the different epistemic authorities of professional groups and the concomitant incommensurabilities. In the architecture-historical community this is illustrated by the adherence to the so-called Authorised Heritage Discourse (AHD) (Pendlebury, 2013; Smith, 2006).

So, we have seen that commensuration of historical and environmental values brings these values in a common framework and entails boundary work to delineate epistemic authority and a division of labour. In our case study of the DuMo-instrument this brings the question how the instrument affords and guides the reconciliation of values and how it depends on boundary work between professional groups.

7.4. Method and materials

The research was set up as a case study (Yin, 1994), employing various materials to investigate the case of the development, goals and application of the DuMo-instrument. To explore practices with DuMo-assessments we held qualitative interviews with four members of the national steering group that was responsible for the development of DuMo. This includes architectural historians and building engineers, representing the main disciplinary perspectives in our study. The interviewees are identified by 'Exp.int.' professional background and a number. The interviews were transcribed and analysed in Atlas.ti.

We also studied documentation on the DuMo-method and its application. First, we relied on the DuMo-Handbook, which describes the method's procedures and gives examples of finished projects. The Handbook also provides (online) assessment sheets. We investigated how experts are addressed in the Handbook and how specific professional values are transmitted through the instructions and energy improvement strategies. Secondly, we examined a sample of full DuMo-reports and archival materials of listed buildings across the Netherlands. A full report is typically between

75 and 100 pages long and includes detailed descriptions and illustrations of valuable features in the investigated building. Lastly, we analysed the overview of 41 DuMo assessments, all performed by NIBE, a sustainable building consultancy that was involved in the development of DuMo. These buildings were restored with a high energy ambition and revealed design strategies used to reconcile energy and historical values. The NIBE-overview provided insights in the results of DuMo-assessments, the applied restoration strategies and allowed comparison of the buildings to search for regularities, for example in building type, age and applied energy measures[18].

In the analysis of the interviews we used an inductive approach (Charmaz, 2014). We first identified and coded meaningful quotations in the interviews. We then performed a thematic analysis and compared the identified themes to the literature on cultural-historical valuation and sustainability. In section 7.5.2 we describe five themes; cultural-historical values, energy performance, intangible values, economic aspects and expert knowledge.

7.5. Case study: DuMo, an instrument for assessing historical and environmental values

7.5.1 Development and design of the DuMo-instrument

Since the 1990s, heritage professionals in the Netherlands felt increasing political pressure to improve the energy efficiency of historic buildings. 'We realized that there was a threat, fear for political decisions on environmental standards, without recognizing that historical buildings are different.' (Exp. int.1, historian). Furthermore, our respondents stated that it was expected that owners of listed buildings would increase their demands regarding comfort and energy efficiency. Together, these developments could lead to ill-advised retrofit measures and ultimately damage historical buildings.

In 2003 the Dutch Cultural Heritage Agency (RCE) initiated the development of an instrument to value the sustainability of historic buildings. The method is called 'DuMo', which is an abbreviation of 'duurzame monumenten'.[19] Moreover, a knowledge base for historical experts would be constructed, which could be used to assess proposals for energy efficiency. 'At that moment we already feared that the obligation for energy labels would be extended to historical buildings, or that new demands would be formulated for energy efficiency, we thought that in that case, we should be able to say, "You can", or "You can't".' (Exp.int.2). A steering group was set up, in which professionals from two backgrounds were represented: cultural heritage and sustainable energy. NIBE, a sustainable building consultancy,

18 The NIBE database can be obtained by the corresponding author.

19 Dutch for 'sustainable historical buildings'

was issued to develop the new method. The architectural and building historians maintained that the instrument should be an expert model, to avoid that lay persons would perform historical valuations. The target groups of the instrument would be architectural historians, energy engineers, civil servants and other heritage professionals.

First, an inventory was made of traditional sustainability features of historical buildings, such as rainwater cellars, window shutters, natural ventilation and insulation. Secondly, pilot-buildings with recent energy efficiency measures were investigated, evaluating energy performance as well as any damage to the historical values. The assessment procedures, examples and strategies for improving the energy performance of historical buildings are described in the 'Handboek Duurzame Monumentenzorg' (Nusselder, Van de Ven, Haas, & Dulski, 2008) (further: Handbook). For practitioners, a code to download the DuMo calculation sheets is included. The Handbook also describes the pilot-projects that formed the empirical basis of the DuMo-methodology.

How does the DuMo-method build the bridge between the historical and environmental values? We will demonstrate below that the reconciliation takes place by recognizing two parts, to be carried out by the appropriate experts. Step 1 is the assessment of historical values, leading to the Historical-Values Coefficient, step 2 is the assessment of sustainability performance, leading to the Sustainability Score. In step 3 the numerical results of these two assessments are multiplied, so the end result is a merger of the two separate assessments. Importantly, valuation with DuMo is not an end in itself, it forms the basis for an energy efficient restoration plan.

Historical Values-coefficient

Assessment of cultural-historical values requires a thorough investigation of building history, through examination in situ as well as by studying archival documents, local history and connections to important residents. The value-bearing features are noted on sketches or drawings of building elements. Next, expert judgements are made on the value of each feature. A DuMo assessment requires considerable cultural-historical knowledge, therefore it can only be carried out by a qualified evaluator.

Main categories are architectural-historical values (max 60 points), cultural-historical values (max 27 points), context values (max 13 points) and completeness (factor min 0,3 – max 1) (Table). Each category has 2 or more subcategories. For each subcategory the importance of the building is scored. These scores are transferred to the aggregate statement (Error: Reference source not found). In this statement, values are translated in an ordinal scale, ranging from very positive (P), positive (Q), average (R), to negative (S). However, the underlying forms contain the quantitative scores.

Table 15. Historical Values Assessment DuMo method

Categories and items of historical value		
Architectural historical values	1.	Building type and style
	2.	Architectural quality
	3.	Building quality
	4.	Importance in oeuvre of architect
Cultural historical values	5.	Importance with respect to historical themes
	6.	Relation with local historical developments
	7.	Relation with historical persons or events
Context values	8.	Significance of environment for the building
	9.	Significance of building for its environment
Completeness	10.	How much of the historical material is preserved
	11.	Technical state

The total of scores leads firstly to the assignment of a Touchability category. This category refers to importance of the historical values and the vulnerability to interventions. DuMo defines four main Touchability categories: A, B, C and X. Category A denotes 'museum quality', B stands for 'important historical value', C is characterized as 'flexible building with historical values' and X is reserved for buildings that are not listed[20] but do possess relevant cultural historical values. Secondly, a numerical Historical Values Coefficient is given based on the point total. This coefficient later becomes the cultural-historical multiplier, as will be shown in Step 3 below. A second assessor replicates the whole procedure in order to validate the assessment. The DuMo report includes a comprehensive description of all identified values.

20 'Listed buildings' is commonly used in English to denote buildings that are placed on a national or municipal 'List of Buildings of Special Architectural or Historic Interest'

Figure 9. Aggregate statement historical values

Verzamelstaat bepaling Mo-coëfficiënt
Object:

Vraag	Item	score P	score Q	score R	score S	
1.	kwaliteit bouwstijl en -type 1- indien zeldzaam of...					Architectuur-historische waarde
	kwaliteit bouwstijl en -type 2- indien algemeen					
2.	kwaliteit architectuur 1- indien zeldzaam of...					
	kwaliteit architectuur 2- indien algemeen					
3.	uitvoeringskwaliteit 1- indien zeldzaam of...					
	uitvoeringskwaliteit 2- indien algemeen					
4.	betekenis in oeuvre architect					
5.	belang mbt. lokale geschiedenisthema's					Cultuur-historische waarde
6.	belang mbt. lokale historische ontwikkelingen					
7.	relatie met historische persoon of gebeurtenis					
8.	betekenis van omgeving voor gebouw					Contextwaarde
9.	betekenis van gebouw voor omgeving					
10.	hoeveel resteert van historisch materiaal					Compleetheid
11.	technische staat					
totaalscore (optelling kolommen P, Q, R en S) →		x P	x Q	x R	x S	

Toegekende Aanraakbaarheidscategorie (A, B, C, Xa, Xb of Xc) →

Getalswaarde van de Mo-coëfficiënt →

P ☐ geeft een zeer positieve score op het beoordeelde punt weer
Q ☐ geeft een positieve tot redelijke score op het beoordeelde punt weer
R ☐ geeft een matige score op het beoordeelde punt weer
S ☐ geeft een negatieve of zelfs storende score op het beoordeelde punt weer

Sustainability Score

The Sustainability Score is based on Greencalc+, a certified environmental assessment method which was widely used when the DuMo instrument was developed. The sustainability sheets include three themes: water, materials and energy. The questions relate for example to the measurements of the building, technical installations, insulation, glazing, yearly energy use, and so on. According to our respondents, these forms are not difficult to fill out; any building professional could do it on the basis of their education. The software performs calculations in the background and presents the viewer with the result. The sustainability score can be translated to an energy label in the widely used system of labels ranging from A (very efficient) to G (very inefficient). Energy performance assessments are based on a benchmark, so new versions of the Greencalc+ method reflect changes in energy efficiency technologies and policies. In short, the rankings become more stringent as time progresses, which means that the building owner has to implement more measures to acquire a certain label. See Error: Reference source not found for an example of the labels and required scores in GreenCalc+ 4.0.

Figure 10. Example of sustainability assessment sheet

The calculation of the DuMo-label

The aim of DuMo is to give a building a sustainability score that takes the special character of historical buildings into account. Therefore, the result of the assessment of historical values (Historical values coefficient) is multiplied with the calculated Sustainability-index. The resulting score (DuMo-score) is then translated into a traditional energy label ranging from A to G. This multiplication of values is a unique feature of DuMo.

For example, the sustainability score of Paushuize in Utrecht is 104, which would lead to the assignment of label G (lowest possible label). In DuMo, this score is multiplied with the historical values coefficient of 1,9, and results in a score of 198. With this score, the building receives a DuMo-Label B. Both architectural historians and energy engineers find themselves represented in the results of the assessment.

Dumo as basis for restoration plans

Usually, DuMo-assessments are carried out in preparation for a restoration project with a high-energy efficiency ambition. To support the design process, the DuMo-Handbook gives a broad range of appropriate technical strategies for energy efficiency and other sustainability measures. The restoration design is the basis for a second assessment of both cultural-historical and environmental values. The achievable gain in energy efficiency as well as the gains or losses of cultural-historical values are measured. The DuMo-label (Error: Reference source not found) gives visual insight in the label-jump from the lowest level (G) to the highest level for existing buildings (A) that is achieved or expected after the energy efficient restoration.

We were interested to find out if energy performance depends on historical characteristics. To that end, we examined the NIBE-database to find relationships between historical values and potential improvements of energy performance. In these 41 cases we could find no relation between energy performance and building characteristics such as touchability, age, type or function. For example, the buildings with the highest energy-improvement can be found in all four ‘touchability categories’; the buildings date from the late middle ages to the first half of the 20th Century; building types vary from dwelling to factory to city hall; and functions (both original and new) vary from dwelling, museum, to office. This ties in with the claim of heritage experts that every historical building is unique and therefore requires a tailor-made approach.

High touchability of a building (category A, see 7.5.2) relates to the importance of the historical values present and the vulnerability to interventions. However, high touchability does not preclude energy improvement. Nevertheless, it does give an indication of the amount of care, creativity and architectural knowledge that will be required in the design stage.

Figure 11. GreenCalc 4.0

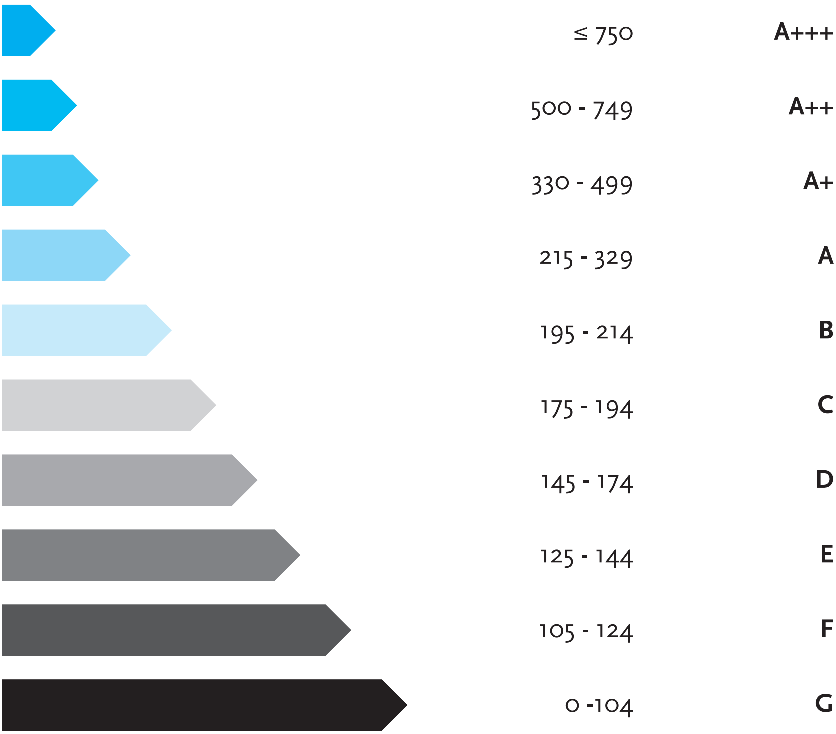
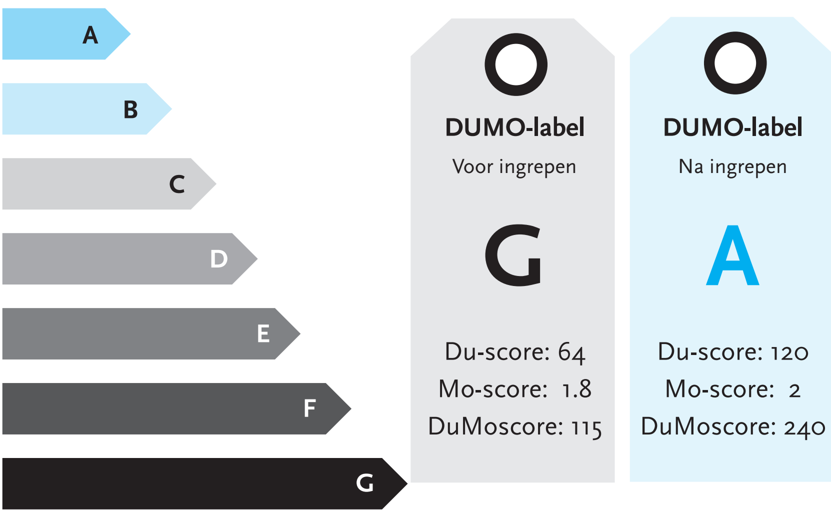


Figure 12. Example of DuMo energy label



7.5.2 Commensuration of environmental and cultural-historical values

In this section, we will discuss the views of the interviewed experts on the performance of the DuMo instrument. Five themes stood out from our interviews: cultural-historical values, intangible values, energy performance, economic aspects and the role of expert knowledge.

1. Commensuration of cultural-historical values

The DuMo procedures in Step 1 (see section 7.5.1) show that we observe here first the identification of what features are valuable, secondly the description of why these features are valuable and thirdly the judgment of how valuable they are, which is congruent with the observations of Fredheim & Khalaf (2016).

At this point, the information about cultural-historical values is made commensurate, it is brought into clear and discrete categories and a judgment is provided which makes the categories comparable. The procedure reduces the large amount of gathered information to a numerical score for each subcategory. Here, within the division of cultural-historical values, a low score in one category can be compensated by a high score in another. The completeness of the building and its features is used as a factor, which may decrease the total score. The valuation process is made more transparent and numerical values are seemingly easier to understand. However, without expert knowledge it is impossible to judge if a building is an excellent, very good, good or not at all an example for a specific style. Or to identify the architectural-historical style in the first place.

The grading of buildings according to 'touchability degree' is the next step within the cultural-historical value division of DuMo. As explained in section 7.5.1, touchability is a concept to express the amount of changes a building can take without damaging historical values. It is based on the scores for historical values in the assessment form. Touchability further condenses the information about the building in a grade and makes buildings comparable along the measure of touchability. This concept was originally developed by one of our interviewees:

'At a certain moment, I just devised that concept, with the idea to investigate the different viewpoints for analysing a building, which could be a building-historical viewpoint, or a cultural-historical viewpoint, an important inhabitant who lived there, well, from these various perspectives, you can start the historical research of the building, with which you can underpin these stories, as well as explain much more clearly where the (historical) values actually reside' (Exp.int.1, historian).

According to this respondent, during the development of DuMo various attempts were made to make touchability measurable, but in the end, it was decided to devise three simple grades (A, B, and C) and a non-grade (X).

'You have buildings that just are very untouchable, for example Hunting lodge St. Hubertus, there you can do approximately nothing; then you have buildings where you can do something, but not too much, the Palace in Amsterdam is an example of that, you can do one thing and the other, but within boundaries, and then you have the average historical houses, where you have a lot more freedom' (Exp.int.1, historian).

The Touchability degree thus is inversely proportional to degrees of freedom for the implementation of energy measures. With grade A you can do 'approximately nothing', with grade B you can do 'something, but not too much'', and with grade C you 'have a lot more freedom'. The Historical Values Coefficient subsequently assigns a numerical value to the building, which is later used as multiplier in the calculation of the DuMo-label.

For the dimension of cultural-historical values, DuMo provides an important reduction of information and makes comparison of buildings possible on the basis of the Touchability degree. The historical values-coefficient makes this judgment bear on the energy-label (here called DuMo-label). However, DuMo also limits the scope of cultural-historical values, for example social values or spiritual values are not included.

2. Intangible values and the stories of buildings

Commensuration theory claims that 'widely disparate or even idiosyncratic values can be expressed in standardized ways' (Espeland & Sauder, 2007, p. 12), so it should be interesting to see how DuMo treats intangible values such as memories and stories of heritage in its procedures. As Calvino writes: 'The city (..) consists of relationships between the measurements of its space and the events of its past' (Calvino, 1972). Traces of such events of the past linger on in historical buildings, just as they do in landscapes. Stephenson (2008) refers to the dimension of temporality, relationships and understandings of landscapes that arose for example from historical events or traditions. She applies the term 'embedded values' that are created by past forms, relationships or practices. This allows to incorporate intangible values in an assessment, by identifying located stories, traditions, genealogies etc. (2008, p. 137). Intangible values have been discussed in international venues under the auspices of UNESCO and are codified in the Burra Charter (ICOMOS, 2013; Vecco, 2010).

The stories of buildings form a part of the collected memories that are connected to buildings and places. Furthermore, such stories serve to interest local citizens and visitors and provide a motivation for protection. 'For example, you know the 'House with the cannon ball'? Everyone immediately reacts to this, asks 'what happened there'? Such a house, even it would not even be there, provides an exciting anecdote, because it has such a beautiful story behind it' (Exp.int.3, historian). Nevertheless, energy measures are unlikely to damage the link with historical figures or important events. *'Take the Binnenhof as the centre of government, and before that of the Graafschap (of Holland), I would say, if I apply double glazing it will still be this symbol'* (Exp.int.1, historian). One of our respondents explicitly connects stories with sustainability: 'Stories also make buildings sustainable.' (Exp.int.3, historian).

In DuMo, values arising from relations to historical themes, local historical developments, historical persons or events are scored in the second part of the cultural-historical dimension (Table 14). Historical research can reveal for example if the building has played a part in local history, or is the birthplace of a local historical figure. However, DuMo does not take up lay values, collected memories or local traditions. As mentioned in theme 1., DuMo takes up a limited scope of cultural-historical values.

3. Energy performance

In the DuMo-method, energy performance is assessed with the sustainability calculation method Greencalc. A point that was brought up in the interviews is that energy efficiency of historical buildings should be measured rather than modelled. Standard energy assessments use a model to predict energy performance, on the basis of the predicted heat loss through the walls, windows, roof and floor. However, one of our interviewees argues that historical buildings cannot be labelled on the basis of calculations, because these are inevitably based on premises that are impossible to ascertain. This is because it is not known how the builder has operated in the building process. *'You know nothing about existing buildings, except when you knock them down and build them up again, thén you know!'* (Exp.int.3, historian). Therefore, a simple yearly report of actual energy use would give a much more reliable indicator for energy performance.

The second issue regarding energy performance is the influence of user behaviour. This is not included in DuMo (or in other energy performance tools) but is very influential in the actual energy use of the building. Many energy efficiency measures are taken because of the demands and habits of present-day users regarding comfort, safety and modernity. However, the definition of what is comfortable, and the required level of comfort, varies considerably. According to our respondents, some users are quite happy to refrain from using certain draughty rooms in winter, if that is the price they have to pay to live in a historical building. They are also prepared to adapt their personal clothing and interior decoration, such as applying heavy curtains. Another example that was mentioned in the interviews is that at the time of the energy crisis in the 1970s, citizens were asked by the Dutch government to close the curtains at night to save energy. Nowadays such appeals are no longer fashionable, laments one of the respondents, because this does not bring revenues to commercial parties. Nevertheless, user behaviour is a very important factor for energy use in buildings. '*Especially in historical buildings behaviour of users is very important for the actual energy use in a building*' (Exp.int.2, engineer). If users do not behave 'energy aware', even in an energy neutral building the actual energy use can be much higher than expected. Therefore, monitoring actual use for heating and ventilation is necessary, both before and after restoration. '*First monitor what they actually do, where energy leaks away, or what it is used for*' (Exp.int.3, historian).

According to our respondents, it is important to know your building, to know where cold draughts are, what spaces are especially cold or moist. The heavy influence of user behaviour together with the impossibility of rating a historical building is the reason one of the respondents concludes that it is the user, not the building which should be labelled. In her view, this also lays the burden where it belongs, because it is actually the user that needs heating, not the building. '*Because, the building doesn't mind if it is draughty, nobody cares, or if doors clatter, doesn't matter! (..) you just have to take care that it does not get wet, that is much more important. Don't get wet and keep it nicely draughty*' (Exp.int.3, historian).

The DuMo instrument calculates energy performance on the basis of forms with concrete questions that lead to an energy performance indicator that is considered reliable in the energy assessment sector. However, DuMo does not consider user behavior, although this has a large influence on energy use in (historic) buildings. So, the risk remains that unnecessary drastic interventions are proposed in the restoration plan.

4. Economic aspects

In the DuMo case, several threads are visible that relate stakeholders to economy. One of the original motivations for the development of DuMo was the expected demand from building owners for lower energy bills, due to the very efficient new buildings that became the norm. 'So, how are we going to do this with historical buildings, because assuredly a question will arise, also from building owners, such as, hey, I also want to do something, I also want a lower energy bill' (Exp.int.3, hist.).

The second observation made by our respondents is that the building sector has products to sell, which is a commercial purpose that has nothing to do with the protection of historical values. Indeed, commercial interests apparently often lead to the proposal of unnecessary large interventions, even when solutions are available which are simpler, cheaper, just as energy efficient, and that do not unnecessarily intervene in the building. Such ‘market solutions’ are not dedicated to conserve buildings, but to sell products, as one of our informants tells us:

‘So, you know, actually the market is lobbying for the application of solutions they have cooked up already, while in the case of a historical building the question is not which market product you can sell, but how you can deal creatively with the building and think of measures that may not be market-driven, but that actually work!’ (Exp.int.1, hist.).

Therefore, from this viewpoint, the starting point for energy advice should be the building itself and how to improve energy efficiency with minimal interventions.

Thirdly, the cost of carrying out a DuMo assessment itself seems to limit widespread use. The Handbook price is €180 and a full DuMo assessment cost falls in the range of €3,000 to €10,000, depending on the size and complexity of the building. Prices for DuMo are thus out of reach for home owners. Furthermore, the costs of the method may also be prohibitive for small municipalities or energy advisors, According to our respondents, this limits the use of the instrument:

‘It could have much more impact if the instrument was widely available. Look here, if this were an online publication, available for free, then a municipal civil servant could put it on their website as advisory tool for owners of historical buildings. (...) But as things are now, we have to admit that most municipal heritage civil servants do not even have access to the DuMo-Handbook. It is too expensive’ (Exp.int.1, hist.).

Cheaper instruments could fill this gap, for example the Quick Scan for Historical Buildings (QSEM) (A. De Groot & Vieveen, 2015), or the Groene Menukaart. QSEM, an instrument developed by one of our informants, costs approximately €800. Application of the Groene Menukaart is free, however as remarked by our respondent, there is a risk that people lack the knowledge to apply the instrument satisfactorily.

Although DuMo simplifies the historical values assessment of buildings to a large extent, it still takes time, expertise and therefore money to carry out. DuMo assessments are primarily used by institutional building owners and for restoration plans for large and complex buildings, in which case a cultural-historical valuation is compulsory anyway and the costs of a valuation are minimal relative to the overall cost of the restoration itself. DuMo is too expensive to attract small building owners or to be used in municipal advisory work. Therefore, DuMo at present does not realise its full potential.

5. Professional groups and DuMo-valuation

DuMo was developed as an 'expert-method' and is not designed to be used by laypersons. In the Handbook target groups are identified, such as contractors, heritage agencies, builders, architects, or engineers. For each group an indication is given which parts of the DuMo method they can accomplish by themselves and for which parts they will need expert help (H Van de Ven et al., 2011, p. 11). Architectural-historical knowledge is essential for a proper assessment of historical values. There are two ways to become a qualified valuator, one is to acquire a master's in architectural history, the second is to complete the postgraduate study 'Building history and restoration'. Furthermore, the assessment of 150 historical buildings is an obligatory requirement for certification. This means that the cultural-historical part of the DuMo-assessment cannot be performed by engineers, laypersons, or civil servants.

Energy engineers do not receive cultural-historical training in their education, so they lack expert knowledge of cultural-historical values. "If you arrive at a building with an experienced architectural-historical expert, he sees a hundred thousand things that I still overlook" (Exp.int.2, engineer). This inhibits engineers to understand historical values and conservation principles and can lead to ill-informed advice regarding insulation, glazing or appliances. It can also lead to the failure to recognize the importance of authenticity. For example, producers or engineers offer new fixtures that 'look just the same' as historic items (Exp.int.2, engineer). However, according to international conservation principles (ICOMOS, 1994) authentic material should have priority, because historical fabrics and materials are a finite resource; once lost, they are irretrievable. This ties in with the principle of minimal intervention as relayed above (Figure 8) (Stovel & Smith, 1996).

DuMo does bring these two professional groups together. Working in DuMo-projects can help engineers to appreciate their own limits of knowledge: '*In all these years I have learned what I don't know (laughing), that is the difference with the EPA-advisors, I think, they don't know what they don't know – and I do*' (Exp.int.2, engineer). However, this is not guaranteed, as is demonstrated here: 'An even this particular advisor, with whom we had lots of contact, we even cooperated in a joint report, and still, they come up with an advice containing a gigantic new installation, without first taking care of the basics' (Exp.int.3, historian). So, experience with restoration projects does not fill the architectural-historical knowledge gap, but cooperating in a DuMo-project can help to see your own limits and respect the knowledge of others.

Expert cultural-historical knowledge is also not available in many municipal organisations. Before giving a building license for restoration work, municipalities in the Netherlands typically employ experts from provincial agencies and rely on the (compulsory) advice from RCE. Civil servants of small municipalities are not experienced valuators: "And I exaggerate enormously, but such a civil servant does historical buildings on Monday, management of the swimming pool on Tuesday, and on Thursday he takes care of parking facilities. So, they have only limited time for heritage, which makes them very uncertain" (Exp.int.2, engineer). This uncertainty precludes civil servants to support citizens with finding appropriate solutions for energy efficiency in historical buildings.

Owners of historical buildings are also laypersons, who although they often display great interest in their building, are usually not trained in architectural history. Some municipalities advise citizens to use freely available DIY-checklists such as the Groene Menukaart to assess their historic buildings. However, according to our respondents, it can still be difficult for laypersons to identify the valuable features of their building, because they do not recognize the historical styles. The absence of cultural-historical knowledge can cause owners to be overwhelmed by advisors that push expensive, heavy equipment that does not suit their building. This development is exacerbated by the pressure for energy labels: *'What you often encounter is that people are overwhelmed by so many parties. There comes a contractor, there is the energy advisor, saying you should implement installation so-and-so, and before you know it, they have done things that don't fit the building at all. Don't fit the use-pattern at all!'* (Exp.int.3). In this instance, we see that laypersons are inappropriately advised by energy engineers that clearly also lack the knowledge of cultural-historical values, but nonetheless push their energy solutions. As quoted earlier 'They don't know what they don't know', and potentially cause considerable damage. Nevertheless, the expertise of the energy engineer comes in at the second stage, in the development of a restoration plan. Here, energy interventions that are specifically suited to historical buildings are required, such as those that are described in the Handbook.

So, the DuMo-instrument brings professional groups together in a restoration process. Cooperating in a DuMo-project can help historians and engineers to acknowledge each other's expertise and their own limits of knowledge. DuMo standardizes and simplifies the process of valuation. However, DuMo does not make expert knowledge superfluous; in particular the assessment of historical values requires considerable cultural-historical knowledge. Furthermore, although the assessment of energy performance is relatively simple, the design of energy interventions that are appropriate for historical buildings still requires expert knowledge.

7.6. Conclusion

The key question of this article is how instruments of valuation afford and guide the reconciliation of values that were formerly considered incommensurable. We studied the so-called DuMo instrument that seeks to commensurate heritage values with environmental criteria and we traced in detail the steps that constitute the instrument. Furthermore, the method forms the basis for restoration plans that include measures improving the energy performance of the historical building. Therefore, assessing buildings with DuMo is performative; not only does it give a valuation of the building in the form of an energy label, it increases this label in proportion to the identified historical values, and furthermore it opens up opportunities for improvement of the energy performance. DuMo has also stimulated innovation; it brought about the development of new energy measures that are suitable for historical buildings. We noted that the threats perceived by the heritage community in the early 2000s are still present. When energy performance assessments become the basis for compulsory measures in historical buildings, as is the case in some countries, the historical values of heritage are seriously under threat. Therefore, the aims and procedures of instruments like DuMo are still very relevant today.

We studied the 'magic' of the DuMo instrument to render incommensurable values commensurable. Inspired by the conceptualization of Espeland (1998) of commensuration processes, we were able to show that with DuMo commensuration is achieved by virtue of the following six processes.

Certification of assessors. A precondition of DuMo is that in particular the assessment of cultural-historical values requires 'the right' valuators, as explained in 5.2. So, valuators are selected, and certification schemes are employed.

Categorisation. Different values and aspects are divided into two domains or dimensions: cultural-historical values and sustainability. Within these two domains further categorisation takes place; different values are articulated and acknowledged as categories with questions or subcategories that can be scored. First of all, the cultural-historical values are condensed in categories and then a judgment is made regarding the importance of the values.

Reduction. We note, however, that not all types of values are included here, leading to a reduction of information. A monument may have more than historical values and energy performance properties; it may, for instance, also be appreciated as a touristic highlight, as a meeting place for a community or as a token of spiritual value.

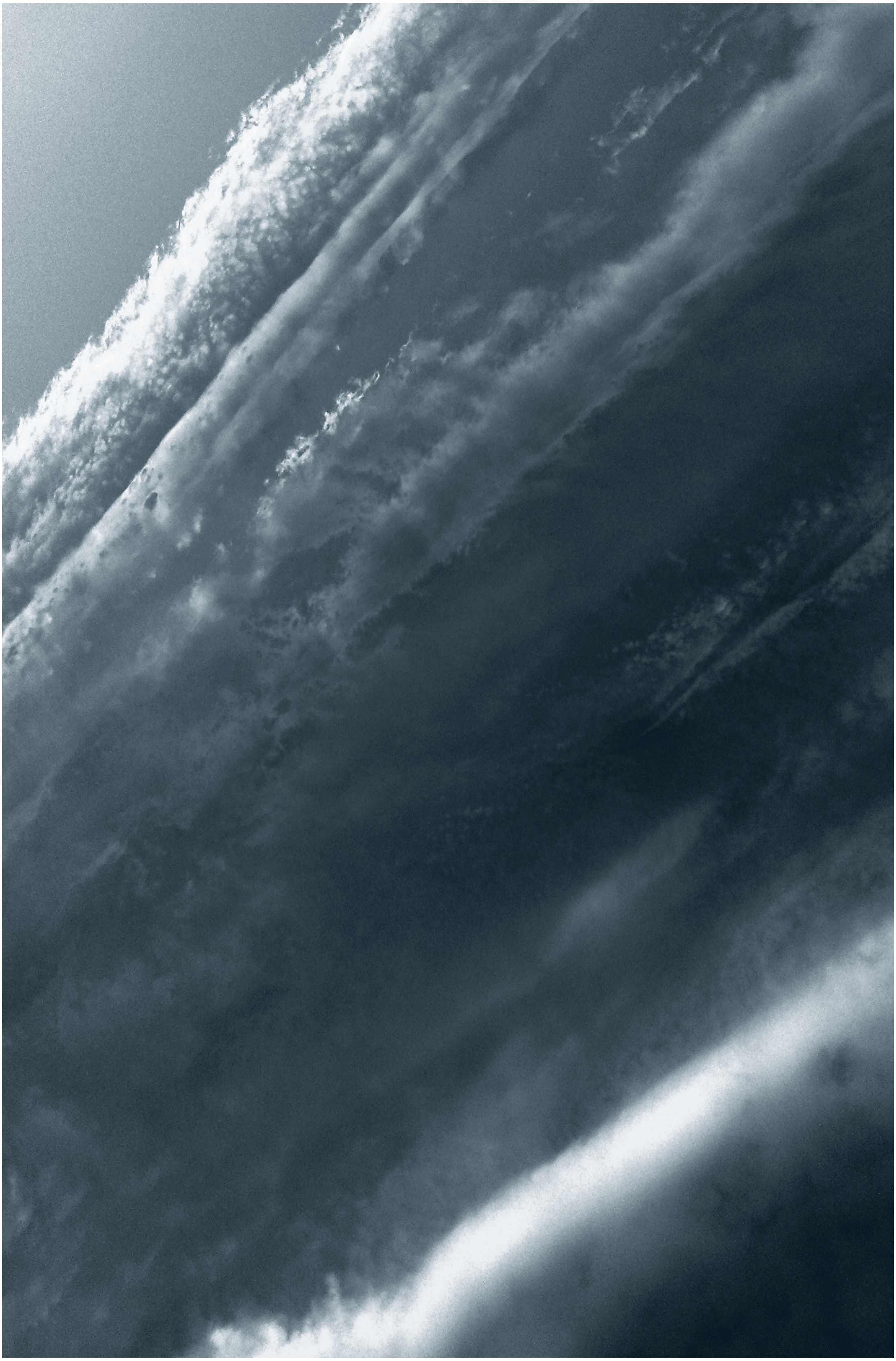
Simplification takes place by condensing the multiple themes and aspects of cultural history in questions that can be answered by expert judgment. Nevertheless, a DuMo report still contains an elaborate description and illustration of all found cultural-historical values.

Scoring of values takes place in both dimensions. The scoring for historical values is based on awarding points for valuable features, leading to qualifications on a scale from very positive to negative. The sum total leads to the historical value coefficient and the Touchability degree (A, B, C or X). The sustainability score is expressed in an interval scale.

Shared metric on what remains. The multiplication of the historical value-coefficient and the sustainability score makes the cultural-historical value bear on the energy label. Notably, if the cultural-historical value is low, there is no increase of the label. We note however that the shared metric in this case is basically an 'energy metric' with a cultural-historical multiplier. The resulting DuMo-label acts as a translation of historical values in numbers, which can be understood in the different worlds of heritage experts and energy professionals. DuMo produces a single number as outcome of the valuation process. This creates authority and makes the DuMo-labels easy to understand for experts and laypersons alike.

The DuMo instrument did more, however. The analysis showed that commensuration can also bring professional groups together and strengthen their identity. The ongoing discourse about energy and historical buildings is also a conflict over 'epistemic authority', that is 'the legitimate power to define, describe and explain bounded domains of reality' (Gieryn, 1999, p. 2). On the one hand, new guidelines for energy assessment of buildings could be interpreted as an infringement on the 'epistemic authority' of historical building professionals. They feel that their knowledge and experience are not taken into account, to the detriment of the historic buildings they care about. On the other hand, the commissioning of the development of the DuMo-method is also an attempt to settle or redraw the boundaries between the involved professions and to clearly state which tasks should be left exclusively to architectural historians. In fact, the demarcation of boundaries between professionals from the world of architectural historians and energy experts is reinforced with the separate assessment forms of the DuMo-method, to be filled out by the respective professionals.

In other words, the DuMo-method paradoxically brings reconciliation across borders by reinforcing boundaries; it keeps the epistemic authority of the two professions intact through separate assessment forms. So, while environmental and cultural values are reconciled (one final score), their incommensurability is maintained as well (separate forms). Our claim thus is that valuation instruments can perform commensuration and at the same time guard the boundaries of incommensurables by acknowledging multiple professions.



8.
Energy scripts; choreographed patterns of energy use

An earlier version of this chapter was submitted as a conference paper to the DEMAND Conference, Lancaster, 13-15 April 2016.

Abstract
Technology is infused with scripts that indicate how we as users should behave around, live in or use an artefact. Drawing inspiration from literature discussing user scripts and gender scripts, we develop the notion of energy scripts. We apply this concept to buildings, to analyse if and how the energy demand of buildings is choreographed by architectural design.

We argue that dwellings have energy-scripts, for example kitchens are designed for housing separate appliances, instead of using cool storage. The use of technology for heating and lighting is ubiquitous in modern buildings, while the need to reduce energy demand often leads to the installation of even more technology, smart or otherwise. On the other hand, 'passive design' demonstrates that it is quite possible to design buildings that need almost no energy for heating.

Researching the concept of energy-scripts we contribute to our understanding of the constraints and flexibilities for reduced energy demand in buildings. Our approach also sheds light on the social construction of the 'resident' or 'house consumer' as an end-user. Investigating implicit expectations regarding energy use, which could ultimately assist in designing building scripts that specifically invite energy efficient use of a building.

Keywords: energy-scripts, buildings, cool storage, 'passive house' designs

8.1. Introduction

Building is creating and organizing spaces to live in, so buildings not only provide for our way of life, but also for an important part determine its boundaries and opportunities. However, they are never beyond influence of human actors. Indeed, buildings are continuously being re-configured, as they undergo processes of restoration, redesign, refurbishment and re-interpretation. So, although they may look static, in fact buildings are 'halfway between agency and structure', as Gieryn remarks (Gieryn 2002, 35-74).

In this paper, I conduct a preliminary exploration of how buildings shape our daily lives with embedded scripts. The paper focuses in particular on the relation of building scripts with energy use. The question is if and in what way energy demand of buildings is choreographed by architectural design. To find answers to this question, I apply script analysis to the built environment (Fallan, 2008), more specifically to the scripts that invite or inhibit household energy use and production, in order to deepen our understanding of patterns of energy use. To that end, I develop the notion of an energy script, which can be defined as 'the way the distribution of light, heat and power within a building choreographs its functional use and stimulates or discourages energy use'. Scripts, however, should be related to actual practices, to enquire the connections between human actors and technological artefacts. Therefore, I consider four examples of energy scripts on the level of a specific room (the kitchen), a practice (cooking), a national infrastructure (gas) and the role that scripts can play in new sustainable design (Passifhaus).

The organization of this paper is as follows. In section 8.2 I further reflect on scripts, buildings and energy use. In section 8.3, I will discuss the mentioned examples relating energy scripts to buildings. In the fourth and final section I reflect and draw some preliminary conclusions.

8.2. Scripts, buildings and energy use

8.2.1 The interaction of buildings and social life

In the literature, there is a range of concepts used to describe the influence of buildings on social life. Here, I will discuss three of these approaches. First, we can identify a functional approach, which relates the social use of buildings with specific building types. Second, the school of architectural or physical determinism assumes a one-way influence from the physical built environment on social life. Thirdly, STS-scholars generally emphasise the interrelatedness of buildings and social action, or structure and agency as expressed in Figure 1 (p. 17).

Buildings are usually designed for specific functions, such as dwelling, teaching, office work, caring for patients or locking up prisoners. Since the beginning of the 19th century the range of building types for specific purposes increased considerably (Pevsner, 1976). It is claimed that building types co-construct cultural relations, express views on social life, instil discipline, give material expression to the division of labour, and/or are designed to impress the spectator with the wealth and power of the owner (King et al., 1980; Markus, 1993). Furthermore, not only the design, but also building materials and technologies reflect social and economic priorities from the period of building. The influence of building types can be intended by the designer, who translates societal visions in material form. So, through the work of designers, expectations of users, views on lifestyles or domestic organisation become embedded in the layout of dwellings (Franck, 1984; Lipman, 1969). Of course, it remains to be seen if the design is successful in influencing social life as envisaged; this is dependent on multiple factors, including the actions of users themselves.

In the 20th century the belief of architects in the influence of buildings on social life was rather strong. For example, Noble stated that ‘as architects we help to shape people’s future behaviour by the environment we create’ (quoted in Lipman, 1969, p. 192). Architects strongly believed that they should contribute not only to aesthetic but also to psychic and social needs. According to Lipman this belief must be seen in relation to the changed position of architects since the advent of modernism and mass housing. Lipman argues that as architects became detached from the social group their designs were for, they needed this belief for their professional self-esteem. Social engineering thus became one of the important roles of architecture as a profession (Lipman, 1969, p. 201). Furthermore, this ‘architectural determinism’ fitted very well in the utopian views of functionalism (Watkin, 1977). Architectural determinism was heavily criticised in the social sciences, because it assumes a one-way process directly leading from the physical environment to the expected human behaviour (Dostoglu, 1988; Franck, 1984; Golembiewski, 2016). Moreover, functionalist designs were often not successful in reaching the desired social goals, or even had adverse effects. However, Franck (1984) plead for a more nuanced view and argues for careful scientific investigations of direct or indirect influences of buildings on social life, thereby saving the valuable contributions this perspective can add to our understanding.

The mutual relationship of buildings and social life is investigated in several historical and STS-studies. For example Lewis Mumford investigates the relations between functions, materials and social norms in *The city in history* (Mumford, 1961). Multiple themes are covered, including urban planning, the design of houses, the provision of energy and the exercise of power, spanning a period from the stone age to the present. An architectural-historical enquiry is provided by Van der Woud (2011), who investigated the housing situation in the 19th century in the Netherlands and demonstrates how the slums kept the vast majority of citizens in sickening circumstances.

The intricate relationships between power and buildings are examined in *Discipline and punishment* (Foucault, 1979). Here, Foucault links buildings and their specific architectural form with the disciplining of bodies in society, drawing on the example of the panopticon. He refers to the system of relations between the elements of an ensemble as the 'apparatus': *'a thoroughly heterogeneous ensemble consisting of discourses, institutions, architectural forms, regulatory decisions, laws, administrative measures, scientific statements, philosophical, moral and philanthropic propositions'* (Foucault, 1980). In Foucault's work, however, the actual buildings are less important than the disciplinary system itself, which relates not only to prisons, but is a rationality, consisting of rules and expectations of behaviour. These ideas about how to behave like a useful and productive citizen have found their way into the architecture of schools, factories, mines, barracks and prisons. So, Foucault's perspective enriches the sociological analysis of building types as mentioned above. A comparable approach is taken by Murphy (2006), who uses the term 'assemblages' to describe the loose interacting elements of office workers, health inspection, feminists, research tools and building parts. She defines an assemblage as *an arrangement of discourses, objects, practices and subject positions that work together within a particular discipline or knowledge tradition'*.

In a case study of the Cornell biotechnology building, Gieryn (2002) describes the way its design is shaped by expectations and ideas about the development of scientific research, and how subsequently the building shapes the way research, commercial ventures and education are practiced at this department. Moore & Karvonen (2008) also emphasize that societal preferences are embedded in concrete buildings and argue that design is a thoroughly social process. To be able to carefully describe how expectations are embedded in buildings, I will now turn to the concept of scripts.

8.2.2 The concept of scripts

According to Akrich (1992) technology is infused with a script in which the designers define the 'right' way to use an artefact. Socio-technical scripts encompass the design, production, materiality, symbolic meanings, functions and actual use of the built artefact. Akrich applied the notion on the design of an electrical lighting kit in Africa, which precluded users from tinkering with the appliance, because the designers thought that this would cause problems such as damage to the installation. Scripts thus are explicitly meant to influence or restrain user behaviour, according to the views that the designer has of appropriate behaviour. 'So it was that the technical object defined the actors with which it was to interact. (..) It would tolerate only a docile user and excluded other actors ..' (Akrich, 1992, p. 211). A script can be seen as a 'device' that instructs the elements of the network how to behave regarding each other. These instructions or expectations are transmitted to the user in various manners; they can be embedded in materiality (Latour 1992, 225-258), in the layout of buildings, in regulations or in cultural habits. Moreover, not only individual buildings, but also the assemblage of buildings in a neighbourhood and the infrastructure for energy, water and mobility are influential in determining our way of life.

Akrich and Latour (1992) devised a whole vocabulary around the concept of scripts, for example *inscriptions*, which refer to the values inscribed or embedded in the design of an artefact, *pre-inscriptions*, which are used to enrol actors in the network, and *de-scription*, which is used for the analysis of an artefact regarding inscribed values, for example referring to gender, user-practices, class, or age. 'De-scription (or analysis) by the academic is thus the opposite movement (or reverse process) of inscription (or design) by the engineer or inventor' (1992, p. 259). A related concept here is affordances 'what a device allows or forbids from the actors – humans and nonhuman – that it anticipates; it is the morality of a setting both negative (what it pre-scribes) and positive (what it permits)' (1992, p. 261).

Scripts act as choreographies that guide the actors in their daily movements and actions. They define or pre-figure a range of social expressions and relations, such as expressions of status; specific functions; division of labour; gender and class roles. For example, several authors argue that scripts play a role in configuring the user (Oudshoorn & Pinch, 2003, 2007; Woolgar, 1990). Investigations of gender scripts have been performed by Oudshoorn, Hubak and others (Hubak, 1996; Oudshoorn, 1998; Oudshoorn et al., 2002).

However, scripts are not rigid, possibilities for resistance or noncompliance always remain. Users retain a certain freedom to redesign artefacts, and can also misunderstand, ignore, discard of reject the script (Wyatt et al., 2002). Depending on their motivation and situation, non-users are divided in resisters, rejectors, excluded, and expelled. Furthermore, Kärrholm (2013) emphasizes the freedom of users to redesign spaces, using the example of a child that designs a hopscotch in a take-away restaurant. Thus, human actors are not the passive receptacles of embedded scripts; they have opportunities to ignore, resist or even redesign artefacts. Furthermore, meaning and use of domestic spaces can differ significantly between cultures, even if the layout of rooms is similar (Lawrence, 1982). Preferences for eating dinner in the kitchen are related to cultural habits as well as domestic design. Nevertheless, while some scripts may be easy to ignore or resist, others will be literally 'in the way' and put up material, financial or other barriers for adaptation.

In the literature, it is argued that script analysis could be a useful tool to investigate how utilitarian functions, aesthetic expressions, social meanings, and cultural identities are constructed. Markus and Cameron (2002) aim to uncover scripts that are embedded in buildings through content analysis of architectural texts, such as briefs. Architects and engineers imbue their designs with numerous indications for their use, thereby contributing to the reproduction of historically developed lifestyles or the execution of social policy (Markus, 1987, pp. 467–484; Markus & Cameron, 2002). Furthermore, Fallan (2008) proposes to use script-analysis as a method for the analysis of design, which can add to the understanding of the interaction between product and user (2008, p. 67). He also underscores the active role of consumers/ users in adapting products to fit their needs, a process often referred to as domestication (Silverstone & Haddon, 1996).

The application of script analysis to the built environment enables us to examine how buildings, just like other technological artefacts, are infused with scripts that indicate how we as users should dwell. This is clearly recognizable in building plans, for example for dwellings. Here, texts indicate which rooms are meant as living room, kitchen, parents' bedroom or children's bedroom. Moreover, often the placement of furniture in these rooms is also suggested in the printed layout, more or less precisely indicating how the dwelling should be used. This prefigures the domestic organisation that is expected by the designer.

Scholars have investigated cultural meanings that are attached to the arrangement of rooms in dwellings, and the relation of changing social norms with housing designs. Shifting social norms are for example apparent in the number of bedrooms. Where in the beginning of the 20th century it was considered acceptable that a whole family lived in just one room, new norms of social and sexual 'hygiene' demanded more bedrooms. First parents and children were separated in two bedrooms, later also children of different sexes were no longer supposed to share a room. Secondly, from the 1920s onwards it is gradually required that a toilet should be included in each dwelling, even in 'minimal existence dwellings' (Porotto, 2018). Regarding the organisation of domestic spaces, Lawrence (1982) argues, on the basis of a study of UK and Australian dwellings, that rooms associated with 'clean' functions are often situated at the front or street side, and rooms associated with dirt at the back side. However, this needs further comparison across countries, as for example in the Netherlands it is quite common to find bathrooms and toilets at the public or street side, often right next to the front entrance.

Adapting buildings to new needs and demands can be challenging for financial, cultural and material reasons. So, although in the course of the 20th century welfare and lifestyle have changed dramatically, the original embedded scripts can still influence our way of dwelling.

8.2.3 Energy scripts

Dwelling requires energy. We need heating, lighting and ventilation to make buildings comfortable. We need electricity for household practices such as cleaning, cooking, storing, or washing; for practices related to personal hygiene, such as showering (Shove & Walker, 2010), and for home entertainment devices, such as radio, television, and computers. All these practices have changed over time, and the layout of buildings has changed accordingly.

As a further development of the notion of 'script', we argue that the notion of 'energy script' is useful to analyse how buildings are used and (re-) designed. Take for instance the calefactorium, which refers to the only heated sitting room in a medieval convent. Calefactorium is derived from Latin *calefacere*, to warm. This room was often situated next to the 'refter' (refectorium), the eating room for the choir monks. At the other side of the refter the kitchen was situated, so that the dining room could profit from two heated rooms. Right above this calefactorium we often see the scriptorium or writing room. The work of copying manuscripts could thus take place in a room that had at least some heat provided from below. The layout ensured that the available warmth was directed at often-used rooms (refectorium, scriptorium, calefactorium), but note that the working monks or lay brothers did not have these facilities at all. They had their own quarters, which were unheated. Thus, the distribution of heat follows the division of labour and class lines. A second example can be found in the medieval castle. Here, the 'kemenade' (from Latin *caminata*, heated, or *caminus*, hearth) is a heated room in, this is typically the central hall. It was often used by the female inhabitants of the castle and therefore could also be called the women's room. In many cases the bedroom of the lord is placed above this room, which then benefited from the heating below.

Energy scripts are defined as how the distribution of heat and power within a building co-choreographs its functional use, while inviting or discouraging energy use. I argue that energy scripts can help us to better understand the energy use of a building and its users. Furthermore, it could assist in designing building scripts that specifically invite energy efficient use of a (historic) building. Thirdly, it allows to trace hidden expectations regarding energy use. As Hayden (1981) and Schwartz-Cowan (1989) show in their studies, there have been 'paths not taken', such as build-in fridges instead of separate appliances. Lastly, this approach could shed light on the social construction of the 'resident' or 'house consumer' as an end-user.

8.3. Four examples of energy scripts

In this section, I will investigate four examples of scripts, and how they influenced energy use in the built environment. The focus is on housing, because as Moore & Karvonen (2008, p. 31) argue, "there is general agreement among architectural historians, cultural geographers, and anthropologists that dwellings symbolize and are spatially ordered as 'microcosms' of principal cultural constructs, so housing can be considered a representative building practice" To examine energy and housing, I rely on historical and empirical studies of energy-using practices, such as cooking, storing, and heating. The examples are chosen on four levels: the organisation of domestic spaces (the kitchen), appliances for household practices (food conservation), the infrastructure providing energy to our homes (gas) and the building shell (passive building).

In connection to these examples, I will enquire if there are 'paths not taken', because I expect such counterexamples can expose existing arrangements that have come to be taken for granted, and can alert us to the fact that it could have been otherwise.

8.3.1 The kitchen

It may seem quite natural to us that every dwelling has a kitchen and a dedicated space for a dinner table, to cater for the feeding of the family. However, this facility has been the subject of heavy debates in the 20th century. For example, Hayden (1980, 1981) asks herself 'What would a non-sexist city look like?' She demonstrates that in the first quarter of the 20th century feminist architects answered this question with: 'without kitchens'. In their view cooking and dining was most efficiently done in communal kitchens and dining rooms. A house without a kitchen obviously influences the living arrangements of its inhabitants, as well as necessitating catering services. In the same way, the present layout of dwellings with kitchens also steers behaviour of consumers and has influence on service arrangements. In her study, Hayden (1981) unearths a series of architectural designs that have in common the expectation that the provision of meals, the care for children, the provision of clean clothes and the cleaning of the interior, would be provided by shared facilities. Hayden presents layouts of apartment houses, with a common kitchen and dining room, but also terraced houses with a separate building housing a canteen, kitchen and childcare facilities. Similar designs are proposed by Teige (2002 originally published in 1932), who strongly argues that the live-in kitchen is a medieval practice, soon to be overturned by the provision of meals by collectivist services. Teige also refers to the 'hotel-type' dwelling, with a room for every adult citizen. Other family practices, such as laundry or child-rearing, were also expected to become collectivised. Teige even contends that the family itself is due to disappear. In the Netherlands, collectivization of cooking and washing was promoted by different social groups, such as the National Union of Housewifes (NVVH), architects and municipal housing departments. However, the collectivization ideal gradually gave way to the compact family ideology with women as mother and housewife (Berendsen & Otterloo, 2002, pp. 301–322).

Freeman (2004, pp. 155–171) identifies two major developments in the history of kitchen design in the 20th century: on the one hand ideals of functionalism and 'scientific management', which led to the design of small efficient kitchens and had a large influence on modern housing in Europe. Catherine Beecher, one of the first promotors of the efficient kitchen, was primarily concerned with order, while Christine Frederick adopted 'scientific management' as a method to save time, effort and money. In Europe the 'functionalist' kitchen was developed through designs of Adolf Meyer, J.J.P. Oud, and the 'Frankfurt kitchen' of Margrete Schutte-Lihotsky.

On the other hand, Freeman identifies the 'concept of the English kitchen as the heart of the home', the kitchen as a 'multi-purpose eating-living-working room' (2004, p. pp.72-75). Freeman finds a persistent desire to be able to eat in the kitchen, which has an aura of cosiness, informality, domesticity and family values. However, this desire often meets with architectural limits, firstly because the measurements of the functionalist galley kitchens of the Schutte-Lihotsky-genre are far too small to fit in a table with chairs. Secondly, the location of water, gas and electricity outlets is a material constraint to redesign (Freeman, 2004, pp. 85–86). Therefore, as Freeman shows, most people did not go into radical constructive work, but solved their 'layout problems' by themselves. The living-kitchen has according to Freeman never been a part of professional design concerns, but in Freemans' investigation, it turns out that people go to considerable lengths to combine the two concepts and are prepared to sacrifice some efficiency to cater for the possibility to use the kitchen for eating and living.

In the same period a similar debate took place in the Netherlands between proponents of the 'living-kitchen' and the 'working-kitchen', both under the adage of rationalizing household work (Oldenziel, Ruth; Zachman, 2009; Oldenziel & Bouw, 1998). The 'living kitchen' was supposed to be better adapted to daily practices of families, gave mothers more opportunities to combine household tasks and supervision of children, and would furthermore require less fuel for heating. However, after the First World War, the separated 'working-kitchen' became the national norm for new dwellings, codified in building regulations. Effectively this led to the banishment of the housewife to the kitchen for decades.

If the collectivization vision had taken hold, the organisation of our households would have taken a very different path, instead of the atomized pattern we see today. Probably, the use of energy and materials in such a setup would have been much lower than our present household energy use. We would need only a fraction of the number of fridges, washing machines and other facilities, to give an example. The path that historically was taken eventually led to an energy- and material intensive lifestyle, where a large part of household duties is shifted to the consumer (Schwartz Cowan, 1989).

8.3.2 Cool storage and cooking range

The second example concerns kitchen technologies, in particular cooking and cooling. Ierley (1999) describes the development of kitchen technology from the 17th to the 20th century. For ages, the open fire determined cooking practices and kitchen design for centuries. As Wilson (2012) says in 'Consider the fork', cooking was arranged around the open fire. A whole range of special instruments was needed to be able to reach out to the fire without burning oneself. Housewives had learned special skills to handle this and reported difficulties and resistance to the learning of new skills to use the new type of kitchen range. Apparently, some people even reverted to the open fire because they could not get used to the new methods (Wilson 2012). The open fire also needed a lot of fuel, so it is not surprising that many 19th century inventions had fuel economy as part of their goal. Take for example the Rumford range, which 'tamed' the open fire, used less fuel and at the same time provided more places for pots and pans. In the 20th century, according to Ierley (1999), comfort and labour saving were the most important goals for innovators.

Schwartz Cowan (1989) discusses the development that took place in the US in the 20th century, focusing on household organization, the gendered division of labour and the role of marketing in creating the present 'atomized' households. The earlier envisioned shared facilities vanished, energy-efficient designs did not attract much attention or were actively repressed. Schwartz Cowan also investigated why the design of cool storage was discontinued. It turns out that the selling of appliances, such as fridges, was more in the interest of dominant economic groups. For the Netherlands, Van Overbeeke (2001) followed the development of stoves, hot water appliances and furnaces. Jobse van Putten (1989) investigated earlier practices and technologies of food conservation in the Netherlands, such as drying, salting and 'wecken'.

These practices were gradually replaced by industrially conserved food products and on the other hand the development of the freezer. The breakthrough of the refrigerator in the Netherlands took off after a hugely successful supermarket campaign in the beginning of the 1960s (Lintsen, 1992). In the meantime, the cellar had disappeared from the standard layout of buildings after the 1950s, leaving dwellings without cool spaces. The refrigerator therefore was presumably very welcome to fill this gap. However, this depends on national building traditions, for example in Germany many houses contain large cellars, which can be used as cool space.

In this example we see how practices of cooking and storing are connected to technologies, regulations and economic developments. Energy use was an important criterion in the shift from open fire to cooking range, while cooling and storing practices were influenced by multiple factors such as economic interests and housing design.

8.3.3 Natural gas for every household

Heating technology has influenced the layout of our homes considerably. In the past, large cellars were needed for housing large boilers, and even small homes had dedicated storage room for coal or turf. Although sometimes worker's families had to use the turf shed as sleeping room for their children, as is sketched in Tilbusscher (2014).

The designs for the so called Minimum Dwelling, which were first presented at CIAM II in Frankfurt am Main in 1929, have been analysed in many ways (Bevilaqua, 2011; Porotto, 2018; Teige, 2002). They depart from expectations of working-class family life, based on the sociological theory of Müller-Lyer. The minimum requirements for heat and light were taken up in the definition of 'Existenzminimum' by Gropius (1929), so a careful reading of the designs gives information on the role of heating appliances in the organisation of domestic functions.

In the Netherlands, integration of heating appliances radically changed after the discovery of the Slochteren gas reserve in the Netherlands, in 1959. After the war the regulations for (social) housing were rather restrictive with respect to heating and hot water. These services were considered a luxury. However, the new and vast gas reserves gave rise to the idea that it would be best to sell these resources as quickly as possible, in order to be sold out before the then-expected cheap nuclear energy would hit the market. Therefore, national housing regulations were relaxed; provision of gas, hot water and central heating became the new norm (Van Overbeeke, 2001).

At the same time, the energy efficiency of buildings from that period is very poor, due to the use of cheap materials and building techniques. Also, the layouts did no longer include heat-conserving building techniques, such as hallways and double doors, which were used to keep cold and draughts outside.

Since the 1980s the practices of heating, cooking and storing are targeted by policies aimed at reducing energy use. EU rules and labelling have decreased the use of energy by fridges and other appliances. Highly efficient gas heaters decrease the use of natural gas for heating. Insulation policies aim to convince house owners to upgrade their property, in order to decrease the energy loss through the fabric of the building. However, all these measures are targeted at the moral responsibility and behaviour of consumer-citizens and come with considerable costs and mess for homeowners. At the same time, the layout and functional characteristics of dwellings are not so easily changed. However, new designs have made it possible to proverbially heat your home with a light bulb. This is the so-called passive house, which is the subject of the next section.

8.3.4 The passive house

In the passive house the energy script is changed, although the user or gender scripts have not necessarily been altered. Examples of passive houses can be found all over Europe. In Austria, the concept became almost identical with 'quality'. In the Netherlands there is considerable interest, although it is not yet mainstream. How is this accomplished? The 'passive house' is regulated by a European standard. These standards are primarily geared to ensure that the building envelope is heat- and draught proof and can function within strict maximum of energy use for heating and in total. Within the envelope, the organisation of domestic space is up to the architect or the commissioner. Installations for heating are provided, and a central ventilation system safeguards the integrity of the draught proof concept.

Appliances have to be chosen carefully, to stay within the set maximum for electricity use. Furthermore, the heat that is emitted by appliances such as refrigerators is used in the total heat balance of the dwelling. The question is if old technologies for keeping cold have been incorporated, such as cellars for food storage? A preliminary search for cellars in combination with passive house delivers lots of hits concentrating on technical recommendations to avoid cold bridges between the crawl space and the passive construction, but only one layout with cool storage was found. Cooling is an important challenge for the future, given the rise in temperature due to global warming.

Keeping warm is no longer a problem with passive house technology, but for keeping fresh products cool, these houses still rely on refrigerator technology. Maybe the design needs to incorporate cool spaces, comparable to the cellars in dwellings from the first half of the 20th century. Furthermore, with climate change the main challenge in the next decades is no longer energy required for heating, but for cooling.

8.4. Discussion

This paper argues that the embedding of energy scripts in our dwellings takes place in multiple ways, including organisation of spaces, government regulations, changing practices and new energy infrastructures. On the building level, it appears that organizing functions and spaces is closely related to organizing heat and cold. Energy use is influenced in multiple ways by the layout and materiality of the dwelling. According to Hayden, American standard layouts are especially prone to leakage of heat, while the passive house is explicitly designed to preserve heat.

National building regulations were very influential in determining the organisation of spaces within dwellings. In the Netherlands, the abandonment of the housewife to the kitchen was strongly influenced by the design requirement of separate 'working' kitchens. The location and design of kitchens is discursively scripted, based on ideology of the nuclear family with a specific role for women as housewife. Furthermore, the separate kitchen made more stoves necessary. Furthermore, we have highlighted the importance of government regulations for the inclusion of the social, gender and energy scripts in our dwellings. This relates not only to building and (energy) infrastructure, but also to allowed practices for food and energy production. The 'consumption junction' (Schwartz Cowan, 1987) also concerns furniture and appliances, which in some cases fulfil functions that in the past were integral to our dwellings. Parallel to the disappearance of built-in beds, drawers, iceboxes, and cellars, the sales of furniture and appliances saw an enormous increase in the course of the 20th century. For example, the lack of cool storage space led to the popularity of the refrigerator. Moreover, regulations regarding meat production got more stringent with the increase in population density. At the same time, increasing industrial food conservation and decreasing production of vegetables on allotments took away the need for food conservation at home. A whole range of practices and technologies for food conservation disappeared, together with the spaces in dwellings that provided room for these practices.

The use of cheap building materials became widespread in the 20th century, leading to dwellings that have poor energy efficiency. The majority of these buildings are still extant, although several rounds of retrofit have taken place since the first oil crisis in 1973. Not only the layouts and materials of our dwellings have changed, also the provision of fuel to our homes. After the discovery of gigantic gas reserves in the Netherlands, national regulations re-configured the design of dwellings in the 1960 by introducing new norms for the provision of gas for heating and cooking. Gas-fired central heating facilitated the heating of other rooms, instead of only the living room. With cheap gas, hot water was allowed to become a necessity instead of a luxury.

We argued that investigating implicit expectations regarding energy use could assist in designing building scripts that specifically invite energy efficient dwelling. The passive house movement sets rules by the adoption of a stringent European standard to ensure comparable quality across buildings and countries. Passive house designs seem to have solved the issue of heat preservation, however the provision of cold is not yet solved. For the existing stock a promising innovation was recently published, which allows home-owners to install a cool storage space in their back garden.

The 'kitchen of the future', with the button-pushing housewife, did not materialize, or rather, it turns out to be quite different from early visions. Innovations have a tendency to appear in unforeseen directions, although refrigerators do not yet manage their own supplies, new services sprang up to deliver boxes with fresh food and recipes to your door.

Although the utopian architectural visions from the 1920s are no longer relevant, the debate about autarchy and local self-sufficiency is recently revived. How can our buildings provide for energy production, individually and as a local community? In that respect, the present struggle for governance of community energy production can be understood as an attempt to (re)gain control of energy production and consumption.

This paper discussed some of the ways that energy scripts are embedded in our buildings, through the layout of domestic spaces, the incorporation of specific functions in the building itself or in separate appliances, the use of materials, and the provision of fuel to our homes. These examples show that in the development of our built environment chosen paths have influenced the way we live, keep warm and do our chores. In the event, the paths that have been chosen not only shifted the burden of household duties to consumers, predominantly to women (Schwartz Cowan, 1989), but at the same time these paths are very energy intensive.

Part IV
To conclude

9.
Conclusion

9.1. Introduction

The starting point of this study is that the so-called energy transition takes place within an existing world, which both constrains and enables the transformations that are envisaged and attempted. Local communities, for instance, seek to transform the production and consumption of energy and build new networks to supplement and countervail the existing ones. Similarly, the existing built environment both provides structure and hinders change. The energy transition thus unfolds in a double reality, in the sense that it is shaped by us while at the same time it is shaping us. This notion underlies this thesis and it renders the challenge of energy transition into an exercise of 'reconfiguration'. In Chapter 1 reconfiguration is visualized as a cycle (Figure 1) while in Chapter 2 I introduced approaches that help to study and understand the ways that reconfiguration of the built environment is constrained and enabled.

Reconfiguration activities are diverse and heterogeneous – to study such processes I have use the notions of 'values', 'script and 'obduracy'. Reconfiguration is played out, for instance, on different organization scales, ranging from large scale infrastructures to local practices. Visions of reconfiguration are driven by different values, such as democracy, sustainability, localism, and cultural-historical values. Furthermore, expectations of users are embedded in the built environment ('script'), which in its turn influences human activities. Structures tend to reproduce themselves and become more and more obdurate. Consequently, actors have to overcome considerable constraints to achieve their goals. In this study, I have followed, characterized and analyzed the strategies in reconfiguration processes. In the preceding chapters I have described how local actors reconfigure buildings and infrastructures and what strategies are employed to realize values and overcome obduracy.

Two situations of reconfiguration have been studied in particular. In the first situation, I examined how a social movement aims to develop a decentralized and sustainable energy system. The community energy movement consists of small cooperative ventures with a considerable share of volunteers. They aspire to goals such as sustainability, democracy and localism and challenge the present centralized energy system based on fossil fuels. Energy policy in the Netherlands and elsewhere is gradually making room for cooperative production, however, existing patterns and incumbent interests remain very powerful. Community energy groups increasingly organize themselves in local, regional and national clusters, challenging the governance of the energy system and providing a decentralized alternative.

In the second situation, I studied how value conflicts regarding historical buildings are conciliated or 'commensurated' and how they are negotiated and solved in practice. Sustainability values, which are important drivers of reconfigurations, can come into conflict with cultural values. In this respect, I examined three categories of strategies in restoration projects. Furthermore, I looked at the practice of sustainable valuation of historical buildings, taking the design and employment of an instrument, DuMo, as an example. Here, I investigated strategies for the reconciliation of conflicting values in energy efficient restoration.

In this final chapter I will – as an answer to my research questions - reflect on my empirical findings and I will draw conceptual, theoretical and practical lessons from the study of these two situations. First, I discuss my empirical findings in connection with the three guiding concepts that I used: values, scripts and obduracy. Next, I will briefly revisit my empirical case studies and provide an overview of the most important reconfiguration strategies that I identified. Section 9.4 will formulate how the findings contribute to scholarly traditions. The last section is devoted to policy recommendations.

9.2. Guiding concepts, reflection and findings

9.2.1 Values, an important driver for reconfiguration

The role of values in reconfiguration processes is wide-ranging. Firstly, societal values lie at the basis of the design of the existing built environment at the time of building. In the Introduction, I described the 'Design for values-approach' as developed by Van de Poel (2009), which can be used to specifically enumerate the values that are to be taken up in the design. This approach can also be used retrospectively, to identify expectations, norms and values that are embedded in existing buildings. This acknowledges that values of the past can still influence present use of buildings.

Secondly, we find that actors, like those in the community energy movement are inspired by values like sustainability, democracy and localism. These values underlie the new organizational structures and the technologies that are favoured in the community energy movement. In the second situation, we studied the multiple ways of combining cultural-historical values with sustainability values.

Values and the energy system

The values that underlie the energy infrastructures are not immediately apparent, because its structures of physical lines, regulations and vested interests have developed over several decades. To uncover these values, historical studies can be enlightening. For example, Hughes (1983) shows how the confluence of political and economic values in different countries was an important factor for the layout of the electricity system. In general, there was a strong belief in centrally organized capital-intensive systems. The present energy system still reflects this principle. Therefore, to transform this system into a sustainable, decentralized system requires a different set of values.

In chapters 4 and 5 I showed that the challengers of the energy system are driven by values of sustainability, democracy and localism. Sustainability lies at the core of the community energy movement. Democratic governance of renewable energy production is necessary to safeguard sustainability goals and to ensure social sustainability. Ideals of new localism aim to ensure that the economic benefits, such as employment and investments, benefit the region itself and can be used for new sustainable projects in the community. Cooperative ideals require strong commitment, as is shown in Chapter 5, where strategies to increase and maintain this commitment are described.

We can also identify embedded values and expectations in existing infrastructures by looking at what is enabled and what is constrained. In this way, we can analyze the position of consumer groups by identifying expected or allowed roles and behaviors of 'end-users'. For example, rules that were originally meant to protect the consumer can now become a constraint to development of new grids.

Taken together, community energy values present the almost perfect opposite of the profit-oriented, fossil fuel dependent, international energy companies. It is important to acknowledge this fundamental difference in values between incumbent energy companies and the community energy movement since what is at stake here is not merely to market a new or improved 'product', but a challenge to the existing distribution of power over energy resources.

Values in the built environment

Cultural-historical values are attributed to historical buildings and towns; both experts, amateurs, owners and local stakeholders strive to protect these values. New values, such as sustainability values, can come into conflict with protection of cultural-historical values in restoration practice. My enquiry into this subject had three parts, negotiation of values in restoration practice, reconciliation of values with an evaluation instrument, and the identification of embedded values in the design of buildings.

In Chapter 6 I described how design strategies, identity strategies and communication strategies are used for the reconfiguration of historical buildings. The 'design for values' approach (Van de Poel, 2015) inform the search for practical solutions - or design strategies - that are detailed in the Handbook for Sustainable Care for Historical Buildings (H Van de Ven et al., 2011). Furthermore, cultural-historical values are actively mobilized to protect locally valued buildings. Communication strategies are employed to make the chosen values bear on the restoration process, as is described in Chapter 6.

However, as values often come into conflict, instruments are sometimes developed for commensuration. In Chapter 7 I examined how the design and application of a specific instrument, DuMo, systematized commensuration of cultural-historical and sustainability values.

In Chapter 8 I have examined how societal values inform designs of buildings and (energy) infrastructure in various ways, both consciously and unconsciously. Firstly, values about social and gender roles have been the departure point of housing designs. For example, the ideology of the nuclear family is reflected in the traditional layout of domestic space, which organised gender roles of production and reproduction (Hayden, 1981). Secondly, economic goals, such as the sales of energy and appliances, are reflected in domestic layouts (Hayden, 1981; Schwartz Cowan, 1989).

9.2.2 Scripts; how old ideologies linger on in the built environment

How embedded values and expectations can influence users of technology is often examined with the concept of scripts (Akrich, 1992). This concept implies that artefacts are designed with the user in mind. These artefacts then contain embedded features that both enable and constrain, but not fully determine, their users. Scripts thus connect the roles of designers, users and artefacts. They can at the same time construct the relationships between users and institutions, as Akrich (1992) shows. Expectations of users are not always explicit; they can be a taken-for-granted part of visions prevalent in a specific period. Furthermore, there can be unforeseen consequences, which were not meant by the designer or commissioner.

For the building environment, this means that values and expectations from the time of building are embedded in buildings and infrastructures. For example, the organization of domestic activities or class relations can be identified in the layout of dwellings. Moreover, embedded scripts continue to influence present users, because material aspects can be difficult or expensive to change. On the other hand, users are also actively interpreting and changing buildings to better fit their needs.

The situation becomes more complex when looking for scripts embedded in infrastructures. The energy system consists of a whole range of complicated artefacts, combined with a structure of regulations and organizations. Nevertheless, infrastructures were at least partly designed with the user in mind and include a whole variety of intended user behaviors. Decentralized structures, as the community energy movement promotes, create new avenues of action for prosumers, citizen's groups and local entrepreneurs.

Script analysis (Fallan, 2008) can be used as a tool to uncover the expectations and ideologies that formed the basis of the design of buildings. To this end, I further developed a method using texts and layouts for the analysis of embedded scripts in buildings (Markus & Cameron, 2002). In Chapter 8 I developed a new concept, energy scripts, as a heuristic instrument to look for ways that energy demand is constructed in buildings. 'Energy scripts' account for the expectations regarding the use of heat and electricity for different periods and types of building. For example, in the 20th century, cheap energy, expensive labor and ideals about family life were translated in building design (Schwartz Cowan, 1987, 1989). Decades later, when contexts and societal ideals have changed, the built environment continues to influence energy demand, as is discussed in Chapter 8. Therefore, embedded energy scripts have to be taken into account in the design of energy reconfigurations. Furthermore, visions and designs for low carbon living should include new scripts that stimulate low energy demand. In Chapter 8 I discuss how this could be done in the case of passive building design.

9.2.3 Obduracy, both a challenge and an ally for reconfiguration

The built environment shapes and stabilizes social life, and is subject to reconfiguration. Nevertheless, both material and social structures are resistant to change; therefore, agency is needed for reconfigurations, not only to develop and design new structures, but also to overcome the obduracy of existing ones. Network ties have to be loosened or even destabilized, before new values and principles can get hold. However, obduracy also has a positive side, it contributes to maintaining the stability of sociotechnical arrangements and helps to conserve cultural values.

In this thesis I have focused on two kinds of conditions with respect to obduracy: maintaining obduracy and challenging obduracy. In the first situation, strategies are employed to challenge the obduracy of the energy system, to create new networks. In the second situation, strategies are directed to support network stabilization, to conserve cultural-historical values.

Challenging the obduracy of the energy system

The community energy movement argues for a new guiding vision, where values of sustainability, democracy and the local economy prevail. However, the question remains if the community energy movement is progressing from 'nibbling at the fringes' to a more substantial participation in the energy sector. In chapters 4 and 5 causes and limits of obduracy are discussed through the agency that is employed to achieve system change. Limits of agency come to the fore in the high dependency on volunteers, who are limited because of time and knowledge. Obduracy is also produced by regulations, which are heavily influenced by past and present incumbents. Thus, the existing large scale (fossil) energy companies use their networks and political power to protect their interests. Especially the mode of energy governance is challenged by small and innovative producers; the main part of the existing (physical) electricity infrastructure can be adapted to suit new regulations, uses and technologies. The main challenge for the community energy movement thus is to change governance, which are presently geared to multinational companies operating in a centralized energy system. To succeed, national and EU-regulations have to facilitate decentralized energy production, distribution and supply, and provide room for prosumers. Currently, the Clean Energy Package[21] promises important steps forward in that regard.

Large technical systems can undergo phases of reconfiguration, stagnation and decline (Sovacool et al., 2018). To that extent, Sovacool et al. also argue for a larger role of users in LTS. However, the community energy movement has a vision on governance that exceeds individual prosumerism or the relatively minor activities of user innovation. In fact, the community energy movement is providing new 'system builders' that can develop 'momentum' (T.P. Hughes, 1983). Strategies that contribute to momentum according to Hughes, are the spreading of knowledge, the creation of professional

21 https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans (Accessed July 30th 2019)

networks, and gaining traction in politics. I have shown in chapters 3, 4 and 5 that the community energy movement is in fact using these strategies.

The community energy movement argues for a reversal of the centralization process, with local decentralized provision as the most appropriate basis of the electricity system, starting with individual households, but already expanding to larger units such as supermarkets, schools or factories. The community energy movement challenges the existing energy system and aims to create new stable networks or 'momentum' (Hughes). Moreover, in the community energy movement, users are moral actors and, in many cases, also economic actors. Thus, the usual distribution of agency between on the one hand 'large scale centralized energy providers' and 'small individual users' is contested. Decentralization entails re-distributing agency to include a more diverse group of actors, from prosumers to energy cooperatives to innovative SMEs.

Obduracy as an ally instead of a constraint

The protection of existing cultural-historical values, while at the same time incorporating new values such as sustainability is the central topic of my cases on energy efficient restoration. Furthermore, my research takes a new perspective on the maintenance and strengthening of obduracy. Instead of taking obduracy as an obstacle, I highlight its positive side as a factor in the protection of historic cities, buildings and landscapes. Here, it shows that obduracy can be taken as an ally for conservation, it can be mobilized to protect valued elements in the built environment.

An example of 'obduracy as ally' is described in Chapter 6. Here, the focus is on the strategies that are used by different actors in restoration processes. The cultural-historical values of buildings, both tangible and intangible, are employed by local stakeholders to prevent the demolishment of historical and characteristic buildings. Initiators (architects, owners) use several types of strategies to convince decision-makers and other stakeholders (neighbours, politicians) of the value of the restoration plan. A mixture of stories, memories and heritage regulations is mobilized for the protection of cherished parts of towns and cities. Thus, obduracy allows buildings and cities to provide identity and a link to our past.

9.3. Strategies for reconfiguration

Knowing that the existing built environment both constrains and enables reconfigurations, my research questions relate to the strategies that are used to realize and protect values and to overcome obduracy. In this section I will look back on my findings in this respect.

9.3.1 Community energy in an international perspective

In Chapter 3, *Strategies of community energy*; a literature review, a broad literature overview of community energy is presented, providing the ground work for the empirical research of community energy. The overview gives insights in the goals, strategies and present situation of the community energy movement. This literature has taken off about ten years ago and focuses on the interchange between power generation and distribution, social networks and local institutions. Community energy is studied from a variety of theoretical perspectives. Unfortunately, the distribution over countries is rather skewed, as the majority of studies investigate the UK, namely one out of three studies. However, Germany is catching up quickly with a host of studies investigating the Energiewende. Together, studies about the UK, USA, Germany, and the Netherlands make up almost 70% of all cases.

Furthermore, only a limited number of studies explicitly compare policies and experiences in multiple countries. Nevertheless, it is evident that the use and spread of specific technologies and the opportunities for decentralized governance are for an important part determined by past and present national policies, cultural differences, geographic characteristics, fiscal regimes, subsidies, price differences; all these factors together lead to a different situation regarding renewable energy production, the roles of local cooperatives and municipalities, and the (expected) contribution of local energy to the energy transition in general. Hughes called this phenomenon 'regional style', which is produced by the dynamic interplay of geography, economy and politics. Other authors focus on the 'institutional fit', the regulatory and institutional context which for a large part explains the relative success of local energy initiatives. As a result, the differences between countries are striking. For example, the development paths of renewables in Denmark, Germany, UK and the Netherlands, four EU-countries in close proximity of each other, are radically different.

Connecting this literature study to the findings of chapters 4 and 5, it appears that although community energy in the Netherlands started out relatively late, it is quickly catching up, thanks to a growth in public interest and a better 'institutional fit'.

9.3.2 Bottom-up strategies for a new energy system

The need to develop a low carbon, renewable energy system is urged both by climate change and the depletion of fossil fuels. One of the central ambitions in my PhD has been to investigate what happens when the energy system is challenged by new actors, in particular community energy initiatives. What strategies are employed by the community energy movement to create more room for decentralized democratic ownership in the energy system? Chapter 4, *Power to the People: Local community initiatives and the transition* *to sustainable energy* describes what is happening at the local community level towards realizing community energy ambitions from a social perspective. In a case study we investigated the following question: How do local community energy initiatives contribute to a decentralized sustainable energy system? We developed a conceptual framework based on Law & Callon (1992, p. 49), which includes two dimensions. The first dimension is the quality and strength of relations with global networks; how are these attachments increased and ensured. The second dimension pertains to the commitment of local network actors. To be able to assess these dimensions we added an operationalisation, as outlined in Chapter 5.

Regarding the first dimension, our findings suggest that a high degree of attachments of local actors to 'global' networks is a prerequisite for continuity and local effectiveness of the initiative. Local initiatives continually develop and update relations with local, regional and national networks. These attachments also include informal ties, such as through the occupation of members in the energy and/or governmental sector. Relations on the local level partly determine the local support of local government, local economic actors, schools and other local constituencies. The embeddedness of the local organization in regional and national energy networks gives inspiration, information and support.

As to the second dimension, we found that especially organisation development, the development of a shared vision, and a high level of activities are important factors of the strength of the 'local network'. The main challenge for local groups is how to (continue to) involve and inspire members of the local organization and how to develop an effective team. Many community energy initiatives went through a formalization process, which strengthened the organization. Important aspects include the continuity of membership, the number of active members and the amount of time members can and will spare for common activities. Furthermore, a robust organization structure allows growth and continuity and enhances the commitment of members. However, my case studies also indicate that democratic leadership is an important factor for the effectiveness of local organizations. The values of the community energy movement include more democratic decision-making; therefore, democratic and accountable leadership is important for local organizations.

Many practical guidelines state that the development of a shared long-term vision, made concrete in practical steps, is an important strategy for community energy initiatives. However, we find that local visions often consist of general or superficial views on energy neutrality and the development of low-carbon communities. More developed local visions with clear energy goals are rare.

Lastly, we mention that the level of activities, including communication efforts, is an important indicator of the commitment of members as well as local team effectiveness. We saw a sharp rise of activities in the Netherlands in general, as well as in our cases. However, due to time-constraints and other competing issues, it is a challenge for citizens initiatives to continue on this high level.

The developed framework with the two dimensions of 'relations with outside networks' and 'commitment of members', including specification of relevant activities provided a useful ordering device of strategies employed by local energy initiatives. The framework was expanded and concretised to arrive at indicators for the performance of the studied initiatives on the two dimensions.

9.3.3 Connecting energy networks on a regional scale

In Chapter 4, *Challenging obduracy, how local communities transform the energy system*, we presented an in-depth study of new networks that challenge the established way of centralized decision-making on energy resources. We described how these co-operations are linked to local, regional and national networks for community energy. These community energy networks constitute a so-called social innovation, aimed to realize a decentralized and decarbonized energy system. For a recent overview of social innovation in community energy, see Hoppe and De Vries (2018). Strategies identified in this study primarily relate to the organization structure and the growing cooperation on regional and national levels.

Here, I order the identified strategies along the two dimensions as developed in Chapter 4. Not surprisingly, as this is a study of network development, the majority of strategies can be placed on the dimension that marks the level of attachment to outside networks. The first group of strategies is directed at 'like-minded' organizations. Here, we observe a regional clustering of community energy networks. In many regions in the Netherlands local organizations get together to form new umbrella organizations, with a view to support and strengthen the local volunteer initiatives. Further clustering occurred when three Northern umbrellas founded a cooperative energy provider. Furthermore, nationally organized networks aim to develop stronger cooperation. Coordination on a national level is increasing with the continuous founding and merging of community energy organizations. The second group of strategies relates to cooperation with other types of networks, such as political or government organizations. We see increasing connections with 'neighbouring' organizations on the provincial level, such as environmental and rural support organizations. Lastly, provincial governments are approached, which developed several schemes and funds for financial and other assistance. Moreover, on a national scale, there is active lobbying for community energy. In the Netherlands, the fiscal structure still favours large (industrial) consumers and lays a relatively high fiscal burden on households.

Therefore, an important strategy for the community energy movement is lobbying for a more balanced fiscal structure. This resulted in a new policy tool, the Postcoderoos-facility.

On the second dimension, relating to the commitment of actors, we observe strategies directed at motivating active members, finding new members and reaching out to the larger public. The community energy movement is a social movement, which is largely based on committed volunteers. However, this situation also carries risks to the budding local organizations. Voluntary employees have to spend their (limited) free time on the project, which restricts the amount of time and energy they can invest and even can lead to 'volunteers burn-out'. Volunteers often leave the organisation for a more promising formal job. The high turnover of volunteers is a strain to the continuity of the organisation.

To reach out to the general public and to find new members and customers, a close relationship with regional culture is emphasized. Constituencies are organized along provincial boundaries and purposefully relate to the mentality and regional language to connect to people living in the region. Furthermore, it is argued that the cooperative energy provider should limit itself to the northern provinces, to remain close to local networks and people.

A separate issue is the development of specialized knowledge. For example, regulations are an important part of the energy infrastructure. The rules and conditions for energy providers are extremely complex, presupposing a knowledgeable paid staff. The community energy activists thus have to complete a steep learning curve to be able to comply to all the rules. However, as new networks such as I described in Chapter 4 continue to develop and expand, this will stimulate knowledge exchange and development.

Summarizing, the two dimensions identified in Chapter 4 also operate on regional and national levels. The activities in national policy networks and the strengthening of cooperation on a national and regional scale is crucial for the effectivity of actors. Furthermore, such cooperation is important to exchange knowledge and strengthen common interests. The role and meaning of volunteering are crucial in this new social movement. The type of leadership seems to be an important factor in the success of voluntary organisations. As a social movement, Community Energy is still growing in size, degree of organisation and development of types of activities. Presently, the community energy movement challenges existing modes of energy governance with increasing success.

9.3.4 Strategies to negotiate conflicts of sustainability values and cultural values in restoration practices

For the case of reconfiguration processes in historical buildings I examined the conflicts between sustainability and cultural values that arise in restoration processes. In Chapter 6, *Struggles of restoration in sociotechnical networks; three types of strategies for the conservation of identity and energy*, I investigated what strategies are used in energy reconfigurations of historical buildings. Based on 14 case studies of energy efficient restorations I developed a framework of applied strategies and illustrated this framework with one of the case studies. I identified three types of strategies to negotiate between sustainability values and cultural-historical values: design strategies; identity strategies and communication strategies.

Design strategies. In restoration design and practice, architects and engineers often need to find creative solutions to let light in, hide ventilation ducts, or use non-authentic building parts for new technology. Such technical solutions have to be consistent with cultural-historical values. Continual decisions have to be made on what to do with existing parts and features. My case studies show how design strategies were applied to cater for new use(r)s of the building and to implement a range of energy efficiency measures.

Identity strategies. These strategies entail emphasizing cultural-historical values to convince stakeholders of the importance of conservation of the cultural-historical values of a building. For example, in the exemplar building in Franeker, the identity of the town became intertwined with the goals of a network of local actors. Identity strategies were used to identify cultural values, strengthen social values and embed the building in local regulations. Context value and social value were taken up in new plans for the development of the immediate neighborhood. The existing and newly identified values were translated in legislation documents and urban planning decisions.

Communication strategies. Communication strategies are directed at the strengthening of the ties between stakeholders in a restoration project. Communication strategies include the search for new users, the creation of a sounding board with stakeholders, seeking approval by neighbors, or the involvement of the heritage board in an early stage of the project. Furthermore, publication of the history of the building, including its role in the community. Cooperation with the local authority and the (national) heritage board is often instrumental in securing financial resources and necessary building licenses.

The main goal of the research described in Chapter 6 was to examine what types of strategies were employed in resolving value conflicts in restoration projects. The usefulness of these strategies was discussed in several workshops with practitioners. In particular, the use of communication strategies in restoration projects adds to our understanding of the possible ways to reconcile sustainability and heritage values in restoration practice.

9.3.5 Commensurate conflicting values with a valuation instrument

In many cases sustainability values and cultural-historical values are incommensurable, and accordance with one value potentially causes damage to the other. In Chapter 7, Instruments of valuation: the case of assessing historical buildings, we examined the development and application of the so-called DuMo instrument, which combines the assessment of historical and sustainability values. Inspired by the conceptualization of Espeland (1998) of commensuration processes, we showed that with DuMo commensuration is achieved by processes to reduce and simplify information, categorization and scoring of values in two dimensions, and applying a shared metric on the result. Furthermore, only certified assessors can conduct the valuation procedure.

The DuMo-label acts as a translation of historical values in numbers, which can be understood in the different worlds of heritage experts and energy professionals. This creates authority and makes the DuMo-labels easy to understand for experts and laypersons alike. In this chapter, we also showed that commensuration can bring professional groups together and strengthen their identity. Commensuration thus is an important strategy, which adds written and formalized procedures to the more informal communication strategies discussed in Chapter 6.

9.4. Further social studies on the energy transition

In the preceding sections I have drawn conclusions on concepts and strategies for energy reconfiguration, in order to answer my research questions. In my thesis I have benefitted from various scholarly traditions. I am now in a position to reflect on the merits of the approaches and concepts used and to consider what my thesis possibly has to offer for further social studies of the built environment and the energy transition.

Values and roles of human actors in the energy transition

The energy transition comes with new opportunities, values and roles for citizens. Examples of these new roles are prosumer, system builder, and intermediary. Examples of new values in this respect are democracy, localism and sustainability. So, to be able to realize such values, citizens increasingly want to take part in the governance of energy resources. In that respect, community energy networks constitute a new type of intermediary, which is promoting ownership of energy assets. However, in energy literature as well as energy policy, there is a bias towards financial motivations, thereby overlooking the importance of other values. This unbalance can be remedied by drawing on Social Movement Theory, because this interprets social movements as a conflict over the governance of resources (see Chapter 4). Furthermore, citizens are interpreted as moral actors who strive to attain multiple values. To further examine values and roles of citizens in the energy transition, it would be useful to unpack the development of the category of 'users' or 'end-users' in the energy discourse, as Forty (2000) has done with regard to buildings.

Secondly, given the multifaceted character of the energy transition, studies profit from a combination of approaches. Moreover, participation of stakeholders is important to ensure alignment of energy research to relevant questions for community energy. Therefore, I propose to apply transdisciplinary theory, which draws on multiple academic disciplines and involves local stakeholders in problem definition and problem solving (see Chapter 3).

Governance and limits of agency for community energy

This thesis emphasized the potential roles of local initiatives in the energy tradition. It showed how local initiatives heavily depend on national and international regulations, which provide both boundaries and resources. Examples are feed-in tariffs, subsidies, opportunities or barriers for small scale energy companies.

In general, energy regulations reflect the past and present interests of the incumbents, in this case large fossil energy companies, and are historically structured to facilitate centralized fossil fuel energy production. In this respect, Geels et al. (2018) show how dynamics and frictions between local, national and European policies have an important impact on the success of low carbon innovations (2018, p. 31). Future development of community energy therefore is dependent on a suitable 'institutional fit' (Oteman, Kooij, & Wiering, 2017; Oteman et al., 2014).

In light of the important contribution that community energy can have to the energy transition, the limits of agency that are posed by energy regulations and solutions to overcome or redress these limits should be further studied.

Acknowledge structuring power of existing built environment

The built environment is powerful in shaping actions and strategies, not just because it is 'obdurate', but especially because it embodies visions about its use. Such visions might clash with current visions. To capture this, I introduced the notion of 'energy script', to point to the forceful guiding of actions according to 'old' ideas of use. To analyze how past visions ended up in the built environment and to question if and how these visions still structure social life is a first step to uncover hidden expectations of users in the built environment.

This raises the question of what methods are available to reconstruct, measure and analyse this. In Chapter 8 I argue that script analysis, which I further developed to combine texts, layouts and historical contexts, is a fitting method to make this force of the built environment visible.

While architects have often been overly optimistic about the utopian force of new buildings and cities, my thesis supports the argument that to create designs for different patterns of life, we need new visions (Markus & Cameron, 2002). Therefore, the second step is the development and embedding of visions on low-carbon living, to arrive at energy conscious design of buildings and infrastructures.

This also relates to the observation in this thesis that cooperatives are more successful in starting new production facilities, compared to the retrofit of existing buildings or development of infrastructures. Combining these two steps of analysis and visioning can support and enhance the outreach and effectiveness of community energy.

Roles of experts and laypersons in the reconciliation of values in heritage conservation

Energy reconfigurations require value reconciliations. Partly because it mobilizes different professional groups (each with their own epistemologies and normativities). Partly because it mobilizes other stakeholders ('laypersons') as well. The roles of experts and laypersons in heritage management are changing. The vector approach to heritage planning expects that 'the traditional hierarchy of experts and non-experts fades away: plans emerge pre-eminently from the stories and memories (and initiative) of local inhabitants in combination with the knowledge of experts' (Janssen et al., 2017, p. 1665). My findings align in several ways with the vector approach to heritage management. As is shown in Chapter 6, local stakeholders play an important role in the conservation of historical buildings as well as the realization of sustainability values. Secondly, in Chapter 7 we showed how the cooperation of two professional groups, in other words two different groups of experts, contributes to the reconciliation of sustainability values and heritage values. In a related article, we reflect on the role of laypersons in the conservation of medieval churches (van der Schoor, Colmenero-Acevedo, & Vieveen, 2019). Taken together, these three papers show the range of work that is done in different heritage practices to overcome the 'rivalry of siblings' (Saint, 2007) that is present between heritage experts and engineers, and the traditional hierarchy of experts and non-experts. The acknowledgement and further research of these processes of communication and cooperation can shed light on how the mentioned 'traditional hierarchy' between experts and non-experts is made to 'fade away' in practice.

Communication strategies should be acknowledged as important part of restoration processes

Reconciliation, in its turn, requires communication strategies: professionals and other stakeholders need to be aligned. While the literature tends to focus on technical interventions and historical identity, it underestimates the open-ended, pluralistic nature of reconfigurations.

Communication strategies can be characterized as informal or 'in-between' strategies and are used by both experts and laypersons to achieve their goals (i.e. to realize their values); these strategies should therefore be acknowledged as important part of the restoration process. I have followed local networks of actors where they engage in practices and evaluations of historical buildings and examined the various social processes that are taking place, such as negotiation and commensuration. It showed that communication strategies of local stakeholders and heritage experts were instrumental in reconciling sustainability with heritage values in the production of restoration plans. Furthermore, while the strategies directed at technical interventions and at strengthening historical identity have been described in the literature (H. Van de Ven et al., 2011), the mentioned communication strategies are not yet included.

Commensuration processes as extension of the 'plural heritage approach'

This thesis aligns with the ambitions of 'plural heritage approach', which stresses that 'dealing with multiplicity' is necessary, as Janssen et al. argue (2017, p. 1665). However, the question remains how this can be achieved in practice. My study of commensuration processes aims to fill this gap. Connected to this, as shown in Chapter 7, this also sheds light on what is lost and gained with the use of valuation instruments. Moreover, it provides a method to include the stories and memories that are connected to historic environments as one of the important carriers of local identity. In careful assessments, such as carried out with the DuMo-instrument, intangible values are made open for scoring and thus can have a bearing on the valuation and conservation of heritage.

Similarities: levels of aggregation, reconciliations, novel questions

It is now also appropriate to reflect on a distinctive characteristic of this study: the choice to investigate in parallel the dynamics of energy cooperatives and the struggles to render historical buildings energy efficient. So, what have been the intellectual benefits of this choice?

First of all, it made me sensitive to the importance of levels of aggregations. Energy cooperatives and historical buildings alike involve many different stakeholders. What is less visible is that stakeholders come in various groupings, in different degrees of aggregation: local, regional, national, international.

Second, it helped to highlight that energy reconfigurations are always necessarily a matter of value reconciliations. This is apparent in historical buildings, but also plays out in energy cooperatives – it is often overlooked.

Third, the choice to study these two settings in parallel forced me to conceptualize the dynamics in both settings in rather abstract terms. This, then, allowed me to raise novel questions, for instance about what is 'obdurate' in energy infrastructures, or how buildings embody ideas of how to live, in other words, how buildings house forms of activism.

9.5. Policy recommendations

Energy reconfigurations offer important academic challenges, which I addressed in this thesis. Yet, the energy transition is, of course, much more than an academic concern. In this closing section, therefore, I will offer some recommendations for policy and practice.

The community energy movement should take on role as new system builder

The community energy movement and its organizations could develop themselves more fully as system builders of a sustainable energy system. This entails strengthening organization structures on local, regional, national and EU-level, by stronger coordination, increasing political action.

Related to this, the development of a solid and expanding knowledge base and the dissemination of knowledge to local actors is important for innovation of technologies and services that can strengthen grassroots and prosumer agency. To this end, education and research play an important role. Furthermore, the community energy movement could stimulate research and engineering institutes to develop technology that is geared to decentralized applications and bottom up governance.

Policy should provide opportunities and remove barriers for community energy

Community energy has an important impact on the energy transition, by building renewable energy systems and by reaching out to the general public in a positive manner, thereby increasing acceptance. This role should be more fully reflected in policy, to provide for and incentivize local citizens' initiatives. The growth of renewable energy production will have important effects on grid management. Investments will be needed for two-way grids, as well as for enlarging grid-capacity. Energy initiatives have indicated that they want to take on roles in grid management, for example by supplying balancing services. Therefore, the combination of decentralization and democratic ownership call for new visions on energy governance and grid management.

Design for values in the built environment

In the past, the built environment has been designed with the availability of cheap and abundant energy in mind. Therefore, in many cases, energy efficiency is not stimulated or even hampered by existing layouts and structures. In light of climate goals, large scale retrofits are considered necessary, which provides new chances to stimulate low-carbon living by integrating energy efficiency in retrofit designs. In energy policies directed at retrofit of existing buildings, the influence on energy demand of the layout and materials of buildings, cities and infrastructures should be more explicitly incorporated in retrofit strategies. 'Design for values' (Van de Poel, 2009) can be applied to improve the design of buildings. This not only means that sustainable heating, cooling and mobility patterns should be high on the list of requirements for retrofit of the built environment, but that the use-patterns embedded in buildings should be critically analyzed for effects on energy use.

Communication strategies should be acknowledged as important part of restoration processes

Heritage organizations and local government could improve information and guidance for owners of historical buildings who aim to increase energy efficiency. This includes provision of early and understandable information about heritage values and technical solutions as well as easy access to civil servants or heritage boards that are involved in licensing procedures.

In order to contribute to reconciliation of values in heritage conservation it is important to involve both experts and laypersons in reconfiguration and restoration processes.

Valuation instruments act as bridge to reconcile values of different professional backgrounds. Therefore, easy instruments to use by heritage and sustainability experts should be further developed and more widely used. The education of energy advisers should include information about historical values, not with the view of becoming a heritage expert, but to instill basic knowledge of what are appropriate or more importantly inappropriate measures for use in historical buildings.

With these recommendations my journey through energy reconfigurations ends. Via the moves of energy communities, the experts on cultural heritage and the historical buildings themselves I have explored energy reconfigurations. My starting point was their key duality: open for change, yet structuring agency. To address this, I have followed the paths of values, scripts and obduracy and traced the various strategies that stakeholders may employ. I started this thesis with the persistent urgency of energy transitions; I end with the hope that my academic efforts indeed contribute to this aim.

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Consulted websites and documents

Chapter 4:

Websites regional and local energy cooperatives (accessed June 24, 2015)

- www.grek.nl
- www.drentsekei.org
- www.nldenergie.org
- www.uskooperaasje.nl
- www.duurzameenergie.org
- www.facebook.com/pekela.duurzaamwww.facebook.com/pekela.duurzaam
- www.hieropgewekt.nl
- www.edecentraal.nl

Other documents included in analysis

- Letter to parliament concerning the implementation of the Energy Covenant (in Dutch)
- Notysje Enerzjy Kooperaasje (in Frisian)
- blogs
- newspaper articles 2010-2014 (assessed via LexisNexis)

Chapter 8:

Wolfe, Ross, https://thecharnelhouse.org/2011/09/20/the-sociohistoric-mission-of-modernist-architecture-the-housing-shortage-the-urban-proletariat-and-the-liberation-of-woman/#_ftn19

Appendix A : Corpus (Chapter 3)

Nr.	Authors	Journal	Title
1	Abegg, B.	Mountain Research and Development	Energy self-sufficient regions in the European Alps
2	Adams, C. A.; Bell, S.	Local Environment	Local energy generation projects: assessing equity and risks.
3	Aiken, G.	Geography Compass	Community Transitions to Low Carbon Futures in the Transition Towns Network (TTN)
4	Aiken, G. Taylor	Political Geography	Prosaic state governance of community low carbon transitions
5	Aiken, G. Taylor	Environment & Planning A	The politics of community, Togetherness, transition and post-politics
6	Aitken, Mhairi	Energy Policy	Why we still don't understand the social aspects of wind power: A critique of key assumptions within the literature
7	Alexander, Roy; Hope, Max; Degg, Martin	Local Economy	Mainstreaming sustainable development, a case study: Ashton Hayes is going carbon neutral
8	Allen, Joshua; Sheate, William R.; Diaz-Chavez, Rocio	Local Environment	Community-based renewable energy in the Lake District National Park, local drivers, enablers, barriers and solutions
9	Anzoise, Valentina; Sardo, Stefania	Evaluation and program planning	Dynamic systems and the role of evaluation, The case of the Green Communities project
10	Arentsen, M.; Bellekom, S.	Energy, Sustainability and Society,	Power to the people: Local energy initiatives as seedbeds of innovation?
11	Armstrong, A.; Bulkeley, H.	Geoforum	Micro-hydro politics: Producing and contesting community energy in the North of England
12	Bailey, I.; Hopkins, R.; Wilson, G.	Geoforum	Some things old, some things new: The spatial representations and politics of change of the peak oil relocalisation movement
13	Bale, Catherine S.E.; Foxon, Timothy J.; Hannon,; Matthew J.; Gale, William F.	Energy Policy	Strategic energy planning within local authorities in the UK, A study of the city of Leeds
14	Barber, Jeffrey	Journal of Cleaner Production	Mapping the movement to achieve sustainable production and consumption in North America
15	Barbero, Silvia	Design principles and practices	Local Bio-Energy Promotes Distributed Economy for Sustainable Development: Systemic Design Approach and Case-Studies
16	Barr, Stewart; Pollard, Justin	Environment & Planning A	Geographies of Transition, Narrating environmental activism in an age of climate change and 'Peak Oil'

Year	Country	TAnr	Theoretical Approach	Keywords
2011	Austria	7	Energy planning	energy autonomy; energy self-sufficiency; European Alps; policy; sustainable regional development
2015	UK	9	Norms & Values	community; energy; equity; policy; risk
2012	UK	9	Norms & Values	none
2016	UK	5	Sociology	Low carbon transitions Community transitions Transition towns Prosaic state Number governa...
2017	multiple	5	Sociology	Low carbon transitions, community, environmentalism, post-politics
2010	none	4	Acceptance	planning; wind; public
2007	UK	5	Sociology	none
2012	UK	6	Governance	community; renewable energy; Lake District; planning; partnerships
2016	Italy	5	Sociology	Evaluation; Innovation; Local development; Complexity Dynamic systems; Narratives; Uncertainty
2014	Netherlands	6	Governance	bottom-up innovation; local energy initiative; renewable energy; seedbed of innovation
2014	UK	2	Science & Techn	community energy; energy resources; Hexham river hydro; micro-hydro; north of England; politics of community energy production
2010	UK	9	Norms & Values	peak oil; relocalisation; transition; network; spatial representations; politics of range; hybridity
2012	UK	7	Energy planning	Strategic energy planning; Local government; Energy Service Companies (ESCos)
2007	Canada, USA	6	Governance	consumption; production; sustainable; strategies; policy; practices; North America
2010	Sweden	7	Energy planning	systemic design; network of enterprises; small scale production systems; local sustainable development; distributed economies
2016	UK	9	Norms & Values	Transition Town Movement; environmental activism; re-localisation

17	Barry, J.; Ellis, G.; Robinson, C.	Global Environmental Politics	Cool rationalities and hot air: A rhetorical approach to understanding debates on renewable energy
18	Barton, Hugh	Local Environment	Eco-urban neighbourhoods: A review of projects
19	Bassett,E.; Shandas, V.	Journal of the American Planning Association	Innovation and climate action planning: Perspectives from municipal plans
20	Bauwens, Thomas	Energy Policy	Explaining the diversity of motivations behind community renewable energy
21	Bauwens, Thomas Defourny, Jacques	Annals of Public and Cooperative Economics	Social capital and mutual versus public benefit, the case of renewable energy cooperatives
22	Bauwens, Thomas; Gotchev, Boris; Holstenkamp, Lars	Energy Research & Social Science	What drives the development of community energy in Europe, The case of wind power cooperatives
23	Becker, Sören; Kunze, Conrad; Vancea, Mihaela	Journal of Cleaner Production	Community energy and social entrepreneurship, Addressing purpose, organisation and embeddedness of renewable energy projects
24	Becker, Sören; Naumann, Matthias	Geography Compass	Energy democracy, Mapping the debate on energy alternatives
25	Becker, S.; Beveridge, R.; Naumann, M.	Space and Polity	Remunicipalization in German cities: contesting neo-liberalism and reimagining urban governance?
26	Bellekom, Sandra; Arentsen, Maarten; van Gorkum, Kirsten	Journal Energy, Sustainability & Society	Prosumption and the distribution and supply of electricity
27	Bere, Jemma; Jones, Calvin; Jones, Stuart; Munday, Max	Environment and Planing C: government and policy	Energy and development in the periphery, A regional perspective on small hydropower projects
28	Bergman, Noam; Eyre, Nick	Energy Efficiency	What role for microgeneration in a shift to a low carbon domestic energy sector in the UK?
29	Berkhout, T.; Westerhoff, L.	Environment and Planning C: Government and Policy	Local energy systems: Evaluating network effectiveness for transformation in British Columbia, Canada
30	Berlo, Kurt; Wagner, Oliver; Heenen, Marisa	Sustainability	The Incumbents' Conservation Strategies in the German Energy Regime as an Impediment to Re-Municipalization – An Analysis Guided by the Multi-Level Perspective
31	Berry, David	Environmental Practice	Community clean energy programs: proficiencies and practices
32	Beveridge, Ross; Kern, Kristine	Renewable Energy Law & Policy Review	Energiewende in Germany: Background, Developments and Future Challenges, The
33	Bhagavatula, Laasya; Garzillo, Cristina; Simpson, Richard	Journal of Cleaner Production	Bridging the gap between science and practice: An ICLEI perspective
34	Blokhuis,Erik; Advokaat, Bart; Schaefer, Wim	Energy Policy	Assessing the performance of Dutch local energy companies

2008	UK	4	Acceptance	none
1998	UK	8	Spatial design	none
2010	USA	7	Energy planning	climate action planning; plan evaluation
2016	Belgium	9	Norms & Values	Renewable energy Investments Community Institutions Social norms Flanders
2017	Belgium	3	Economics	Social capital, community, sustainability transition, social economy, renewable energy coo...
2016	Belgium, Denmark, Germany, UK	5	Sociology	Wind power Cooperative Community energy Social-Ecological System
2017	Germany, Italy, Spain, UK	3	Economics	Renewable energy Social entrepreneurship Social movements Community energy Energy cooperat...
2017	none	5	Sociology	none
2015	Germany	6	Governance	remunicipalization; privatization; energy; urban commons; Berlin
2016	Netherlands	3	Economics	Prosumption, Residential storage, Peer-to-peer, Business models, Electricity supply compan...
2016	UK	3	Economics	Community development, cluster growth, community energy, environmental sustainability, sust...
2011	UK	1	Transition Studies	microgeneration; domestic energy; behaviour; transition; socio-technical regime; niches; strategic niche management
2013	Canada	6	Governance	Canada; climate change; energy; local government; networks; social network analysis; transformation
2016	Germany	1	Transition Studies	transition research; energy transition; re-municipalization; municipal utilities; local po...
2013	USA	7	Energy planning	none
2013	Germany	6	Governance	none
2013	none	6	Governance	research; practice; local governments; cities; sustainable development; informed cities
2012	Netherlands	3	Economics	local energy company; renewable energy technology; data envelopment analysis

35	Bomberg, E.; McEwen, N	Energy Policy	Mobilizing community energy
36	Boon Frank Pieter; Dieperink, Carel	Energy Policy	Local civil society based renewable energy organisations in the Netherlands, Exploring the factors that stimulate their emergence and development
37	Bosman, Rick; Loorbach, Derk; Frantzeskaki, Niki; Pistorius, Till	Environmental Innovation and Societal Transitions	Discursive regime dynamics in the Dutch energy transition
38	Breukers, S.; Mourik, R. M.; van Summeren, L. F.M.; Verbong, Geert P. J.	Energy Research & Social Science	Institutional 'lock-out' towards local self-governance, Environmental justice and sustainable transformations in Dutch social housing neighbourhoods
39	Bridge, Gavin; Bouzarovski, Stefan; Bradshaw, Michael; Eyre, Nick	Energy Policy	Geographies of energy transition: Space, place and the low-carbon economy
40	Britton, J.; Woodman, B.	Local Economy	Local Enterprise Partnerships and the low-carbon economy: Front runners, uncertainty and divergence
41	Brummer, Vasco	Energy Research & Social Science	Of expertise, social capital, and democracy, Assessing the organizational governance and decision-making in German Renewable Energy Cooperatives
42	Bulkeley, H.	Public Understanding of Science	Common knowledge? Public understanding of climate change in Newcastle, Australia
43	Bulkeley, Harriet; Betsill, Michele M.	Environmental Politics	Revisiting the urban politics of climate change
44	Burch, Sarah	Energy Policy	In pursuit of resilient, low carbon communities: An examination of barriers to action in three Canadian cities
45	Burnham, Morey; Eaton, Weston; Selfa, Theresa; Hinrichs, Clare; Feldpausch-Parker, Andrea	Geoforum	The politics of imaginaries and bioenergy sub-niches in the emerging Northeast U.S. bioenergy economy
46	Burton, Jonathan; Hubacek, Klaus	Energy Policy	Is small beautiful? A multicriteria assessment of small-scale energy technology applications in local governments
47	Busch, H.; McCormick, K.	Energy, Sustainability and Society	Local power: Exploring the motivations of mayors and key success factors for local municipalities to go 100% renewable energy
48	Byrne, John; Martinez, Cecilia; Ruggero, Colin	Bulletin of Science, Technology & Society	Relocating energy in the social commons ideas for a sustainable energy utility
49	Callaghan, G.; Williams, D.	Local Economy	Teddy bears and tigers: How renewable energy can revitalise local communities
50	Cass, Noel; Walker, Gordon	Emotion, Space and Society	Emotion and rationality: The characterisation and evaluation of opposition to renewable energy projects

2012	UK	9	Norms & Values	community energy; resource mobilization; Scotland
2014	Netherlands	5	Sociology	Local renewable energy organisation Renewable energy Netherlands Decentralised generation
2014	Germany, Netherlands	1	Transition Studies	destabilization; discourse; energy transition; regime; the Netherlands
2016	Netherlands	9	Norms & Values	Environmental justice Energy efficiency Path-dependency Institutions Neighbourhood Social...
2013	UK	8	Spatial design	geography; transition; low-carbon
2014	UK	6	Governance	decentralisation, energy, green growth, Local Enterprise Partnerships, localism, low-carbon economy
2018	Germany	6	Governance	Energy cooperatives Governance Renewable energy Community energy
2000	Australia	6	Governance	none
2013	Australia, Canada, UK	6	Governance	urban governance; climate change; multilevel governance; politics; transition
2010	Canada	1	Transition Studies	climate change; capacity; policy
2017	USA	1	Transition Studies	Bio-energy Marginal land Multi-level perspective Object conflict Scale Sociotechnical imaginaries
2007	UK	7	Energy planning	small-scale energy technology; Multicriteria decision aid (MCDA); local government
2014	Germany	6	Governance	renewable energy; sustainable development; local municipalities; climate change; energy policies; local environmental governance
2009	USA	7	Energy planning	energy policy; energy commons; sustainable energy; commonwealth; ecological justice
2014	UK	3	Economics	community empowerment;community ownership; local economic development; renewable energy; supply chains
2009	UK	4	Acceptance	emotions; engagement; activism; place attachments; renewable energy

51	Catney, Philip; Dobson, Andrew; Hall, Sarah Marie; Hards, Sarah; MacGregor, Sherilyn; Robinson, Zoe; Ormerod, Mark; Ross, Simon	Local Environment	Community knowledge networks: an action-orientated approach to energy research
52	Catney, Philip; MacGregor, Sherilyn; Dobson, Andrew; Hall, Sarah Marie; Royston, Sarah; Robinson, Zoe; Ormerod, Mark; Ross, Simon	Local Environment	Big society, little justice? Community renewable energy and the politics of localism
53	Cebotari, Sorin; Benedek, Jozsef	Sustainability	Renewable Energy Project as a Source of Innovation in Rural Communities, Lessons from the Periphery
54	Cebotari, Sorin; Cristea, Marius; Moldovan, Ciprian; Zubascu, Florin	Energy for Sustainable Development	Renewable energy's impact on rural development in northwestern Romania
55	Chatterton, P.	International Journal of Urban and Regional Research	Towards an agenda for post-carbon cities: Lessons from lilac, the uk's first ecological, affordable cohousing community
56	Chen, Fengzhen; Duic, Neven; Alves, Luis Manuel; da Graca Carvalho, Maria	Renewable and Sustainable Energy Reviews	Renewislands, Renewable energy solutions for islands
57	Coenen, Lars; Benneworth, Paul; Truffer, Bernhard;	Research Policy	Toward a spatial perspective on sustainability transitions
58	Connors Phil; McDonald, Peter	Community Development Journal	Transitioning communities: community, participation and the Transition Town movement
59	Costello, D.	International Journal of Environmental, Cultural, Economic and Social Sustainability	Incorporating community governance: Planning sustainable energy security
60	Cowell, Richard; Bristow, Gill; Munday, Max	Journal of Environmental Planning and Management	Acceptance, acceptability and environmental justice: the role of community benefits in wind energy development
61	Crawford, Jenny; French, Will	Energy Policy	A low-carbon future: Spatial planning's role in enhancing technological innovation in the built environment
62	Dampier, Jason Ernest Elvin; Lemelin, R. Harvey; Shahi, Chander; Luckai, Nancy	Energy, Sustainability and Society	Small town identity and history's contribution to a response in policy change: a case study of transition from coal to biomass energy conversion
63	Darby, Sarah	Energy Policy	Social learning and public policy: Lessons from an energy-conscious village

2013	UK	3	Economics	energy; justice; community; knowledge; networks
2014	UK	9	Norms& Values	none
2017	Rumania	3	Economics	renewable energy projects; peripheralization; innovation; development
2017	Rumania	3	Economics	RES Rural development Employment Revenues Demographics Agriculture
2013	UK	7	Energy planning	post-carbon, cities, cohousing, low impact, equality, co-operative, community
2007	Denmark, Greece, Portugal, Spain	3	Economics	islands; intermittent; renewable energy supply; hydrogen; integration system
2012	Denmark, Netherlands	8	Spatial design	geographies of transitions; Multi-level perspective; technological innovation systems; economic geography
2011	UK	4	Acceptance	none
2011	Australia	9	Norms & Values	community engagement; decentralized renewable energy; sustainable energy planning; deliberative democracy; procedural and distributive justice; community energy; sustainability planning
2011	UK	4	Acceptance	renewable energy, community, compensation, justice, planning
2008	UK	8	Spatial design	governance; innovation; spatial planning
2014	Canada	9	Norms & Values	bio-energy; Atikokan Generating Station; lignite coal; social impacts; wood pellets
2006	UK	5	Sociology	social learning; tacit knowledge; feedback

64	De Boer, C.; Hewitt, R.;Bressers, H.; Martinez Alonso,P.; Hernandez Jimenez, V.; Diaz Pacheco, J.; Roman Bermejo, L.	Energy, Sustainability and Society	Local power and land use: spatial implications for local energy development
65	De Vries, Gerben W.; Boon, Wouter P.C.; Peine, Alexander	Environmental Innovation and Societal Transitions	User-led innovation in civic energy communities
66	De Waal, Renee M.; Stremke, Sven	Sustainability	Energy transition: Missed opportunities and emerging challenges for landscape planning and designing
67	Del Rio, Pablo; Burguillo, Mercedes	Renewable and Sustainable Energy Reviews	Assessing the impact of renewable energy deployment on local sustainability: Towards a theoretical framework
68	Del Rio, Pablo; Burguillo, Mercedes	Renewable and Sustainable Energy Reviews	An empirical analysis of the impact of renewable energy deployment on local sustainability
69	Delicado, Ana; Junqueira, Luis; Fonseca, Susana; Truninger, Monica; Silva, Luis; Horta, Ana; Figueiredo,Elisabete	Science & Technology Studies	Not in Anyone's Backyard? Civil Society Attitudes towards Wind Power at the National and Local Levels in Portugal
70	Devine-Wright, P.	Local Environment	Local aspects of UK renewable energy development: Exploring public beliefs and policy implications
71	Devine-Wright,Patrick; Wiersma, Bouke	Local Environment	Opening up the 'local' to analysis: exploring the spatiality of UK urban decentralised energy initiatives
72	Dobbelsteen Van Den, Andy;Broersma, Siebe;Stremke, Sven	International Journal of sustainable building technology and urban development	Energy potential mapping for energy-producing neighborhoods
73	Doci, Gabriella; Vasileiadou,Eleftheria; Petersen, Arthur C.	Futures	Exploring the transition potential of renewable energy communities
74	Doci, Gabriella; Gotchev, Boris	Energy Research & Social Science	When energy policy meets community, Rethinking risk perceptions of renewable energy in Germany and the Netherlands
75	Eaton,Weston M.; Gasteyer, Stephen P.; Busch, Lawrence	Rural Sociology	Bioenergy futures: framing sociotechnical imaginaries in local places
76	Emelianoff, C.	Urban Studies	Local Energy Transition and Multilevel Climate Governance: The Contrasted Experiences of Two Pioneer Cities (Hanover, Germany, and Växjö, Sweden)
77	Fast, Stewart	Geography Compass	Social acceptance of renewable energy: Trends, concepts, and geographies

2015	Netherlands, Spain	8	Spatial design	integrated modelling; land use impacts; renewable energy
2016	Netherlands	2	Science& Techn	User innovation User-led technological change User communities Civic energy communities Co...
2014	Denmark, Germany	8	Spatial design	renewable energy; sustainable energy landscapes; landscape architecture; operational design; strategic design; climate change mitigation; transition management; Güssing; Jühnde; Samsø
2008	Spain	3	Economics	renewable energy; regional development; local sustainability
2009	Spain	3	Economics	renewable energy; regional development; local sustainability
2014	Portugal	4	Acceptance	renewable energy, public opinion, environmental non-governmental organisations
2005	UK	9	Norms & Values	none
2013	UK, Austria	4	Acceptance	decentralised energy; community energy; local; scale; spatiality
2011	Netherlands	8	Spatial design	sustainable development; Energy potential mapping; energy neutrality; heat maps; spatial planning; regional development; urban planning
2015	Netherlands	1	Transition Studies	Multi Level Perspective; social niche; social innovation; renewable energy communities
2016	Germany, Netherlands	3	Economics	Renewable energy communities Renewable energy policy Investors risk Perception
2014	USA	9	Norms & Values	none
2014	Sweden	6	Governance	Hanover; local climate governance; low carbon city; multilevel climate governance; urban energy transition; Växjö
2013	UK	4	Acceptance	none

78	Feder D,	Professional Geographer	A Regionally Based Energy End-Use Strategy: Case Studies from Centre County, Pennsylvania
79	Feliciano, M.; Prosperi, D.C.	Cities	Planning for low carbon cities: Reflection on the case of Broward County, Florida, USA
80	Fischer, Anke; Holstead, Kirsty; Hendrickson, Cary Y.; Virkkula, Outi; Prampolini, Alessandra	Environment & Planning A	Community-led initiatives' everyday politics for sustainability – Conflicting rationalities and aspirations for change
81	Forrest, Nigel; Wiek, Arnim	Environmental Innovation and Societal Transitions	Learning from success, Toward evidence-informed sustainability transitions in communities
82	Foxon, T. J.	Ecological Economics	A coevolutionary framework for analysing a transition to a sustainable low carbon economy
83	Foxon, Timothy J.; Hammond, Geoffrey P.; Pearson,Peter J.G.	Technological Forecasting and Social Change	Developing transition pathways for a low carbon electricity system in the UK
84	Fuchs, G.; Hinderer, N.	Energy, Sustainability and Society	Situative governance and energy transitions in a spatial context: case studies from Germany
85	Fudge, Shane; Peters, Michael	Journal of Integrative Environmental Sciences	Motivating carbon reduction in the UK: the role of local government as an agent of social change
86	Fudge, Shane; Peters, Michael; Woodman, Bridget	Environmental Innovation and Societal Transitions	Local authorities as niche actors, the case of energy governance in the UK
87	Gailing, Ludger; Röhring, Andreas	Utilities Policy	Is it all about collaborative governance, Alternative ways of understanding the success of energy regions
88	Gasteyer, Stephen; Carrera, Jennifer	Rural Sociology	The Coal-Corn Divide: Colliding Treadmills in Rural Community Energy Development
89	Geels, Frank W.	Theory, Culture & Society	Regime resistance against low-carbon transitions: Introducing politics and power into the multi-level perspective
90	Geels, Frank W.; Kern, Florian; Fuchs, Gerhard; Hinderer, Nele; Kungl, Gregor; Mylan, Josephine; Neukirch, Mario; Wassermann, Sandra	Research Policy	The enactment of socio-technical transition pathways, A reformulated typology and a comparative multi-level analysis of the German and UK low-carbon electricity transitions (1990–2014)
91	Genus, Audley; Theobald, Kate	European Urban and Regional Studies	Creating low-carbon neighbourhoods, a critical discourse analysis
92	Giddings, Bob; Underwood, Chris	Journal of Environmental Planning and Management	Renewable energy in remote communities
93	Goedkoop, Fleur; Devine-Wright, Patrick	Energy Research & Social Science	Partnership or placation, The role of trust and justice in the shared ownership of renewable energy projects

2004	USA	7	Energy planning	renewable energy, regional geography, end-use analysis
2011	USA	7	Energy planning	greenhouse gases; carbon cities; energy; climate change; planning; public policy; Florida; energy efficiency
2017	Finland, Italy, UK	1	Transition Studies	Discourses, expectations, grassroots, low carbon, transitions
2014	?	5	Sociology	analytical-evaluative framework; community initiatives; sustainability interventions; sustainability transitions; transition pathways/mechanisms
2011	none	1	Transition Studies	co-evolution; transition pathways; low-carbon economy; long-term industrial change
2010	UK	1	Transition Studies	transition pathways; Multi-level perspective; dynamic processes; technological innovation systems; UK; energy system
2014	Germany	6	Governance	electricity supply; Germany; local initiatives; sustainable energy transitions
2009	UK	6	Governance	local agenda 21; climate change; governance; local authorities; community engagement
2016	UK	1	Transition Studies	Multi-Level Perspective Local authorities Energy governance Transition Sustainability
2016	Germany	6	Governance	Socio-materiality Power Individuals
2013	USA	3	Economics	none
2014	UK	1	Transition Studies	climate change, electricity, incumbent regimes, resistance, transitions
2016	Germany, UK	1	Transition Studies	Transition pathways typology Enactment Low-carbon electricity transition Multi-level persp...
2016	UK	9	Norms & Values	Critical discourse analysis, engagement, low-carbon neighbourhoods, sustainable communities...
2007	UK	7	Energy planning	none
2016	UK	9	Norms & Values	Shared ownership Renewable energy Community energy Trust Justice

94	Gormally, AM; Pooley, CG; Whyatt, JD; Timmis, RJ	Local Environment	'They made gunpowder, yes down by the river there, that's your energy source': attitudes towards community renewable energy in Cumbria
95	Gormally, A.M.; Whyatt, J.D.; Timmis, R.J.; Pooley, C.G.	Applied Geography	Renewable energy scenarios, Exploring technology, acceptance and climate, Options at the community-scale
96	Graichen,P.R.; Requate, T.; Dijkstra, B.R.	Public Choice	How to win the political contest: A monopolist vs. environmentalists
97	Granberg, Mikael; Elander,Ingemar	Local Environment	Local governance and climate change: reflections on the Swedish experience
98	Graziano, A.M.; Whyatt, J.D.; Timmis, R.J.; Pooley, C.G.	Energy Research & Social Science	A transformational paradigm for marine renewable energy development
99	Groth Niels Boje; Fertner, Christian; Grosse, Juliane	Journal of Settlements and Spatial Planning	Urban energy generation and the role of cities
100	Grydehøj Adam; Kelman, Ilan	Area	The eco-island trap, climate change mitigation and conspicuous sustainability
101	Gustafsson, S.; Ivner, J.; Palm, J.	Journal of Cleaner Production	Management and stakeholder participation in local strategic energy planning - Examples from Sweden
102	Haf, Sioned; Parkhill, Karen	Energy Research & Social Science	The Muillean Gaoithe and the Melin Wynt, Cultural sustainability and community owned wind energy schemes in Gaelic and Welsh speaking communities in the United Kingdom
103	Hall, Nina L.; Taplin, Ros; Goldstein,Wendy	Action research	Empowerment of individuals and realization of community agency Applying action research to climate change responses in Australia
104	Hall, Stephen; Foxon, Timothy J.; Bolton, Ronan	Energy Research & Social Science	Financing the civic energy sector, How financial institutions affect ownership models in Germany and the United Kingdom
105	Hanley, Nick; Nevin, Ceara	Energy Policy	Appraising renewable energy developments in remote communities: the case of the North Assynt Estate, Scotland
106	Hargreaves, Tom; Hielscher, Sabine; Seyfang, Gill; Smith, Adrian	Global Environmental Change	Grassroots innovations in community energy: The role of intermediaries in niche development
107	Hargreaves, Tom; Longhurst, Noel; Seyfang, Gill	Environment and Planning A	Up, down, round and round: connecting regimes and practices in innovation for sustainability
108	Hasanov, Mustafa; Zuidema, Christian	Energy Research & Social Science	The transformative power of self-organization, Towards a conceptual framework for understanding local energy initiatives in The Netherlands

2014	UK	5	Sociology	community renewable energy; place-based identity; historical hydropower; community participation
2016	UK	7	Energy planning	Energy scenarios Energy & environment Community-based renewables Climate
2001	Germany	3	Economics	none
2007	Sweden	6	Governance	none
2016	UK	6	Governance	Community Development paradigm Economic development Marine renewables
2016	multiple	7	Energy planning	local energy, energy self-sufficiency, medium-sized cities, sustainable development...
2017	multiple	9	Norms & Values	islands, climate change mitigation, conspicuous sustainability, renewable energy, sustain...
2015	Sweden	7	Energy planning	energy strategy; management; municipality; participation; planning
2017	UK	5	Sociology	Community renewables Cultural sustainability Language Heritage Wales Scotland
2010	Australia	6	Governance	agency; Australia; climate change; grassroots; Participatory Action Research (PAR)
2016	Germany, UK	3	Economics	Civic energy sector Institutional economics Energy transitions Energy ownership
1999	Sweden, UK	3	Economics	renewable energy; impact analysis; contingent valuation
2013	UK	1	Transition Studies	Strategic niche management; intermediary actors; grassroots innovation; community energy
2013	none	1	Transition Studies	sustainability transitions, sustainable innovation, local organic food, pro-environmental behaviour, multilevel perspective, social practice theory
2018	Netherlands	5	Sociology	Self-organization Local energy initiatives The Netherlands Energy transition Transformativ...

109	Hatzl, Stefanie; Seebauer, Sebastian; Fleiß, Eva; Posch, Alfred	Futures	Market-based vs. grassroots citizen participation initiatives in photovoltaics, A qualitative comparison of niche development
110	Hauber, J.; Ruppert-Winkel, C.	Sustainability	Moving towards energy self-sufficiency based on renewables: Comparative case studies on the emergence of regional processes of socio-technical change in germany
111	Hawkey, David; Webb, Janette; Winskel, Mark	Journal of Cleaner Production	Organisation and governance of urban energy systems: district heating and cooling in the UK
112	Hawkins, Christopher V.; Wang, XiaoHu	Public Works Management & Policy	Sustainable development governance: Citizen participation and support networks in local sustainability initiatives
113	Heiman, Michael K.; Solomon, Barry D.	Annals of the Association of American Geographers	Power to the people: Electric utility restructuring and the commitment to renewable energy
114	Heiskanen, E.; Jalas, M.; Rinkinen, J.; Tainio, P.	Environmental Innovation and Societal Transitions	The local community as a “low-carbon lab”: Promises and perils
115	Heiskanen, Eva; Johnson, Mikael; Robinson, Simon; Vadovics,Edina; Saastamoinen, Mika	Energy Policy	Low-carbon communities as a context for individual behavioural change
116	Heiskanen, Eva; Lovio, Raimo; Jalas, Mikko	Journal of Cleaner Production	Path creation for sustainable consumption: promoting alternative heating systems in Finland
117	Heldeweg, M. A.; Sanders, M.; Harmsen, M.	Energy, Sustainability and Society	Public-private or private-private energy partnerships? Toward good energy governance in regional and local green gas projects
118	Heldeweg, Michiel A.	Sustainability	Normative Alignment, Institutional Resilience and Shifts in Legal Governance of the Energy Transition
119	Hicks, Jarra; Ison, Nicola	Energy Policy	An exploration of the boundaries of ‘community’ in community renewable energy projects, Navigating between motivations and context
120	Hicks, Jarra; Ison, Nicky	Rural Society	Community-owned renewable energy (CRE): Opportunities for rural Australia
121	Hinshelwood, Emily	Community Development Journal	Power to the People: community‚Äêled wind energy, Äìobstacles and opportunities in a South Wales Valley
122	Hobson, Kersty; Hamilton, Jo; Mayne, Ruth	Environment & Planning A	Monitoring and evaluating eco-localisation, Lessons from UK low carbon community groups
123	Hobson, Kersty; Mayne, Ruth; Hamilton, Jo	Local Environment	Monitoring and evaluation in UK low carbon community groups benefits barriers and the politics of the local

2016	Austria	1	Transition Studies	Citizen participation initiatives Photovoltaics Grassroots innovations Market-based innova...
2012	Germany	2	Science & Techn	energy system based on renewable energy; phase model; processual analysis; renewable energy; socio-technical change
2013	UK	7	Energy planning	sustainable energy; urban; district heating and cooling; governance; organization
2011	USA	6	Governance	citizen participation–public works, environmental planning
2004	USA	3	Economics	carbon dioxide (CO_2) emissions, electric utility, energy policy, renewable energy, wind power
2015	Finland	5	Sociology	community; local experiments; Strategic niche management
2010	Finland, Hungary, UK	1	Transition Studies	low-carbon communities; energy conservation; behaviour change
2011	Finland	1	Transition Studies	path dependence; path creation; residential energy efficiency; heat pumps; entrepreneurs
2015	Netherlands	6	Governance	Public-private partnerships (PPP); energy transition and green gas
2017	Netherlands	9	Norms & Values	renewable energy; legal governance; normative alignment; institutional resilience; legal i...
2018	Australia, Austria, Canada, Denmark, Germany, USA	9	Norms & Values	Community renewable energy Action research
2011	Australia, UK, USA	5	Sociology	community development, community renewable energy, climate change, resilience
2001	UK	5	Sociology	None
2016	UK	5	Sociology	Localisation, knowledge exchange, monitoring and evaluation, community
2016	UK	5	Sociology	low-carbon community groups; monitoring and evaluation

124	Hoffman, S. M.; Fudge, S.; Pawlisch, L.; High-Pippert, A.; Peters, M.; Haskard, J.	Sustainability (Switzerland)	Public values and community energy: Lessons from the US and UK
125	Hoffman, S.M.; High-Pippert, A.	Bulletin of Science, Technology and Society	Community energy: A social architecture for an alternative energy future
126	Hoffman, Steven M.; High-Pippert, Angela	Energy Policy	From private lives to collective action: Recruitment and participation incentives for a community energy program
127	Homsy, George C.	Environment and Planing C: government and policy	Powering sustainability, Municipal utilities and local government policymaking
128	Hooimeijer F.L.; Puts, H.; Geerdink, T.	Journal of Settlements and Spatial Planning	Successful Development of Decentralised District Heating Application of a Theoretical Framework
129	Hoppe, T.; Graf, A.; Warbroek, B.; Lammers,I.; Lepping, I.	Sustainability (Switzerland)	Local governments supporting local energy initiatives: Lessons from the best practices of Saerbeck (Germany) and Lochem (The Netherlands)
130	Hoppe, Thomas; van der Vegt, Arjen; Stegmaier, Peter	Sustainability	Presenting a Framework to Analyze Local Climate policy and action in small and medium-sized cities
131	Hufen, J.A.M.; Koppenjan, J.F.M.	Energy, Sustainability and Society	Local renewable energy cooperatives: revolution in disguise?
132	Hughes, Kristen	Bulletin of Science, Technology & Society	An Applied Local Sustainable Energy Model: The Case of Austin, Texas
133	Islar, Mine; Busch, Henner	Innovation, the European Journal of Social Science Research	We are not in this to save the polar bears the link between community renewable energy development and ecological citizenship
134	Ivner, J.	Local Environment	Energy planning with decision-making tools: Experiences from an energy-planning project
135	Ivner, J.; Björklund, A.E.; Dreborg, K.-H; Johansson, J.; Viklund, P.; Wiklund, H.	Local Environment	New tools in local energy planning: Experimenting with scenarios, public participation and environmental assessment
136	Jaccard, Mark; Failing, Lee; Berry, Trent	Energy Policy	From equipment to infrastructure: community energy management and greenhouse gas emission reduction
137	Kalkbrenner, Bernhard J.; Roosen, Jutta	Energy Research & Social Science	Citizens' willingness to participate in local renewable energy projects, The role of community and trust in Germany
138	Klein, Sharon J.W.; Coffey, Stephanie	Renewable & Sustainable Energy Reviews	Building a sustainable energy future, one community at a time

2013	USA, UK	5	Sociology	community energy; local energy governance; public sphere; public values
2005	USA	6	Governance	civic culture; community energy; community participation; distributed generation; energy
2010	USA	9	Norms& Values	civic engagement; participation; recruitment
2016	USA	6	Governance	Local government, municipal utilities, energy policy, electricity
2016	Netherlands	7	Energy planning	energy planning, district heating, decentralized energy, spatial arrangements, orga...
2015	Germany, Netherlands	1	Transition Studies	civil society; energy transition; governance; grassroots innovation; leadership; local capacity; local energy initiatives; low carbon; strategic niche management
2016	Netherlands	6	Governance	small and medium-sized cities; climate governance; energy transition; climate change mitig...
2015	Netherlands	1	Transition Studies	Bottom-up innovation; Energy innovation systems; Energy transition; Local renewable energy; Local renewable energy cooperatives; Radical innovation
2009	USA	7	Energy planning	sustainable development; sustainable urban development; environmental engineering; climatic changes; renewable energy sources; economics; sociological aspects; energy economics; alternative fuels; energy conservation; AUSTIN (Tex.); Texas; communities; distributed generation; electricity; municipal utility; renewable energy;sustainable energy
2016	Denmark, Germany	9	Norms & Values	ecological citizenship; energy commons; local renewable energy; communal energy; energy tr...
2009	Sweden	7	Energy planning	energy planning; LCA; local authority; participation; scenarios
2010	Sweden	7	Energy planning	decision-making tools; energy planning; life cycle assessment; local authority; public participation; scenarios
1997	Canada	7	Energy planning	none
2016	Germany	9	Norms & Values	Citizen participation Community energy Community identity Energy transition Pro-environmen...
2016	USA	3	Economics	Community energy Renewable energy Sustainable energy Grassroots innovation Strategic niche managemen...

139	Koehrsen, Jens	Sustainability	Boundary Bridging Arrangements, A Boundary Work Approach to Local Energy Transitions
140	Koehrsen, J.	Social Compass	Does religion promote environmental sustainability? Exploring the role of religion in local energy transitions
141	Koirala, Binod Prasad; Koliou, Elta; Friege, Jonas; Hakvoort, Rudi A.; Herder, Paulien M.	Renewable & Sustainable Energy Reviews	Energetic communities for community energy, A review of key issues and trends shaping integrated community energy systems
142	Komendantova, Nadejda; Riegler, Monika; Neumueller, Sonata	Energy Research & Social Science	Of transitions and models, Community engagement, democracy, and empowerment in the Austrian energy transition
143	Kooij, Henk Jan; Oteman, Marieke; Veenman, Sietske; Sperling, Karl; Magnusson, Dick; Palm, Jenny; Hvelplund, Frede	Energy Research & Social Science	Between grassroots and treetops, Community power and institutional dependence in the renewable energy sector in Denmark, Sweden and the Netherlands
144	Kruijsen, J.H J.; Owen, A.; Boyd, D.M.G.	Local Environment	Community Sustainability Plans to enable change towards sustainable practice - a Scottish case study
145	Krupa, J.; Galbraith, L.; Burch, S.	Local Environment	Participatory and multi-level governance: applications to Aboriginal renewable energy projects
146	Kunze, Conrad; Becker, Sören	Sustainability Science	Collective ownership in renewable energy and opportunities for sustainable degrowth
147	Kunze, Conrad; Busch, Henner	Electronic Green Journal	The social complexity of renewable energy production in the countryside
148	Leenheer, Jorna; de Nooij, Michiel; Sheikh, Omer	Energy Policy	Own power: Motives of having electricity without the energy company
149	Lucas, Karen; Hamilton, Jo; Mayne, Ruth	Local Environment	Building capacity through action research reflections on working with low carbon communities in the UK
150	MacArthur, Julie L.	Journal of Environmental Studies & Sciences	Challenging public engagement, participation, deliberation and power in renewable energy policy
151	MacArthur, Julie L.	Sustainability	Trade, Tarsands and Treaties, The Political Economy Context of Community Energy in Canada
152	Madlener, Reinhard	Energy Policy	Innovation diffusion, public policy, and local initiative: The case of wood-fuelled district heating systems in Austria
153	Magnani, Natalia; Maretti, Mara; Salvatore, Rita; Scotti, Ivano	Energy Research & Social Science	Does civil society matter, Challenges and strategies of grassroots initiatives in Italy's energy transition

2017	Germany	2	Science & Techn	boundary work; energy transition; cities; collaboration; boundary objects; boundary organi...
2015	Germany	1	Transition Studies	climate change; ecology; Germany; regional innovation systems; religion
2016	multiple	7	Energy planning	Distributed energy resources Local energy systems Energy systems integration Self-organize...
2018	Austria	5	Sociology	Climate and energy model regions Renewable energy sources Energy and climate policy in Aus...
2018	Denmark, Netherlands, Sweden	6	Governance	Grassroots initiatives Renewable energy transition Institutional change Conditions of poss...
2014	UK	7	Energy planning	sustainable development; resilient community development; Community Sustainability Plan; behavioural change; Huntly UK
2015	Canada	7	Energy planning	Aboriginal peoples; Canadian energy markets; community energy planning; renewable energy
2015	Germany, Italy, Spain, UK	5	Sociology	community energy; remunicipalisation; energy cooperatives; energy geography; degrowth; renewable energy; energy transition
2011	Germany	3	Economics	renewable energy; energy autarky, energy region, rural development, Germany, Europe, social research
2011	Netherlands	9	Norms & Values	own power; electricity; sustainability
2017	UK	5	Sociology	Energy behaviours; communities; action research; methodologies; focus groups; social learni...
2016	Canada, Denmark	6	Governance	Renewable energy . Participation . Public engagement . Policy
2017	Canada	6	Governance	community energy; energy policy; Canada; political economy; renewable electricity; public...
2007	Austria	7	Energy planning	socio-economic aspects; local actors; biomass district heating
2016	Italy	5	Sociology	Energy cooperatives Civil society Community renewable energy Energy transition Italy

154	Magnani, Natalia; Osti, Giorgio	Journal of Rural Studies	Ecopreneurs, rural development and alternative socio-technical arrangements for community renewable energy
155	Malgand, M.; Bay-Mortensen, N.; Bedkowska, B.; Hansen, F.N.; Schow, M.; Thomsen, A.A.; Hunka, A.D.	Geoforum	Environmental awareness, the Transition Movement, and place: Den Selvforsynende Landsby, a Danish Transition initiative
156	Markantoni, Marianna	Environmental Policy and Governance	Low Carbon Governance, Mobilizing Community Energy through Top-Down Support
157	Markantoni, M.; Woolvin, M.	Local Environment	The role of rural communities in the transition to a low-carbon Scotland: A review
158	Mårtensson, Kjell; Westerberg, Karin	Energy Policy	How to transform local energy systems towards bio-energy? Three strategy models for transformation
159	Martiskainen, Mari	Environmental Innovation and Societal Transitions	The role of community leadership in the development of grassroots innovations
160	Martiskainen, Mari; Heiskanen, Eva; Speciale, Giovanna	Local Environment	Community energy initiatives to alleviate fuel poverty the material politics of Energy Cafes
161	Mey, Franziska; Diesendorf, Mark; MacGill, Iain	Energy Research & Social Science	Can local government play a greater role for community renewable energy, A case study from Australia
162	Middlemiss, Lucie; Parrish, Bradley D.	Energy Policy	Building capacity for low-carbon communities: The role of grassroots initiatives
163	Moloney, S.; Horne, R.	Sustainability (Switzerland)	Low carbon urban transitioning: From local experimentation to urban transformation?
164	Moloney, Susie; Horne, Ralph E.; Fien, John	Energy Policy	Transitioning to low carbon communities, from behaviour change to systemic change: Lessons from Australia
165	Monstadt, J.	International Journal of Urban and Regional Research	Urban governance and the transition of energy systems: Institutional change and shifting energy and climate policies in Berlin
166	Morris, Jason	Culture, Agriculture, Food and Environment	The Evolving Localism (and Neoliberalism) of Urban Renewable Energy Projects
167	Moss, T.; Becker, S.; Naumann, M.	Local Environment	Whose energy transition is it, anyway? Organisation and ownership of the Energiewende in villages, cities and regions

2017	Italy	3	Economics	none
2014	Denmark	9	Norms & Values	constructed landscape; place attachment; transition network; climate change; environmental awareness; peak oil
2016	UK	6	Governance	community renewable energy; evolutionary governance; multi-level governance
2015	UK	6	Governance	rural communities; low-carbon; transition; rural Scotland
2007	Sweden	6	Governance	local energy system; renewable energy; strategy models
2016	UK	1	Transition Studies	Community leadership Grassroots innovations Nurturing Intermediaries Community energy
2018	UK	1	Transition Studies	Grassroots innovations; material politics; community energy; fuel poverty; Energy Café
2016	Australia	6	Governance	Local government Renewable energy Community renewable energy
2010	UK	5	Sociology	low-carbon communities; grassroots action; sustainable communities
2015	Australia	5	Sociology	socio-technical transitions; low carbon governance; urban policy
2010	Australia	1	Transition Studies	behaviour change; socio-technical analysis; behaviour change programmes
2007	Germany	6	Governance	none
2013	USA	3	Economics	renewable energy, neoliberalization, localism, political economy, United States
2015	Germany	5	Sociology	Berlin; Brandenburg; commons; Germany; local energy transitions; organisation; ownership

168	Müller, Matthias Otto; Stämpfli, Adrian; Dold,Ursula; Hammer, Thomas	Energy Policy	Energy autarky: A conceptual framework for sustainable regional development
169	Musall, Fabian David; Kuik, Onno	Energy Policy	Local acceptance of renewable energy, a case study from southeast Germany
170	Nijkamp, Peter; Pepping, Gerard	Urban Studies	A meta-analytical evaluation of sustainable city initiatives
171	Nilsson, J. Stenlund; Mårtensson, A.	Applied Energy	Municipal energy-planning and development of local energy-systems
172	Nolden, Colin	Energy Policy	Governing community energy – Feed-in tariffs and the development of community wind energy schemes in the United Kingdom and Germany
173	North,Peter	Environment and Planning-Part A	The politics of climate activism in the UK: a social movement analysis
174	Ornetzeder, Michael; Rohracher, Harald	Energy Policy	User-led innovations and participation processes: lessons from sustainable energy technologies
175	Ornetzeder, M.; Rohracher, H.	Global Environmental Change	Of solar collectors, wind power, and car sharing: Comparing and understanding successful cases of grassroots innovations
176	Oteman, M.; Wiering, M.; Helderman, J.-K	Energy, Sustainability and Society	The institutional space of community initiatives for renewable energy: a comparative case study of the Netherlands, Germany and Denmark
177	Palm, J.	Local Environment	Development of sustainable energy systems in Swedish municipalities: A matter of path dependency and power relations
178	Palm, Jenny; Fallde, Magdalena	Sustainability	What Characterizes a System Builder, The Role of Local Energy Companies in Energy System Transformation
179	Parag,Yael; Janda, Kathryn B.	Energy Research & Social Science	More than filler: Middle actors and socio-technical change in the energy system from the 'middle-out'
180	Park, J. J.	Local Environment	Fostering community energy and equal opportunities between communities
181	Parkhill, Karen Anne; Shirani, Fiona; Butler, Catherine; Henwood, KL; Groves, Chris; Pidgeon, Nick F.	Environmental Science & Policy	We are a community [but] that takes a certain amount of energy': Exploring shared visions, social action, and resilience in place-based community-led energy initiatives
182	Petersen, Jens Phillip	Sustainable Cities and Society	Energy concepts for self-supplying communities based on local and renewable energy sources, A case study from northern Germany
183	Petrakopoulou, Fontina	Sustainability	The Social Perspective on the Renewable Energy Autonomy of Geographically Isolated Communities, Evidence from a Mediterranean Island

2011	Austria, Germany, Switzerland	7	Energy planning	energy autarky; renewable energy; regional development
2011	Germany	4	Acceptance	wind energy; local acceptance; community co-ownership
1998	Greece, Italy, Netherlands	6	Governance	none
2003	Sweden	7	Energy planning	energy-planning; national energy; municipal energy; environmental impact; strategies
2013	UK	6	Governance	Governance of innovation diffusion Feed-in tariff Community energy
2011	UK	5	Sociology	none
2006	Austria	1	Transition Studies	user-led innovations; sustainable energy technology; constructive technology assessment
2013	Austria, Denmark	2	Science & Techn	sustainability; grassroots innovation; energy; transport; socio-technical systems; civil society
2014	Denmark, Germany, Netherlands	6	Governance	community initiatives; institutional arrangements; institutional space; policy analysis; renewable energy
2006	Sweden	2	Science & Techn	none
2016	Sweden	2	Science & Techn	system builder; energy system; municipality; energy company; policy processes
2014	UK	5	Sociology	energy system transition; middle-out; agency and capacity; middle actors
2012	UK	9	Norms & Values	community capacity; community development; energy policy; equity; renewable energy; sustainable energy
2015	UK	5	Sociology	community energy; sustainable places; social capital; civic engagement; social resilience
2016	Germany	7	Energy planning	Energy concept Community energy planning Energy-self-sufficient community Renewable energi...
2017	Greece	4	Acceptance	green energy autonomy; renewable energy; survey; island; Greece

184	Phillips, M.; Dickie, J.	Geoforum	Climate change, carbon dependency and narratives of transition and stasis in four English rural communities
185	Pitt Damian; Congreve, Alina	Local Environment	Collaborative approaches to local climate change and clean energy initiatives in the USA and England
186	Pitt, Damian; Bassett, Ellen	Journal of the American Planning Association	Collaborative planning for clean energy initiatives in small to mid-sized cities
187	Poupeau, Francois-Mathieu	Environmental Policy and Governance	Central-Local Relations in French Energy Policy-Making: Towards a New Pattern of Territorial Governance
188	Raven, R.P.; Heiskanen, E.; Lovio, R.; Hodson, M.; Brohmann, B.	Bulletin of Science, Technology & Society	The contribution of local experiments and negotiation processes to field-level learning in emerging (niche) technologies meta-analysis of 27 new energy projects in europe.
189	Raven, R.P.J.M.; Mourik, R.M.; Feenstra, C.F.J.; Heiskanen, E.	Energy	Modulating societal acceptance in new energy projects: Towards a toolkit methodology for project managers
190	Reiche, Danyel; Bechberger, Mischa	Energy Policy	Policy differences in the promotion of renewable energies in the EU member states
191	Reusswig, Fritz; Braun, Florian; Heger, Ines; Ludewig, Thomas; Eichenauer, Eva; Lass, Wiebke	Utilities Policy	Against the wind, Local opposition to the German Energiewende
192	Rezaei, Maryam; Dowlatabadi, Hadi	Local Environment	Off grid community energy and the pursuit of self sufficiency in British Columbia s remote and First Nations communities
193	Rogers, Jennifer C.; Simmons, Eunice A.; Convery, Ian; Weatherall, Andrew	Energy Policy	Public perceptions of opportunities for community-based renewable energy projects
194	Rogers, Jennifer C.; Simmons, Eunice A.; Convery, Ian; Weatherall, Andrew	Local Economy	What factors enable community leadership of renewable energy projects? Lessons from a woodfuel heating initiative
195	Rommel, Jens; Radtke, Jorg; von Jorck, Gerrit; Mey, Franziska; Yildiz, Özgür	Journal of Cleaner Production	Community renewable energy at a crossroads, A think piece on degrowth, technology, and the democratization of the German energy system
196	Roseland, Mark	Progress in Planning	Sustainable community development: integrating environmental, economic, and social objectives
197	Ruggiero, Salvatore; Onkila, Tiina; Kuittinen, Ville	Energy Research & Social Science	Realizing the social acceptance of community renewable energy: A process-outcome analysis of stakeholder influence

2015	UK	9	Norms & Values	climate change; carbon; rural; transition; stasis; narrative
2017	UK, USA	7	Energy planning	Energy; climate mitigation; community planning; collaborative planning
2013	USA	6	Governance	clean energy, energy policy, climate change, collaborative planning
2014	France	6	Governance	central-local relations; decentralization; energy transition; local authorities; territorial governance
2008	Germany, Sweden	1	Transition Studies	strategic niche management; learning; expectations; biogas
2009	multiple	4	Acceptance	social acceptance; new energy projects; participation
2004	multiple	6	Governance	project management
2016	Germany	4	Acceptance	Energy conflicts Acceptance of wind energy Discourse networks Conflict dynamics
2016	Canada	9	Norms & Values	community energy; remote communities; self-sufficiency; self- determination
2008	UK	5	Sociology	renewable energy; community; participation
2012	UK	5	Sociology	community, participation, place-based identity, renewable energy, rural sustainability
2016	Germany	3	Economics	Cooperatives Energy transition Conviviality Sustainable consumption
2000	none	8	Spatial design	none
2014	multiple	5	Sociology	community renewable energy; stakeholder influence; process and outcome

198	Rydin, Y.; Guy, S.; Goodier, C.; Chmutina, K.; Devine-Wright, P.; Wiersma, B.	Geoforum	The financial entanglements of local energy projects
199	Sagebiel, J.; Müller, J. R.; Rommel, J.	Energy Research & Social Science	Are consumers willing to pay more for electricity from cooperatives? results from an online choice experiment in Germany
200	Saintier, Séverine	Sustainability	Community Energy Companies in the UK, A Potential Model for Sustainable Development in "Local" Energy
201	Sanders, M.P.T.; Heldeweg, M.A.; Straatman, E.G.P.; Wempe, J.F.D.B.	Energy, Sustainability and Society	Energy policy by beauty contests: The legitimacy of interactive sustainability policies at regional levels of the regulatory state
202	Schmidt, Johannes; Schönhart, Martin; Biberacher, Markus; Guggenberger, Thomas; Hausl, Stephan; Kalt, Gerald; Leduc, Sylvain; Schardinger, Ingrid; Schmid, Ervin	Energy Policy	Regional energy autarky: Potentials, costs and consequences for an Austrian region
203	Schoor van der, Tineke; Scholtens, Bert	Renewable and Sustainable Energy Reviews	Power to the people: Local community initiatives and the transition to sustainable energy
204	Schreuer, Anna	Energy Research & Social Science	The establishment of citizen power plants in Austria, A process of empowerment
205	Schweizer-Ries, Petra	Energy Policy	Energy sustainable communities: Environmental psychological investigations
206	Scotti, Ivano; Minervini, Dario	Innovation, the European Journal of Social Science Research	Performative connections translating sustainable energy transition by local communities
207	Seyfang, Gill; Haxeltine, Alex	Environment and Planning-Part C	Growing grassroots innovations: exploring the role of community-based initiatives in governing sustainable energy transitions
208	Seyfang, Gill; Hielscher, Sabine; Hargreaves, Tom; Martiskainen, Mari; Smith, Adrian	Environmental Innovation and Societal Transitions	A grassroots sustainable energy niche? Reflections on community energy in the UK
209	Seyfang, Gill; Park, Jung Jin; Smith, Adrian	Energy Policy	A thousand flowers blooming? An examination of community energy in the UK
210	Seyfang, Gill; Smith, Adrian	Environmental politics	Grassroots innovations for sustainable development: Towards a new research and policy agenda

2015	Germany, Sweden, UK, USA	3	Economics	decentralised energy; economic sociology; energy efficiency; green buildings; market devices
2014	Germany	3	Economics	choice experiments; cooperatives; energy transition
2017	UK	9	Norms & Values	energy transition; renewable energy sources; energy poverty; community interest companies;...
2014	Netherlands	6	Governance	energy transition; interactive governance; legitimacy; regulatory state
2012	Austria	7	Energy planning	regional energy modeling; energy autarky; BeWhere
2015	Netherlands	2	Science & Techn	decentralized energy production; energy initiatives; citizen groups; energy neutrality; sustainable energy; prosumers
2016	Austria	5	Sociology	Citizen power plants Community energy Empowerment Sociotechnical configurations Grassroots...
2008	Germany	4	Acceptance	sustainable energy communities; public acceptance; environmental psychology
2017	Italy	2	Science & Techn	local community; translation; sustainable energy transition
2012	UK	1	Transition Studies	sustainability transitions, grassroots innovations, community energy, civil society, social innovation, ni
2014	UK	5	Sociology	civil society; energy transitions; grassroots innovations; Strategic Niche Management; sustainable innovations
2013	UK	1	Transition Studies	sustainable energy; Grassroots innovations; Civil society
2007	UK	1	Transition Studies	none

211	Shamsuzzoha, AHM; Grant, Andy; Clarke, Joe	Renewable and Sustainable Energy Reviews	Implementation of renewable energy in Scottish rural area: A social study
212	Sharp, Darren; Salter, Robert	Sustainability	Direct Impacts of an Urban Living Lab from the Participants' Perspective, Livewell Yarra
213	Shaw, K.; Hill, S. D.; Boyd, A.D.; Monk, L.; Reid, J.; Einsiedel, E.F.	Energy Research and Social Science	Conflicted or constructive? Exploring community responses to new energy developments in Canada
214	Shih, Cheng Hao; Latham, William; Sarzynski, Andrea	The Electricity Journal	A collaborative framework for U.S. state-level energy efficiency and renewable energy governance
215	Simcock, Neil	Local Environment	Exploring how stakeholders in two community wind projects use a 'those affected' principle to evaluate the fairness of each project's spatial boundary
216	Simcock, Neil	Land Use Policy	Procedural justice and the implementation of community wind energy projects, A case study from South Yorkshire, UK
217	Simpson, Genevieve	Local Environment	Looking beyond incentives the role of champions in the social acceptance of residential solar energy in regional Australian communities
218	Slee, Bill	Renewable and Sustainable Energy Reviews	Is there a case for community-based equity participation in Scottish on-shore wind energy production? Gaps in evidence and research needs
219	Smith, Adrian; Hargreaves, Tom; Hielscher, Sabine; Martiskainen, Mari; Seyfang, Gill	Environment & Planning A	Making the most of community energies, Three perspectives on grassroots innovation
220	Smith, Adrian; Raven, Rob	Research Policy	What is protective space? Reconsidering niches in transitions to sustainability
221	Späth, P.; Rohracher, H.	European Planning Studies	Local Demonstrations for Global Transitions-Dynamics across Governance Levels Fostering Socio-Technical Regime Change Towards Sustainability
222	Sperling, Karl	Renewable & Sustainable Energy Reviews	How does a pioneer community energy project succeed in practice, The case of the Samsø Renewable Energy Island
223	Sperling, Karl; Hvelplund, Frede; Mathiesen, Brian Vad	Energy Policy	Centralisation and decentralisation in strategic municipal energy planning in Denmark
224	St. Denis, Genevieve; Parker, Paul	Renewable and Sustainable Energy Reviews	Community energy planning in Canada: The role of renewable energy
225	Steenhuisen, B.; de Bruijne, M.	Energy, Sustainability and Society	Reflections on the role of energy network companies in the energy transition

2012	UK	4	Acceptance	renewable energy; social study; environmental awareness; Scotland
2017	Australia	1	Transition Studies	urban sustainability; urban living lab; sustainability transitions; urban experiments; act...
2015	Canada	4	Acceptance	climate change; community; low-carbon energy systems; resistance; governance; local context
2016	USA	6	Governance	State energy efficiency and renewable energy program Energy governance Program administrat...
2014	UK	9	Norms & Values	community; wind; justice; renewable energy; local
2016	UK	9	Norms & Values	Community energy Wind energy Justice Fairness Conflict Acceptance
2017	Australia	4	Acceptance	Renewable energy; solar champion; residential solar; diffusion of innovation; social accept...
2015	UK	6	Governance	rural; community; renewable; ownership; targets; environmental citizenship; equity participation
2016	UK	1	Transition Studies	Grassroots innovation, community energy, strategic niche management, critical niches, energ...
2012	none	1	Transition Studies	niche; protective space; empowerment; narratives; sustainability
2012	Austria	1	Transition Studies	none
2017	Denmark	5	Sociology	Community energy Renewable energy Islands Energy planning
2011	Denmark	7	Energy planning	strategic energy planning; municipal energy plans; 100% renewable energy systems
2009	Canada	7	Energy planning	renewable energy policy; community energy plan; community energy management; energy conservation; climate change policy
2015	Netherlands	3	Economics	economics; energy network companies; energy transition; engineering; law; policy; politics

226	Strachan,Peter A.; Cowell, Richard; Ellis, Geraint; Sherry-Brennan, Fionnguala; Toke, David	Sustainable Development	Promoting community renewable energy in a corporate energy world
227	Strunz, Sebastian	Ecological Economics	The German energy transition as a regime shift
228	Sühlsen, Kathrin; Hisschemöller, Matthijs	Energy Policy	Lobbying the Energiewende. Assessing the effectiveness of strategies to promote the renewable energy business in Germany
229	Süsser, Diana; Kannen, Andreas	Journal Sustain Sci	Renewables, Yes, please', perceptions and assessment of community transition induced by renewable-energy projects in North Frisia
230	Thorp, John P.; Curran, Lara	Bulletin of Science, Technology & Society	Affordable and Sustainable Energy in the Borough of Woking in the United Kingdom
231	Tomc, Elizabeth; Vassallo, Anthony M	International Journal of Sustainable Energy Planning and Management	The effect of individual and communal electricity generation, consumption and storage on urban Community Renewable Energy Networks (CREN), an Australian case study
232	Tonn, B.; Stiefel, D.	Futures	Willow pond: A decentralized low-carbon future scenario
233	Tozer, Laura	Local Environment	Community energy plans in Canadian cities: success and barriers in implementation
234	Trutnevyte, E.; Stauffacher, M.	Environmental Development	Opening up to a critical review of ambitious energy goals: Perspectives of academics and practitioners in a rural Swiss community
235	Van der Schoor, Tineke; Van Lente, Harro; Scholtens, Bert; Peine, Alexander	Energy Research & Social Science	Challenging obduracy, How local communities transform the energy system
236	van Rooijen, Sascha N. M.; van Wees, Mark T.	Energy Policy	Green electricity policies in the Netherlands: an analysis of policy decisions
237	Van Veelen, Bregje	Sociologia Ruralis	Uncommon Ground, The Role of Different Place Attachments in Explaining Community Renewable Energy Projects
238	Van Veelen, Bregje; Haggett, Claire	Scottish Geographical Journal	Making Sense of the Scottish Community Energy Sector An Organising Typology
239	van Vliet, Bas J. M.	Journal of Environmental Policy & Planning	Sustainable Innovation in Network-Bound Systems: Implications for the Consumption of Water, Waste Water and Electricity Services

2015	UK	1	Transition Studies	sustainable development; renewable energy; community energy; United Kingdom; devolution; energy transition
2014	Germany	2	Science & Techn	energy system; energy transition; regime shift; renewable energy sources; resilience
2014	Germany	6	Governance	energy transition; lobbying; renewable energy; repertory grid; Germany
2017	Germany	5	Sociology	Community renewable energy; Renewable energy; Energy transition; Community benefits
2009	UK	7	Energy planning	sustainable development; environmental engineering; environmental policy; environmental protection; sustainable urban development; boroughs; cities & towns; local government; electric power distribution; Great Britain; climate change; cogeneration; environment; ESCO; local policy; partnership; reinvestment; sustainability
2016	Australia	7	Energy planning	Community renewable energy network, community energy, off-grid, community consumption, community gen...
2014	USA	5	Sociology	self-sufficiency; decentralized governance; home energy system; local manufacturing system; immersive telecommunications; sprawl farm
2013	Canada	7	Energy planning	community energy planning; energy management; municipalities; cities; local climate change action plan
2012	Switzerland	7	Energy planning	radical energy system change; rural community; transdisciplinary case study
2016	Netherlands	5	Sociology	Community energy Cooperatives Renewable energy Energy transition
2006	Netherlands	6	Governance	green electricity; renewable energy; the Netherlands
2016	UK	8	Spatial design	none
2017	UK	5	Sociology	community energy, typology, Scottish energy policy, energy geographies, critical pluralis...
2012	Netherlands	1	Transition Studies	network-bound systems, sustainable consumption, social practices, electricity supply, drinking water, waste water management, the Netherlands

240	Vancea, Mihaela; Becker, Sören; Kunze, Conrad	Revista Internacional de Sociologia	Local embeddedness in community energy projects, A social entrepreneurship perspective
241	Vanesa, Castán Broto	Environmental Innovation and Societal Transitions	Social housing and low carbon transitions in Ljubljana, Slovenia
242	Verbong, G.; Geels, F.	Energy Policy	The ongoing energy transition: Lessons from a socio-technical, multi-level analysis of the Dutch electricity system (1960–2004)
243	Verbong, Geert P. J.; Beemsterboer, Sjouke; Sengers, Frans	Energy Policy	Smart grids or smart users? Involving users in developing a low carbon electricity economy
244	Viétor, Birte; Hoppe, Thomas; Clancy, Joy	Energy, sustainability and society	Decentralised combined heat and power in the German Ruhr Valley; assessment of factors blocking uptake and integration
245	Viitanen, J.; Connell,P.; Tommis, M.	Journal of Urban Technology	Creating Smart Neighborhoods: Insights from Two Low-Carbon Communities in Sheffield and Leeds, United Kingdom
246	von Bock und Polach, Carlotta; Kunze, Conrad; Maass, Oliver; Grundmann, Philipp	Energy Research & Social Science	Bio-energy as a socio-technical system: The nexus of rules, social capital and cooperation in the development of bioenergy villages in Germany
247	Walker, Gordon	Energy Policy	What are the barriers and incentives for community-owned means of energy production and use?
248	Walker, Gordon	Wiley Interdisciplinary Reviews: Climate Change	The role for 'community' in carbon governance
249	Walker, Gordon; Cass, Noel	Area	Carbon reduction, the public and renewable energy: engaging with socio-technical configurations
250	Walker, Gordon; Devine-Wright,Patrick	Energy Policy	Community renewable energy: What should it mean?
251	Walker, Gordon; Devine-Wright,Patrick; Hunter, Sue; High, Helen; Evans, Bob	Energy Policy	Trust and community: Exploring the meanings, contexts and dynamics of community renewable energy
252	Warbroek, Beau; Hoppe, Thomas	Sustainability	Modes of Governing and Policy of Local and Regional Governments Supporting Local Low-Carbon Energy Initiatives; Exploring the Cases of the Dutch Regions of Overijssel and Fryslân
253	Weil, Benjamin	Journal of Political Ecology	Solar city, bike city, growth city: governance and energy in Davis, California
254	Wesselink, A.; Gouldson, A.	Policy Sciences	Pathways to impact in local government: the mini-Stern review as evidence in policy making in the Leeds City Region

2017	Germany, Spain, UK	3	Economics	Community energy; Energy cooperatives; Public service utilities; Renewable energy; Social e...
2012	Slovenia	1	Transition Studies	bounded socio-technical experiments; climate change experiments; energy vulnerability; Ljubljana; low carbon transitions; social housing
2007	Netherlands	1	Transition Studies	energy transition; long-term socio-technical analysis; Dutch electricity system
2013	Netherlands	1	Transition Studies	smart grids; users; strategic niche management
2015	Germany	1	Transition Studies	energy transition; decentralised CHP; energy efficiency; Multilevel perspective
2015	UK	2	Science & Techn	energy efficiency; ICTs; innovation; neighborhood; smart
2015	Germany	5	Sociology	bio-energy; nexus; social capital; cooperation; rural community
2008	UK	2	Science & Techn	renewable energy; community ownership; cooperatives
2011	UK	2	Science & Techn	none
2007	UK	5	Sociology	renewable energy; public; socio-technical configurations; UK
2008	UK	9	Norms & Values	community; renewable energy; UK policy
2010	UK	2	Science & Techn	community; renewable energy; trust
2017	Netherlands	6	Governance	local low-carbon energy initiatives; low-carbon policy; policy innovation; institutional a...
2013	USA	6	Governance	none
2014	UK	6	Governance	climate change; low carbon policy; local government; evidence-based policy making; policy work

255	Whitmarsh, Lorraine; Seyfang, Gill; O'Neill, Saffron	Global Environmental Change	Public engagement with carbon and climate change: To what extent is the public carbon capable?
256	Wilkens, Ines; Schmuck,Peter	Sustainability	Transdisciplinary evaluation of energy scenarios for a German village using multi-criteria decision analysis
257	Wirth, Steffen	Energy Policy	Communities matter, Institutional preconditions for community renewable energy
258	Wüste, Andre; Schmuck,Peter	Sustainability	Bioenergy villages and regions in Germany: An interview study with initiators of communal bioenergy projects on the success factors for restructuring the energy supply of the community
259	Wüstenhagen, Rolf; Wolsink, Maarten; Bürer, Mary Jean	Energy Policy	Social acceptance of renewable energy innovation: An introduction to the concept
260	Yalcin-Riollet, Melike; Garabuau-Moussaoui, Isabelle; Szuba, Mathilde	Energy Policy	Energy autonomy in Le Mené, A French case of grassroots innovation
261	Yildiz, Özgür	Renewable Energy	Financing renewable energy infrastructures via financial citizen participation, The case of Germany
262	Yildiz, Ozgür; Rommel, Jens; Debor, Sarah; Holstenkamp, Lars; Mey, Franziska; Müller, Jakob R.; Radtke, Jörg; Rognli, Judith	Energy Research & Social Science	Renewable energy cooperatives as gatekeepers or facilitators? Recent developments in Germany and a multidisciplinary research agenda
263	Zoellner, Jan; Schweizer-Ries, Petra; Wemheuer, Christin	Energy Policy	Public acceptance of renewable energies: Results from case studies in Germany

2011	UK	9	Norms & Values	public understanding; climate change; carbon; low-carbon lifestyles
2012	Germany	7	Energy planning	Multi-Criteria Decision Analysis; PROMETHEE; renewable energy systems; public participation; sustainable development
2014	Italy	5	Sociology	Community energy Biogas cooperatives Institutional forces
2012	Germany	5	Sociology	bio-energy village; renewable energy sources; success factors
2007	none	4	Acceptance	social acceptance; wind energy; diffusion of innovation
2014	France	1	Transition Studies	Grassroots innovations Local energy autonomy France
2014	Germany	3	Economics	Renewable energy finance Energy cooperatives Citizen participation Closed-end funds Busine...
2015	Germany	3	Economics	decentralization; energy cooperatives; energy transition; trust; participation; civic engagement
2008	Germany	4	Acceptance	public acceptance; environmental psychology; multi-modal research design

Appendix B: Keywords (Chapter 3)

aboriginal peoples
acceptance
acceptance of wind energy
action research
activism
agency
agency and capacity
agriculture
analytical-evaluative framework
Atikokan Generation Station
Australia
behaviour
behaviour change
behaviour change programmes
Berlin
Berlin-Brandenburg
beWhere
bioenergy
bioenergy village
biogas
biogas cooperatives
biomass district heating
bottom-up innovation
boundary objects
boundary organizations
boundary work
bounded socio-technical experiments
business models
Canada
Canadian energy markets
capacity
carbon
carbon dioxide (CO_2) emissions
central-local relations
choice experiments
cities
citizen groups
citizen participation
citizen participation initiatives
citizen power plants
civic culture
civic energy communities
civic energy sector
civic engagement
civil society
clean energy
climate
climate action planning
climate and energy model regions
climate change
climate change adaptation
climate change experiments
climate change mitigation
climate change policy
climate governance
climate mitigation
closed-end funds
cluster growth
co-operative
coevolution
cogeneration
cohousing
collaboration
collaborative network
collaborative planning
collective identity
commons
commonwealth
communal energy
communities
community
community benefits
community capacity
community co-ownership
community consumption
community development
community empowerment
community energy
community energy management
community energy plan
community energy planning
community engagement
community generation
community identity
community initiatives
community interest companies
community leadership
community ownership
community participation
community planning
community renewable energy
community renewable energy network
community renewables
community sustainability plan
community transitions
community-based renewables
compensation
complexity
conditions of possibility
configurations
conflict
conflict dynamics
conspicuous sustainability
constructed landscape
constructive technology assessment
consumption
contingent valuation
conviviality
cooperation
cooperative

cooperatives
critical discourse analysis
critical niches
critical pluralism
cultural sustainability
data envelopment analysis
decentralisation
decentralised CHP
decentralised energy
decentralised generation
decentralized energy production
decentralized governance
decentralized renewable energy
decision-making tools
degrowth
deliberative democracy
demographics
destabilization
development
development paradigm
devolution
diffusion of innovation
discourse
discourse networks
discourses
distributed economies
distributed energy resources
distributed generation
district heating
district heating and cooling
domestic energy
drinking water
DSO
Dutch electricity system
dynamic processes
dynamic systems
ecological citizenship
ecological justice
ecology
economic development
economic geography
economic sociology
economics
ecotourism
electric utility
electricity
electricity supply
electricity supply companies
emotions
employment
empowerment
enactment
end-use analysis
energy
energy & environment
energy and climate policy in Austria
energy autarky
energy autonomy
energy behaviours
energy café
energy commons
energy company
energy concept
energy conflicts
energy conservation
energy cooperatives
energy efficiency
energy geographies
energy geography
energy governance
energy initiatives
energy innovation systems
energy management
energy network companies
energy neutrality
energy ownership
energy planning
energy policies
energy policy
energy potential mapping
energy poverty
energy region
energy resources
energy scenarios
energy self-sufficiency
energy service companies (ESCos)
energy strategy
energy system
energy system based on renewable energy
energy system transition
energy systems integration
energy transition
energy transition and green gas
energy transitions
energy vulnerability
energy-planning
energy-self-sufficient community
engagement
engineering
entrepreneurs
environment
environmental activism
environmental awareness
environmental citizenship
environmental impact
environmental justice
environmental non-governmental
organisations
environmental planning
environmental psychology

local enterprise partnerships
local environmental governance
local experiments
local government
local governments
local initiatives
local low-carbon energy initiatives
local manufacturing system
local municipalities
local organic food
local policy
local politics
local renewable energy
local renewable energy cooperatives
local renewable energy organisation
local sustainability
local sustainable development
localisation
localism
long-term industrial change
long-term socio-technical analysis
low carbon
low carbon city
low carbon governance
low carbon policy
low carbon transition
low carbon transitions
low impact
low-carbon
low-carbon communities
low-carbon community groups
low-carbon economy
low-carbon electricity transition
low-carbon energy systems
low-carbon lifestyles
low-carbon neighbourhoods
low-carbon policy
low-carbon transitions
management
marginal land
marine renewables
market devices
market-based innovations
material politics
medium-sized cities
methodologies
micro-hydro
microgeneration
middle actors
middle-out
monitoring and evaluation
multi-criteria decision analysis
multi-level perspective
multi-modal research design
multicriteria decision aid (MCDA)
multilevel climate governance
multilevel governance
municipal energy plans
municipal utilities
municipal utility
municipalities
municipality
narrative
narratives
national energy
neighborhood
neoliberalism
Netherlands
network of enterprises
network-bound systems
networks
new energy projects
nexus
niche development
niches
normative alignment
North America
North of England
number governance
nurturing
object conflict
off-grid
operational design
organic urban development
organisation
own power
ownership
participation
Participatory Action Research (PAR)
participatory governance
partnership
path creation
path dependence
path-dependency
peak oil
peer-to-peer
perception
peripheralization
phase model
photovoltaics
place attachment
place attachments
place-based identity
plan evaluation
planning
policy
policy analysis
policy innovation
policy processes
policy work
political economy
politics
politics of community energy production
politics of range
post-carbon
post-politics
power
practice

socio-technical systems
socio-technical transitions
sociotechnical configurations
sociotechnical imaginary
solar champion
spatial arrangements
spatial planning
spatial representations
spatiality
sprawl farm
stakeholder influence
stasis
state energy efficiency and re-newable energy program
strategic design
strategic energy planning
strategic niche management
strategic niche management theory
strategies
strategy models
subnational governments
success conditions
success factors
supply chains
survey
sustainability
sustainability interventions
sustainability planning
sustainability transition
sustainability transitions
sustainable
sustainable communities
sustainable consumption
sustainable development
sustainable energy
sustainable energy communities
sustainable energy landscapes
sustainable energy planning
sustainable energy technology
sustainable energy transition
sustainable energy transitions
sustainable innovation
sustainable places
sustainable regional development
system builder
systemic design
tacit knowledge
targets
technological innovation systems
territorial governance
the Netherlands
the United Kingdom
transformation
transformative power
transition
transition management
transition network
transition pathways
transition pathways typology
transition pathways/mechanisms
transition research
transition town movement
transition towns
transitions
translation
transport
trust
typology
UK
UK energy system
UK policy
uncertainty
United Kingdom
United States
urban
urban commons
urban energy generation
urban energy transition
urban experiments
urban governance
urban living lab
urban planning
urban policy
urban sustainability
user communities
user innovation
user-led innovations
user-led technological change
users
Växjö
visions
Wales
waste water management
wind
wind energy
wind power
wood pellets

Addendum

Research Impact

In this addendum on valorisation of the research undertaken for this thesis I want to draw your attention to three main things. First, the impact that the undertaking of this PhD-trajectory had for the development of research culture and research facilities in my home institution, the Hanze University of Applied Sciences. Secondly, the contribution of the research process and results on the field of community energy, and thirdly, the value this research has for practitioners in the field of energy restoration.

The history of research at Universities of Applied Sciences is relatively young compared to the academic research tradition. Pursuing a Ph.D. trajectory at a University of Applied Sciences (UAS) therefore constitutes impact by itself, because it is expected to further develop the nascent research culture at such institutions. At the start of my work at the Hanze University of Applied Sciences (HUAS), it was not even possible to access online academic journals. Inquiring and making suggestions about this matter resulted in the formalization of a 'guest agreement' with University of Groningen; a clear example of valorisation. Another example of the lack of research culture was that access to scientific software, such as reference managers, software for qualitative analysis, were completely missing in the IT-architecture of the HUAS. Therefore, I actively lobbied to include software for reference management and for qualitative analysis. As the number of PhD students at the institution steadily rose, so more and more colleagues experienced similar needs. Today, the IT situation has improved in this regard, but there still is a long way to go. Also, the notion of what constitutes research is far from settled at HUAS, as it even includes the work of bachelor students.
As such, the concept of research threatens to become rather inflated. Over the years, the work on this thesis has also been instrumental to encourage visiting international academic conferences to present research, to stimulate the publication of results in academic journals, to develop new research avenues, and to promote the use of academic research methods.
However, the reader should keep in mind that the ratio between education and research at UAS-institutions is 93/7, while for non-applied universities this is 50/50. So, research remains only a minor part of the daily work at any UAS. While in public communication engagement with research is highlighted, there is a considerable discrepancy between the ambition and the allocated recources for research.
On the positive side, research at Universities of Applied Sciences is closely

connected to economic and social stakeholders. It is principally meant to be practice-oriented, therefore, research questions and research projects are usually developed in close cooperation with partners such as small and medium enterprises (SMEs), public institutions, local or provincial governments, NGO's and other stakeholders. Societal relevance and valorisation of research thus guides its set-up and execution right from the start. Consequently, the research for this thesis has also been conducted in cooperation with the communities and professionals concerned. Thus, impact has been generated not only by the results, but also by the preparation and cooperative execution of research projects. Many research participants in our projects have expressed that taking part in focus groups, workshops or network meetings was not only a pleasure but also provided them with new insights in their own practice as well as strengthened their networks.

As explained in this thesis, the community energy movement challenges the governance of the energy system and aims to create a new cooperative, sustainable and democratic system. This system will be integrated in or added to the existing energy system. As such, the search is for new socio-technical arrangements, for which new technologies as well as new governance and entrepreneurial models are needed.
The thesis shows how community energy developed and what can be learned about effective ways of organizing the community energy movement, which can help energy initiatives to improve their ways of working. Furthermore, it delivers insights in community energy developments in other countries, which can inspire local initiatives in the Netherlands as well as abroad. In chapter 4 I emphasize the importance of the formation of regional and national structures, to strengthen the community energy movement and to help with realisation of set goals. For the further development of community energy as a social movement, it becomes clear that national representation to lobby for the widening of opportunities for local energy initiatives also remains of paramount importance. The influence in the negotiations on the Climate Agreement in the Netherlands for example resulted in the inclusion of a target of 50% local ownership for energy production on land. For more specific recommendations on community energy the reader is referred to chapter 9.
Valorisation of community energy research has also been in the shape of new research projects, some of which have been finalized already, such as Ruimte voor Nieuwe Energie, where local cooperatives undertaking larger projects were studied. New themes have been developed, such as Buurtwarmte, a study of opportunities to develop cooperative district heating systems. The development of new themes in close cooperation with the community energy movement is a continuous process, for example

a recent theme (the seeds of which were already sown in chapter 4) is cooperative net management. A research proposal for a project on this theme has been recently drafted. Furthermore, a long term stay in the framework of a visiting scholarship at the NTNU in Trondheim was acquired with a view to compare the Dutch and Norwegian situation regarding community energy.

Since the start of this PhD-project, interest in the topic of energy efficient restoration has grown, and new experiences, methods and insights have been developed. Our research in the project Energieke Restauratie (2011-2013) was in the forefront of this development and contributed to setting the agenda.

For this thesis, sustainable valuation of heritage was examined together with heritage professionals, owners of historical buildings, municipalities and other stakeholders, a selection of case studies can be found in chapter 6. This generated a clear and coherent view about the potential and caveats of energy efficient restoration, enabling heritage professionals to reflect on practices of valuation, restoration and energy efficiency. It also resulted in my conclusion that the roles of experts and laypersons in heritage management are changing, following the increasing role that local stakeholders play in the conservation of historical buildings. A broader perspective on heritage is adopted, which includes social values, sustainability values, and laypersons' views. Furthermore, it is important to include the stories and memories that are connected to historic environments, as such stories are one of the important carriers of local identity.

In chapter 7 it is recommended that the training of energy advisers should include information about historical values; not with the view of becoming a heritage expert, but to instill basic knowledge of what are appropriate or more importantly inappropriate measures for use in historical buildings, in chapter 9 a list of specific recommendations is provided.

Chapter 7 also shows how the cooperation of two professional groups, architectural historians and energy advisors, can contribute to the reconciliation of sustainability values and heritage values. In this regard, I want to emphasize the importance of communication between professionals and other stakeholders, including laypersons. This insight led to a separate research project, which resulted in an article on the perspective of laypersons on the valuation of medieval churches (van der Schoor, Colmenero-Acevedo, & Vieveen, 2019)

Furthermore, valuation of heritage is core to a budding project focused on the impact of gas-induced earthquakes on cultural heritage and the landscape in the area of the Slochteren field in Groningen.

Valuation instruments; such as DUMO, as described in chapter 7, act as bridge to reconcile values of different professional backgrounds. Therefore, I recommended to further develop easy to use instruments to use by heritage and sustainability experts. These insights on the role of local stakeholders in heritage valuation and the perceived need of easy-to-use instruments have been instrumental in the development of two new research projects, to which I contributed. The first is Erfgoed Geeft Ameland Energie, focused on the Waddensea island Ameland; and the second is Living Lab Heritage and Energy, which will employ the 'Kolonien van Weldadigheid' in Drenthe as a case study. Here, the perspective of laypersons on energy restorations will be one of the main themes.

Lastly, I want to mention that the method introduced in chapter 8 can be useful to examine patterns of energy use embedded in the built environment. As argued in chapter 8, the built environment has been designed with the availability of cheap and abundant energy in mind. Therefore, in many cases, energy efficiency is not stimulated by building design, even stronger, it is often hampered by existing layouts and structures. In light of sustainability and climate goals, large scale retrofits are considered necessary, which provides new chances to stimulate low carbon living by integrating energy efficiency in retrofit designs. I argue that retrofit policies and strategies should take account of the influence of layout on energy demand. This not only means that sustainable heating, cooling and mobility patterns should be high on the list of requirements for retrofit of the built environment, but that the use-patterns embedded in buildings should be critically analysed for effects on energy use as well.

Activities to share the insights based on my research took the form of presentations, network meetings, or articles. Recently, I started to blog about my research results, with a view to reach out to a broader audience that would not usually read academic articles. Furthermore, results are shared in teaching, such as the module on community building in the Master program Energy for Society at HUAS.

Looking back, I conclude that the original PhD-project gave rise to a considerable number of new research projects and ideas, without exception rooted in societal needs and practices. However, this fruitfulness also caused delays in the finalization of my PhD, as it was not always easy to reserve enough time to concentrate on writing this thesis. Nevertheless, doing these projects in the framework of a PhD-trajectory stimulated the academic quality of my research, was an incentive for publication of results and guaranteed regular valuable feedback. For this, I sincerely thank my supervisors for their patience and continuing interest in my work.

Nederlandse samenvatting

Dit proefschrift onderzoekt energiereconfiguraties, met name gericht op strategieën voor de transformatie van het energiesysteem en de gebouwde omgeving. Reconfiguraties zijn onderzocht in twee situaties. De eerste situatie beschrijft de activiteiten en ontwikkeling van de lokale energiebeweging, een sociale beweging die het huidige gecentraliseerde, op fossiele brandstoffen gebaseerde energiesysteem uitdaagt en streeft naar een lokaal en democratisch geleid systeem, gebaseerd op duurzame energie. In de tweede situatie onderzoek ik hoe historische waarden en duurzaamheidswaarden in de gebouwde omgeving kunnen conflicteren en hoe deze conflicten kunnen worden opgelost, onder meer door het toepassen van een integraal instrument voor waardering. Dit is van belang omdat de sterke druk om bestaande gebouwen energiezuinig te maken potentieel een bedreiging vormt voor de historische waarden in onze gebouwde omgeving.

De energietransitie vindt plaats in de bestaande wereld, die de gewenste transformaties tegelijkertijd beperkt en mogelijk maakt. De bestaande gebouwde omgeving en infrastructuur structureren ons dagelijks leven en belemmeren verandering, maar anderzijds blijft verandering door menselijk handelen altijd mogelijk. De energietransitie ontwikkelt zich dus in een dubbele werkelijkheid, die ons tegelijkertijd vormt en door ons wordt gevormd. Zoals Churchill zei, ‘wij vormen onze gebouwen, en daarna vormen onze

gebouwen ons'. In dit perspectief zijn gebouwen 'structuren die het handelen structureren, maar zelf altijd vatbaar zijn voor herstructurering door menselijke actoren' (Gieryn, 2002). Het concept van de dubbele werkelijkheid is het uitgangspunt van dit proefschrift. Deze gedachte wordt gevisualiseerd in hoofdstuk 1 als een cirkel van reconfiguratie, waarin structuur en handelen elkaar afwisselen (Figuur 1).
Tegen deze achtergrond is de hoofdvraag van dit proefschrift welke strategieën worden toegepast bij energiereconfiguraties, met name door lokale actoren. Energiereconfiguraties zijn bestudeerd met behulp van de concepten waarden, scripts en 'obduracy', oftewel weerstand tegen verandering. Hoofdstuk 2 beschrijft verschillende sociale theorieën in relatie tot de gebouwde omgeving en gaat in op de wederzijdse relatie van gebouwde omgeving en maatschappij. De twee zijden van de reconfiguratiecirkel, structuur en handelen, worden achtereenvolgens behandeld in hoofdstuk 2. Eerst wordt ingegaan op het sociale proces van bouwen en ontwerpen, welke waarden daarin een rol spelen en hoe maatschappelijke opvattingen en ideeën vorm krijgen in de gebouwde omgeving. Het tweede deel van dit hoofdstuk beschrijft hoe de gebouwde omgeving vervolgens invloed uitoefent op het sociale leven, uitgewerkt naar invloed door plaats, type en scripts.

Hoofdstuk 3 bevat een literatuurstudie naar de lokale energiebeweging, 'community energy' genoemd.

Lokale energieinitiatieven streven naar een duurzame decentrale en democratische energievoorziening; zij willen het bestaande energiesysteem aanvullen én tegelijk structureel veranderen. In dit hoofdstuk wordt een overzicht gegeven van de verschillende disciplinaire benaderingen van 'community energy', hoe dit zich heeft ontwikkeld in de tijd en welke verschillen en overeenkomsten op te merken zijn tussen verschillende landen. In de literatuurstudie zijn in totaal 263 studies betrokken, die zijn geanalyseerd op verschillende aspecten: toegepaste benadering, land waar de studie heeft plaatsgevonden, jaar van publicatie, tijdschrift en gebruikte keywords. Onder meer blijkt dat het onderzoek naar lokale energie vooral heeft plaatsgevonden in het Verenigd Koninkrijk, gevolgd door Duitsland, Nederland en de Verenigde Staten. Er worden acht perspectieven onderscheiden, die worden gegroepeerd in de volgende clusters: socio-technische studies, socio-economische studies, sociaalpsychologische studies en bestuurskundige & planning studies. Bij community energy zijn de stakeholders van groot belang bij het onderzoek, met name de energiecoöperaties, (lokale) economische actoren, lokale en regionale overheden. Aanbevolen wordt om op transdisciplinaire wijze onderzoek te doen naar de lokale energiebeweging, zodat verschillende benaderingen en actoren op een samenhangende wijze betrokken kunnen worden bij vraagstelling en uitvoering van onderzoek.

In hoofdstuk 4 ga ik in op de ontwikkeling van collectieve strategieën in de lokale energiebeweging. Ik beschouw deze beweging als een voorbeeld van een sociale beweging, die niet alleen betrekking heeft op de productie van duurzame energie maar ook streeft naar een andere 'governance' van het energiesysteem. In dit hoofdstuk wordt de vorming van nieuwe regionale structuren in de lokale energiebeweging onderzocht, met name in Noord-Nederland. Hierin komt sterk naar voren welke doelen deze energiebeweging heeft en hoe de nieuwe structuren daar vorm aan geven. Deze doelen zijn duurzaamheid, lokale economie en democratie. De lokale energiebeweging wil bovendien aansluiten bij de lokale cultuur en mentaliteit en bijdragen aan de lokale gemeenschap. De lokale energie-initiatieven worden tot op heden vooral gedreven door vrijwilligers, wat enerzijds de aansluiting bij de lokale gemeenschap waarborgt, maar anderzijds belemmeringen oplevert voor de inzet van tijd en de verwerving van de benodigde kennis. Versterking van regionale en landelijke structuren kan helpen om deze belemmeringen te overwinnen door het versterken van lokale kennis en vaardigheden en het uitvoeren van politieke lobby op regionaal en landelijk niveau.

Hoofdstuk 5 gaat vervolgens dieper in op de lokale organisatie van energieinitiatieven. Dertien initiatieven in Noord-Nederland worden bestudeerd met behulp van een raamwerk gebaseerd op Law & Callon (1992), waarin twee dimensies worden beschouwd: de relaties met andere netwerken en de mate van betrokkenheid van de deelnemers. Netwerken zijn lokaal, zoals dorpsvereniging, gemeente, lokale bedrijven; regionaal, zoals provincie, regionale milieuorganisaties; of nationaal. De betrokkenheid van deelnemers is nader uitgewerkt voor de aspecten organisatieontwikkeling, gedeelde visie en aantal activiteiten. Bevindingen uit deze studie zijn onder meer dat er een ontwikkeling te zien is van informele naar formele organisaties. Het activiteitenniveau is een belangrijke graadmeter voor de effectiviteit van de initiatieven. Een goede aansluiting bij lokale en regionale netwerken blijkt eveneens een belangrijke voorwaarde voor succes op lokaal niveau. Communicatie met overheden is bijvoorbeeld van groot belang voor het verwerven van subsidies en het verkrijgen van vergunningen. De meeste initiatieven hadden een tamelijk algemeen geformuleerde gedeelde visie, meer uitgewerkte energieplannen werden niet aangetroffen. Het vasthouden van een hoog niveau van activiteiten is een belangrijke uitdaging voor deze vrijwilligersorganisaties.

Het derde deel van dit proefschrift is gewijd aan energiereconfiguraties in historische gebouwen. In hoofdstuk 6 worden strategieën geïdentificeerd om een energie-efficiënte restauratie zo vorm te geven dat de historische waarden worden beschermd. Op basis van 14 casestudies worden drie typen strategieën onderscheiden: ontwerpstrategieën, identiteitsstrategieën en communicatiestrategieën. Deze strategieën worden geïllustreerd met een beschrijving van een restauratieproject in Franeker. Van belang in deze studie is dat de aandacht wordt gevestigd op een breed scala aan strategieën, waarbij techniek, waarden en communicatie een gelijkwaardige rol spelen. De strategieën worden geplaatst in het kader van energiereconfiguraties, waarbij de ontwerpstrategieën gericht zijn op de materiele en technologische kant van de restauratie, identiteitsstrategieën de historische en sociale waarden van het gebouw benadrukken en communicatiestrategieën gericht zijn op het betrekken van de menselijke actoren in verschillende rollen. Het toepassen van deze strategieën versterkt het socio-technische netwerk en draagt zo bij aan de 'obduracy' van het historische gebouw. Het betrekken van energie-efficiëntie bij een restauratieproces vormt enerzijds een bedreiging voor de historische waarden, maar mobiliseert anderzijds nieuwe actoren bij de bescherming van historische gebouwen.

Hoofdstuk 7 bestudeert de rol die een waarderingsinstrument kan spelen bij de verzoening van conflicterende waarden bij een energie-efficiënte restauratie van historische gebouwen. Historische waarden en duurzaamheidswaarden zijn immers niet altijd verenigbaar; het uitvoeren van energiemaatregelen kan de historische waarden van een gebouw beschadigen of zelfs tenietdoen. De verschillende waarden worden in de praktijk gehanteerd door verschillende beroepsgroepen, enerzijds architectuurhistorici en anderzijds energieadviseurs, die ieder een geheel eigen achtergrond en opleiding hebben. Het instrument DuMo (Duurzame Monumenten) brengt de waardering van cultuurhistorische aspecten en duurzaamheidsaspecten in één methode samen. DuMo geeft ook concrete strategieën om de duurzaamheid van een historisch gebouw te verbeteren. In dit hoofdstuk wordt beschreven hoe DuMo de verschillende waarden commensurabel maakt, zodat zij met één maatlat kunnen worden gemeten. Tegelijkertijd blijft de epistemische autoriteit van de twee beroepsgroepen gehandhaafd.

In hoofdstuk 8 wordt verkend op welke wijze scripts in onze gebouwde omgeving zijn ingebouwd. Scripts zijn gedragspatronen van gebruikers, die door de ontwerper van een artefact zijn voorzien en waarop het ontwerp van het artefact is afgestemd. Scripts kunnen ook de relatie van gebruikers met andere instituties bepalen (Akrich, 1992). Ik pas dit concept toe op gebouwen, om te analyseren hoe sociale opvattingen zijn ingebakken in het ontwerp van gebouwen. Ook ga ik na of deze benadering zinvol kan worden toegepast op het energiegebruik in gebouwen en ontwikkel ik het concept ‘energiescript’. In deze verkennende studie kijk ik bijvoorbeeld naar de scripts van keukens. Hierbij valt op dat de vormgeving van de moderne keuken sterk is beïnvloed door opvattingen over de rol van de vrouw en familiewaarden enerzijds en commerciële belangen van de verkopers van apparaten anderzijds. Energiegebruik speelde weliswaar een rol in de overgang van open vuur naar het fornuis, maar daarna is beperking van energieverbruik lange tijd geen factor van belang geweest. De aanwezigheid van overvloedige en goedkope energie gecombineerd met stijgende prijzen van arbeid en materialen hebben met name in de tweede helft van de 20e eeuw geleid tot slecht geïsoleerde woningen, voorzien van gasgestookte centrale verwarming en warm water. Tenslotte kijk ik wat het doelbewust meenemen van energiegebruik bij het ontwerp van gebouwen kan opleveren, zoals bijvoorbeeld bij het passief huis.

In hoofdstuk 9 wordt teruggekeken op het onderzoek en gepoogd om overkoepelende conclusies te trekken betreffende de concepten waarden, scripts en weerstand tegen verandering (obduracy). Tenslotte worden aanbevelingen gedaan voor nader onderzoek en voor de ontwikkeling van beleid en praktijk gericht op energietransitie.

Curriculum Vitae

Tineke van der Schoor (Utrecht, 1959) studeerde Andragogische Wetenschappen (1979-1985) en Nederlandse Taal- en Letterkunde (1981-1987) aan de Rijksuniversiteit Groningen.
Sindsdien vervulde zij uiteenlopende functies, met name op het gebied van duurzaamheid. Van 1989 tot 2000 werkte zij respectievelijk bij de Alliantie voor Duurzame Ontwikkeling, Platform Brazilië '92 en de Nationale Commissie voor Duurzame Ontwikkeling. In dit verband was zij namens de Nederlandse Ngo's aanwezig bij de United Nations Conference on Environment and Development (UNCED), de VN-conferentie over duurzame ontwikkeling in Rio de Janeiro; vervolgens heeft zij verschillende keren deelgenomen aan de jaarlijkse bijeenkomsten van de VN-Commission on Sustainable Development. Van 2000 tot 2005 heeft zij gewerkt bij de adviesbureaus IWACO en Royal Haskoning als adviseur duurzaamheid. Van 2005 tot 2006 was zij verbonden aan de faculteit Bedrijfskunde, Rijksuniversiteit Groningen. Daarnaast was zij politiek actief als lid van de gemeenteraad Winsum (2002-2006), wethouder van de gemeente Winsum (2006-2008) en lid van het Algemeen Bestuur van het Waterschap Noorderzijlvest (2008-2015). Sinds 2009 werkt zij als hogeschooldocent en onderzoeker bij de Hanzehogeschool Groningen, Kenniscentrum NoorderRuimte, waar het onderzoek voor dit proefschrift is uitgevoerd.

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