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3 Resilient energy landscapes

A spatial quest?¹

Christian Zuidema and Jessica de Boer

Introduction

The past decade has seen a swift increase in societal and political commitment to shift towards a more sustainable energy system. This commitment is confirmed by European Union Climate and Energy targets (CEC, 2010). Among the prime means to accommodate such a shift is the increased use of renewables in the energy mix, which the European Union has set at a twenty percent share in 2020. The use of renewables will have vast spatial implications. Fossil fuels are often found below the surface and transported to centralised units to produce electricity or the distribution of fuels. Renewables such as wind, solar or hydropower are often above the surface, highly visible and require vast amounts of space. Hence, we will have to accept energy production becoming an increasingly prominent part of our landscapes.

The spatial dimension of a shift towards a more sustainable energy system is gradually becoming evident (e.g. de Boer and Zuidema, 2015; Nadaï and Van der Horst, 2010; Noorman and De Roo, 2011; Pasqualetti, 2012; Stoglehner et al., 2011; Stremke and Koh, 2011). Some positive examples exist of towns and villages benefiting from renewable energy production (e.g. de Boer and Zuidema, 2015; Jenssen, 2010). Nevertheless, it is the societal resistance to larger installations such as biodigesters, wind farms and solar fields that are attracting the most societal attention (e.g. Cass et al., 2010; Jones and Eiser, 2010; Walker et al., 2010; Wüstenhagen et al., 2007). Although renewable energy enjoys strong societal support, such support easily fades once renewable energy becomes spatially manifest. In the meantime, it is also clear that renewable energy production in Europe remains 'modest'. The ambition of twenty percent renewables in 2020 is only a first step. A move towards a truly sustainable energy system will require a further doubling or quadrupling of this proportion in the decades to come. In Europe, only Sweden, Norway and Iceland are already reaching levels of fifty percent or more for renewable energy production. Most European countries hover around or below the fifteen percent mark. A tremendous increase in renewable energy production will, therefore, be

required in most European regions. This is certainly true for the region this chapter discusses, which is the Northern Netherlands. The Netherlands is facing a serious challenge to increase renewable energy production as renewable sources contributed only a small proportion, just over five percent of overall renewable energy production in 2014. It is a challenge that will especially affect the Northern Netherlands as it is considered one of the prime areas where the energy shift is to become implemented spatially.

The spatial dimension of renewable energy urges the involvement of spatial planners in pursuing a more sustainable energy system. To date, such involvement has predominantly played a role only in finding appropriate locations for energy production and in streamlining project implementation. It is a role that is limited to addressing isolated projects. Hence, spatial planning has yet to fully grasp the challenges of a wider integration of energy production and distribution within our urban and rural fabrics. It is this integration of the energy system in its physical and socio-economic landscape that this chapter will discuss. This chapter draws from the notion of ‘resilience’ to explain why such integration is not only a societal *challenge* but might have important *benefits* too. The chapter will highlight how this integration can have important benefits for both regional resilience as well as the resilience of the energy system. This also leads to the central thesis of this chapter, which is that taking a spatial perspective can help us to make progress in addressing two tightly interrelated societal challenges: improving the resilience of the energy system and the resilience of the regions in which these energy systems will be embedded.

On the one hand, a spatial perspective can support the development of a more resilient energy system. Renewable energy production depends on local circumstances, ranging from climatic conditions, topography, economic investment opportunities and available social capital. Hence, taking a spatial perspective can assist in developing an energy system that, through adapting to diverse local circumstances, creates alternative development paths for regional energy systems. This will not only support the development and improvement of alternative technologies needed within the energy system but also allow for the exchange of energy between regions. For example, hydroelectricity or biomass can generate energy in one region to compensate for a lack of sun or wind due to weather conditions in another region.

On the other hand, adapting renewable energy systems to local circumstances helps renewable energy to become embedded within a regions’ socio-economic fabric. The result is that renewable energy might well support existing economic activities such as agriculture, chemical industries, transportation or port activities. It can also create new economic pathways, generate jobs or support local liveability. The financial gains from energy production can be used for local investments in local services such as schools, mobility, housing or nature management. This could lead to renewable energy production becoming part of a strategy to improve a region’s resilience.

The discussion below in section two focuses on how the shift towards a sustainable energy system urges us to discuss the relationship between the energy system and the physical and socio-economic landscape in which it is embedded. This discussion provides a background for the subsequent investigation. This investigation begins in section three with exploring the two interrelated challenges of the shift towards sustainable energy landscapes for spatial planning. In section four, the investigation continues by explaining how the notion of resilience can help us to better understand how spatial planners might respond to these challenges.

Sections five and six contain the results of an empirical investigation into how the shift towards a more sustainable energy system might assist in creating both more resilient regions and a more resilient energy system. Data was gathered within the 2012–2015 MACREDES ('MApping the Contextual conditions for Resilient Decentralised Energy Systems') project that the author participated in. Within this interdisciplinary project, the author was part of a team studying the spatial dimensions of the shift towards an energy system based on more renewables. The research involved a study of multiple cases of locally based renewable energy initiatives, of (regional and national) research reports, of supervising and guiding master theses, several workshop sessions and over ten semi-structured interviews with government representatives. Although MACREDES provides important empirical insights for this chapter, it is important to note that this overall chapter takes a more theory-led perspective to explicitly argue and illustrate the relevance and possible use of a resilience perspective in pursuing a transition towards a more sustainable energy system. Finally, in section seven, a reflection will follow and some concluding remarks are presented.

Changing energy landscapes

The energy system and the physical and socio-economic landscape were strongly interdependent until at least the late 19th-century. Noorman and de Roo (2011) describe such interdependence as the 'first generation' energy landscape. Energy harvesting and production often had a visible impact on the landscape, for example through deforestation, the extraction of peat from moorlands and of coal from localized sites. The limited possibilities in transporting energy over long distances resulted in energy production and consumption needing to be close together as energy needed to be produced where it was needed (Pasqualetti, 2012). Consequently, socio-economic activities often developed in close relation to the resources available. However, this close relationship between energy systems and the landscape changed during the industrial revolution due to the availability of high amounts of easily accessible fossil fuels. It created what Noorman and De Roo (2011) call the 'second generation' energy landscape.

Characteristic of the second-generation energy landscape is that the impact of the energy system on the landscape is relatively modest. Production

units are often fairly limited in numbers and size while depending predominantly on underground resources. Furthermore, much of the fossil fuels come from relatively remote areas in the world (EIA, 2012). The result is that energy production has become less visible than before the 20th-century. In the meantime, energy consumption has also become spatially detached from energy production. The higher energy density of fossil fuels allowed for transport over large distances over rail, road, water and through pipelines. The invention of alternating current further enabled transport of energy, as electricity could now be transported over hundreds of kilometres (Jones, 2010). A network of electricity lines, gas pipes and petrol stations, emerged during the 20th-century that now connects almost every household, company and vehicle owner to non-stop power supply. The result is a 'footloose' energy system in which space is implicit (de Boer and Zuidema, 2015). A system where energy is no longer a real factor in deciding where certain functions are located. Hence, spatial planning of energy production and consumption has become marginal. Spatial planning continues to matter when planning pipelines, electricity lines and energy plants, but with only minimal attention paid to the relationship between the energy system and the physical and socio-economic landscape.

The shift towards a more sustainable energy system re-emphasizes the interdependence between the energy system and the physical and socio-economic landscape. It is what De Roo and Noorman (2011) describe as the 'third generation' energy landscape. The shift involves an increased share of renewable energy production and consumption over the next decades. Early 21st-century landscapes in Western Europe are already changing with the emergence of new forms of energy production, dominated by solar energy, wind farms, hydropower, geothermal heat and the utilisation of biomass (e.g. Jenssen et al., 2012; Langbroek and Vanclay, 2012; Nadaï and Van der Horst, 2010; Sijmons and van Dorst, 2012).

Many renewable energy sources (e.g. wind, solar and hydropower) are highly visible, while others (e.g. waste heat, geothermal and biomass) depend strongly on local linkages with both resource suppliers and consumers. Furthermore, renewable energy density is far lower than that of fossil fuels. Compensating the energy produced by one large coal-fired power plant will require up to 80–100 large wind turbines. This amount equals a wind park ranging from about 50km² to maybe more than 100km²; an area similar in size to a city such as The Hague or Florence. The result is that generating enough energy for an industrialised society will require vast amounts of space, even with some additional technological advances. The shift towards a more sustainable energy system will partly be a return to the interrelatedness between energy systems and their landscapes as was common before the 20th-century. However, it is also different from the energy systems of the past in having to meet a far larger energy demand in an increasingly densely populated and intensely used landscape. This poses some significant challenges for spatial planning.

A spatial challenge

The first challenge facing spatial planners is to investigate the varying potentials of different landscapes to produce energy. Although some renewables seem rather generically applicable, specific local and regional circumstances often play a conditioning role in producing renewable energy (e.g. Noorman and De Roo, 2011; Pasqualetti, 2012; Stoeglehner et al., 2011; Stremke and Koh, 2011; van den Dobbelsteen et al., 2007). Variations in solar radiation, wind speed, the presence of mountainous areas, geothermal potentials and abundances of biomass all dictate alternative options on a larger spatial scale. For example, wood-fuelled power plants are common in Sweden, hydroelectricity is found in the Alps and energy from waste is more common in the Netherlands. On a smaller scale the presence of waste heat from industries, well-suited rooftops for solar energy or the availability of residual biomass also condition energy potentials. A spatial perspective becomes relevant for identifying the potentials that a specific urban or rural landscape offers for producing renewable energy (van den Dobbelsteen et al., 2007). But a spatial perspective implies much more than identifying potentials. After all, production of renewable energy will not take place on a 'tabula rasa'.

Secondly then, spatial planners today are urged to investigate how renewable energy might be integrated into the physical and socio-economic landscape (de Boer and Zuidema, 2015). Much of the European landscape is already used for alternative socio-economic functions. This is especially true in more urbanised areas where there is little space left unused. Instead, land uses such as housing, transport, industry, offices, nature protection, agriculture and recreation put large claims on the physical landscape. Sometimes these existing land uses offer great opportunities for renewable energy production, for example, for using residual biomass from agriculture or residual heat from industries. Sometimes only a few tensions exist, as seen with wind farms in areas of very low population density or solar panels on the roofs of warehouses. However, renewable energy production can *compete* with existing land uses and *infringe* upon existing landscape qualities.

Competition can occur when space is specifically used for renewable energy production instead of other land uses. The growing of bio crops is a good example as bio crops can easily compete with crops meant for food production. Another example is the development of wind farms that compete with ecological protection zones or locations for new urban development. In most cases, some form of mixed use is possible with renewable technologies being part of a multifunctional landscape; e.g. solar panels on roofs, wind farms on agricultural land or waste heat in industrialised areas. In the case of multifunctional use, it remains important to recognise that infringement might still be a constraint for development. Infringement can range from the smell produced by biodigesters or the noise caused by wind turbines to the visual impact of wind farms and solar panels. Competition

and infringement can create conflicts, which are especially prone to occur in more densely populated areas. They are conflicts often associated with the so-called NIMBY (not in my back yard) phenomenon (Cass et al., 2010; Walker et al., 2010).

The integration of renewable energy in both the physical and socio-economic landscape remains a relatively novel practice for both spatial planners and practitioners in the energy sector. Some first attempts have been pursued for the physical integration of renewables in the landscape (e.g. Stremke and van den Dobbelsteen, 2012). These attempts show how landscape architects and spatial planners, sometimes with the participation of residents, can facilitate physical integration and potentially soothe conflicts (Sijmons and van Dorst, 2012). Some first examples of the socio-economic integration of renewable energy include examples of farms with biodigesters, households with solar panels and heat-cold storages, and municipalities using their own bio-waste to produce biogas (de Boer and Zuidema, 2016). Revenues are then distributed locally among companies and sometimes also citizens, showing how degrees of socio-economic integration of energy production can be achieved. Some novel tendencies where entire municipalities, villages or islands take charge of their energy production have also emerged, with examples including the Danish island of Samsø and city of Sønderborg and the German towns of Feldheim or Saerbeck. Nevertheless, deliberate attempts at the physical and socio-economic integration of energy systems in their landscapes are rare. Consequently, the large-scale production of renewable energy can take place in projects focussed on energy production isolated from the spatial context (e.g. Spijkerboer et al., 2014).

In the case of renewable energy, spatial planning is considered to go beyond having a role in only preventing or mediating societal resistance to the projects and smoothing project implementation. The vast number of renewables needed and their spatial impact call for a better understanding of how renewables are to be *integrated* into their physical and socio-economic landscapes. Such integration is an attempt at searching for how the vast amount of renewable energy needed can be combined and linked to the characteristics of the physical and the socio-economic landscape. This also applies vice versa with how spatial planning might help in coping with the required changes in the energy system. The underlying idea is the creation of what de Boer and Zuidema (2015) describe as an *integrated energy landscape*, i.e. a multifunctional physical and socio-economic landscape in which the energy system is an integrated part. If successful, integration can smooth the process of project implementation in allocating renewables in our landscape. More importantly, such integration might be beneficial from the perspective of both the regional or local society *and* the energy system. This chapter argues that by using the concept of resilience such benefits might be better understood.

Taking a resilience perspective

The concept of resilience has, within the realm of spatial and political sciences, rapidly gained in popularity and use over the past decades. To some extent, resilience seems to replace ‘sustainability’ as the ‘buzzword’ in academic debates on planning and political sciences in the early 21st-century (Porter and Davoudi, 2012). It is especially its use in relation to systems such as cities, regions, infrastructure or communities, for dealing with external shocks and conditions of continuous change that have fuelled the popularity of resilience within the realm of planning and political sciences. Following its introduction into the realm of ecological studies by Holling in the 1970s, resilience initially had only a limited impact on academic debates within spatial and political sciences. Nevertheless, it was the work of Holling together with Goldberg that set the stage for the introduction of resilience into the spatial sciences. Holling and Goldberg (1971) accommodated a translation of the ecological principle of resilience into that of policy and decision making. Their work allowed spatial planning academics to empirically investigate urban and regional systems based on ecological theory. It was an age of pioneering that set the stage for resilience being positioned outside of the realm of material systems, such as ecosystems, which were considered separate from human systems. Instead, Holling and Goldberg (1971) showed how human societies are directly interrelated with and embedded in ecological and physical systems (also Reed and Lister, 2014). Furthermore, they explained how resilience is a consequence of both human and natural forces in this interrelated system (Holling and Goldberg, 1971). Human behaviour is then not only a constituent part of a system but is also a force for the creation and destruction of resilience. It has allowed us, as spatial planners, to see resilience both as a lens for analysing and describing the world we interact with and as a framework for inspiring policy ambitions. This resonates with the ambitions of this chapter to consider resilience as a lens to investigate the actual and desired development of a renewable-based energy system in the context of both the physical and socio-economic landscape.

More recently, the rising importance of complexity sciences within spatial planning and political sciences has brought resilience to the forefront of the academic debate. Complexity sciences challenge conventional conceptions of predictable change and stable systems by showing the world that planners and policy makers aim to intervene in as being in a constant state of flux. In this understanding of the world, conceptions of stability and linearity are being replaced by those of dynamically interacting social and physical systems that are producing non-linear, emergent and co-evolutionary behaviour. As Davoudi (2012) explains, “among the prescribed remedies for dealing with [such] a state of flux, the one that is rapidly gaining currency is ‘resilience’” (p. 299).

Although Holling (1973) already hinted towards the role of dynamics, unpredictability and nonlinearity, resilience was first adopted in relation

to the capacity of ecological systems to withstand shocks and bounce back to their original state. This view on resilience focusses on systems in stable equilibria, on degrees of disturbance that systems can handle and on their return times, i.e. it is a view that “applies only to behaviour of a linear system, or of a non-linear system in the immediate vicinity of a stable equilibrium where a linear approximation is valid” (Folke, 2006, p. 256). Hence, it is also a view that fits in well with notions of control, certainty and traditional command and control policies. It is a view that has gradually been amended due to the growing acceptance of the complexity and non-linearity of many of the physical and societal processes that planners and policy makers face. The result is a more dynamic understanding of resilience that underlines its potential for planning and policy sciences in the past decade.

When taking a more dynamic perspective, resilience is linked to systems that use mechanisms of self-organisation to adapt and respond to both internal and external processes of change (e.g. Folke et al., 2010; Gunderson and Holling, 2002; Martin and Simmie, 2010). It is a view Davoudi (2012) calls ‘evolutionary resilience’ and that fits with the rise of complexity sciences and more specifically with studies on complex adaptive systems (e.g. Berkes and Folke, 1998; Holland, 1999; Kauffman, 1991). Resilience is, from such a perspective, not necessarily about a system’s capacity to return to its original or ‘normal’ state of equilibrium. Instead, an evolutionary perspective on resilience “challenges the whole idea of equilibrium and advocates that the very nature of systems may change over time” (Davoudi, 2012, p. 302). Therefore, taking an ‘evolutionary’ perspective means that “resilience is not conceived of as return to normality, but rather as the ability of complex socio-ecological systems to change, adapt and crucially, transform in response to stresses and strains” (ibid., p. 302).

In trying to grasp the mechanisms by which a resilient system copes with change, reference is made to what Davoudi (2012, p. 306) summarises as the “dynamic interplay of persistence, adaptability and transformability across multiple scales and timeframes” (also see Folke et al., 2010; Gunderson and Holling, 2002; Walker et al., 2004). Persistence can be linked to the capacity of a system to absorb pressures and shocks without collapsing. Persistence, as seen from a dynamic perspective, need not be interpreted as a system’s ability to maintain or move back to a fixed state or equilibrium. Rather, a system can also persist through processes of adaptation and transformation, allowing some of its key functions to remain (persist) while possibly undergoing some structural changes. Therefore, the notions of adaptability and transformability are also central to a dynamic understanding of resilience (also Folke et al., 2010).

While alternative interpretations exist, adaptability and transformability refer to two complementary capacities that give a system its ability to persist in the face of change and dynamics. As Folke et al. (2010, p. 2) summarise, adaptability refers to a system’s capacity “to learn, combine

experience and knowledge, adjust its responses to changing external drivers and internal processes, and continue developing within the current stability domain or basin of attraction” (also Berkes et al., 2003). Transformability goes one step further and is “the capacity to create a fundamentally new system when ecological, economic, or social structures make the existing system untenable” (Walker et al., 2004, p. 5). Arguably, transformability can be positioned outside of the realm of resilience. After all, if the system fundamentally changes, can we still consider it the same system and hence resilient, or did the original system collapse to be replaced by a new one? Alternatively, transformability might also be a critical element of resilience. This becomes especially clear once we understand a system as being nested across multiple scales. Resilience then stems from the dynamics within and between individual elements or subsystems. The subsystems’ capacity to transform can then be considered to allow the wider system to adjust and be resilient. This can, for example, be the case when fuel stations transform from being stations selling gasoline to places for recharging electrical vehicles. It will transform the function of a fuel station towards that of a recharging station while facilitating the energy system and transport system to continue functioning.

Finally, a dynamic perspective of resilience tends to frame systems as constituting both societal elements and natural elements. A dynamic perspective can also be traced back to the work of Holling and Goldberg (1971) on seeing ecological and social systems to be interrelated. Often described as socio-ecological systems, social and ecological systems are seen to relate to each other in a dynamic fashion (e.g. Berkes and Folke, 1998). It is a holistic perspective that suggests that we need to understand how social systems, such as institutions, economies, cities or communities are intricately linked with the ecological contexts in which they reside, be it nature, waterways, air quality or the climate. Arguably related, the literature on so-called socio-technical transitions further adds to this holistic systems interpretation. It argues that, in addition to seeing social and ecological systems as closely interwoven, technologies should also be included (e.g. Foxon et al., 2008; Grin et al., 2009; Loorbach, 2010; Meadowcraft, 2009; Rip and Kemp, 1998; Rotmans et al., 2001). It is a relevant addition especially in the face of the significant changes in technologies designed to support the shift to a more sustainable energy system. Overall, resilience can be considered as encompassing material characteristics (ecological and technical) with institutional and cultural characteristics also being contributing to or constraining a system’s resilience. It urges us to also consider elements such as social capital, identity and social learning as essential for the resilience of a system: be it cities, regions, infrastructure systems or communities (Olsson et al., 2006).

In this chapter, resilience is understood from a dynamic perspective. It is a choice not just informed by its wide usage within planning and policy sciences, but also by understanding that the emerging energy landscape

highlights major changes that require adaptations and transformations (e.g. Loorbach, 2010). Section five below discusses these changes from the perspective of a specific region; the Northern Netherlands. In this context, resilience relates to the capacity of this region to adapt to the pressure of integrating renewable energy into the physical and socio-economic landscape. Section six turns the tables and discusses these changes from the perspective of the energy system. Resilience is related to the capacity of the system to continuously provide affordable and sufficient amounts of energy while having to integrate more volatile and unstable resources. These two perspectives are not isolated from each other. Instead, as will be discussed in section seven, important synergies become apparent when adopting the idea of an integrated energy landscape in pursuing regional resilience and the idea of a resilient energy system.

Energy and regional resilience

The Northern Netherlands is an area of about 9000km², it is home to 1.7 million inhabitants and is the most peripheral and rural region of the Netherlands. The region faces some of the typical problems that more peripheral and rural areas often face: population decline, unemployment, an aging population, decreased services and a stagnating economy (CBS, 2013; Provincie Groningen, Friesland, Drenthe, 2015). Located on the borders of the North Sea, and for a large part at about sea level, the area is also facing risks associated with climate change. Finally, part of the region faces earthquakes induced by natural gas extraction. This causes additional problems, especially in the province of Groningen, due to damaged property, societal unrest and the increased risks of flooding. Consequently, the Northern Netherlands seems to face a complex mix of challenges.

Some areas, most notably close to the urban agglomeration of Groningen-Assen and Leeuwarden, seem to escape some of the challenges faced and are even expecting additional growth. The rest of the North faces what can be called rural decline (Spijkerboer et al., 2014). Rural decline relates to issues such as (youth) out-migration, decline of human capital and relatively low-income levels (Measham and Fleming, 2014). The result is a decline in the region's vitality. As Koomen (2011) explains, vitality can be linked to a healthy demographic development, sufficient economic activity in the form of employment, the availability of service facilities, strong social cohesion and a strong community identity (Shucksmith et al., 2006). In the Northern Netherlands, the first two indicators of vitality are heavily under pressure, with service facilities increasingly undermined. The possible result is a loss of local liveability.

Liveability can be linked to vitality and relates to opportunities for people to develop a good quality of life in a specific location. Liveability is difficult to define, especially when accepting the highly diverse interpretations and values that different people use to express a place as being liveable.

Nevertheless, liveability, to a certain extent, relates to at least some commonly accepted conditions that spatial planning can influence. As Newton (2012) expresses, “the concept embraces measures of residential amenity, human capital, social capital, human health and the more qualitative elements of personal satisfaction and happiness” (p. 82). There is a wide range of conditions that can support liveability (e.g. Ley and Newton, 2010). In a material sense, these conditions can include infrastructure (internet, drinking water, roads, et cetera), good quality housing, a clean and healthy environment and the secure provision of sufficient amounts of affordable energy. In a social sense, both the availability of services such as education, health care, and employment are crucial as are opportunities for cultural self-expression, for being respected and treated fairly. In the meantime, as Newton (2006) explain, liveability should also be positioned in a wider resilience perspective. Doing so implies that conditions supporting liveability will change. Liveability can only be maintained if these conditions are based on sustainable practices and can resist or transform in the face of internal or external changes. The current reliance on fossil fuels is an example of an unsustainable practice that challenges the potential for future liveability. Transformation towards a renewable based system seems the only long-term option for regaining a stable and affordable flow of energy without further damaging the climate. The crucial realization is that such a transformation could also potentially offer new opportunities for regional development. Renewable energy might be among the strategies to enhance conditions supporting liveability, both in a material sense (e.g. clean environment, nature development, affordable energy) and a social sense (e.g. jobs, local identities, local services). Hence, this chapter argues that liveability can be considered as tightly linked to the transition of the energy system.

In the Northern Netherlands, the potential of renewable energy is directly connected to processes of rural decline and opportunities for enhancing liveability. The main government parties are aware that some of the conditions supporting liveability in the Northern Netherlands are under pressure. In response, several policy directions are elaborated for stimulating economic and social development. Key issues mentioned are the more abstract research and development and international accessibility, while more concrete examples include the development of tourism, agrifood and sustainable energy (Noordervisie, 2015). The choice for sustainable energy is not a surprising one. The Northern Netherlands has a long-standing link to the energy sector. The area is home to a large reserve of natural gas and related human capital and institutional networks. Furthermore, the area is a good place for the development of large-scale wind farms (Ministry of Infrastructure and Environment and Ministry of Economic Affairs, 2014). Energy, therefore, is part of both the region’s history and future.

Renewable based energy might support the region’s social and economic development. Renewable based energy has the potential to strengthen

existing local and regional activities, such as farming (Muller, 2009) and local industries (Avelino et al., 2012), while effects on generating employment also seem positive (Lehr et al., 2012). Renewable based energy has additional benefits for the local society, for example in contributing to citizen commitment to energy projects and the creation of social capital supporting an energy transition (Seyfang and Haxeltine, 2012). These arguments are reinforced in the Northern Netherlands by the availability of relatively large amounts of biomass from nature management and agriculture, good wind potentials and a suitability for novel renewable technologies such as osmosis (Moskvitch, 2014).

Despite its potential, renewable based energy is contested in the Northern Netherlands as also became apparent in the research conducted by de Boer and Zuidema (2015) in the context of the MACREDES project. Part of this research was a focus on large-scale energy projects, which in the Northern Netherlands were only large-scale wind farms. A key example studied was the case of the Veenkoloniën ('Peat Colonies'). The Veenkoloniën are a peripheral area characterised by a low population density and a relatively high economic dependence on state subsidies and unemployment benefits (Commissie Structuurversterking Veenkoloniën, 2001). Wind farms with a total capacity of 700MW are planned in roughly 850km² (Ministry of Economic Affairs, 2011). Due to their size, the wind farms are managed by the state in a specific top-down programme to smooth implementation. Agreements were made between large energy companies and the state, while local landowners would gain some of the revenues (Sijmons and van Dorst, 2012). The wider civil society was largely isolated from these projects and linkages with local initiatives, stakeholder interests and economic functions were not explicitly considered. As a result, the local population and much of the existing economic fabric were overlooked in the plans. Part of the local population swiftly organised into pressure groups and started an anti-wind farm lobby. Interviews reveal that these pressure groups were not against wind energy per se. What seemed to cause most resistance was the sheer size of the projects; the fact people were not actively involved in decision making and felt they had to face only costs and no benefits.

The case of the Veenkoloniën is an example of large state-induced projects that are usually developed in high isolation from their physical and socio-economic context. Although state actors are trying to create an aesthetically responsible allocation there is little or no local spin-off created. Revenues would go to the large investors and energy companies, while a small set of local landowners (often farmers) also benefit. The generation of jobs, creation of local economic revenues that might support local investments, and synergies with local businesses are limited, if not absent. These projects hardly support regional economic or social development and have limited potential for enhancing regional resilience and liveability. Furthermore, they face low societal support and acceptance (Bijl, 2013). Although more recent projects show increased attention for creating financial

compensation for residents, large wind farms remain highly contested in the Northern Netherlands.

In contrast, within the MACREDES project, many energy initiatives were studied that are locally embedded. They are often small scale initiatives based on neighbourhood or village communities. Citizens themselves develop renewable energy initiatives that focus on the local purchase of solar panels, use of biomass or improved isolation measures. The Windpark A7, close to the Frisian village of Pingjum (600 inhabitants), is a good example of such a locally embedded energy initiative. The local community owns about eight percent of the 28MW wind farm together with people from nearby villages (see Dorp Pingjum, 2016). The community invests financial revenues directly into the community. Consequently, a local school and community centre were subsidised and additional solar panels and heat pumps were bought. It is using these revenues that these small villages can gain more control over their destiny. Due to their small size and declining population, it is challenging to retain services such as schools and community centres. In such a context, renewable energy production can be of added value for liveability by generates resources and local pride.

Another example, which is currently on hold due to political reasons, was even more directly contributing to creating local spin-offs. The example is a public-private partnership in the municipality of Hoogetveen (de Boer and Zuidema, 2015). The partnership was established around a wood-fuelled bioenergy plant (1mw) supplied with local residual biomass. The initiative depended on local municipal and business interest and partners. The municipality's participation guarantees a basic amount of available biomass and allows the heat produced in the oven to be distributed to nearby municipality buildings. A local company collects and processes the biomass and benefits from a nearby stable consumption market, while its participation ensures biomass is available in the right quality. Finally, the participation of a local energy company allows for sufficient technological know-how and for creating the physical and institutional infrastructure to distribute the energy. In spreading the risks, combining different fields of expertise and using local potentials, the initiative became financially viable. At the same time, it also created new institutional linkages which fitted with local social and economic ambitions. Nevertheless, doubts about financial returns have put the project on hold at the time of writing.

Locally embedded initiatives often generate modest amounts of energy (e.g. Rijksoverheid, 2013). Their contribution to an energy transition, however, is also in showing that energy initiatives *can* create relevant local spin-offs. These projects help create local institutional capacity, commitments to energy targets and local identities (e.g. Dedden, 2016; Duisterwinkel, 2015; Sulman, 2014). Furthermore, some of these initiatives have the potential to be up-scaled by becoming larger themselves or by growing in impact through inspiring policies, politics or different initiatives. A key example of upscaling studied in MACREDES project is a community initiative around

solar power in the municipality of Groningen: Grunneger Power. The initiative started by supporting its members with solar panel procurement and installation. Gradually, it grew into a green energy company selling electricity for fair prices to its customers as well (Grunneger Power, 2012). Within two years this community initiative grew to about 1,000 private members (Broere, 2013). The initiative has also inspired other institutional changes not necessarily related directly to Grunneger Power. For example, the initiative is strongly involved in developing municipal service points for citizens around renewables and energy saving (Natuur en Milieufederatie Groningen, 2015) and they helped develop the institutional position of energy cooperatives by co-founding an overarching cooperative for the Northern Netherlands (Coöperatieve vereniging NLD Energie U.A., 2013).

The examples illustrate a dynamic interplay between the material energy system and its societal embedding. It is not the isolated energy initiative that gives a region additional transformative power; it is the energy initiative embedded in its physical and socio-economic landscape that provides this additional transformative power. As a result, two key conclusions regarding the role of renewable energy in relation to regional resilience can be drawn from the above. First, renewable energy is not only challenging as it requires incorporation into our landscapes, but it is also a possible solution to local or regional socio-economic challenges. A resilience lens helps us to see why and how. When viewed from the perspective of a specific region, resilience relates to the capacity of this region to adapt to the pressure of integrating renewable energy into the physical and socio-economic landscape. It begs for transformative power where the region can hold on or revitalise its main functionalities, such as jobs, services and amenities in the face of larger global and regional trends. Renewable energy has the potential to give a region increased transformative power, i.e. it can create new jobs, support services and open new economic development models. The examples studied also provide evidence that renewable energy can indeed create economic, institutional or social spin-off. Certainly, this spin-off remains modest due to the small scale of the examples and even local initiatives might still be contested. But what is crucial is that at least the *potential* of creating this spin-off is clear.

Second, renewable energy appears to be highly contested due to its impact on the landscape. On the one hand, if renewable energy is to become part of a strategy to increase regional resilience, its impact will obviously become far larger than now. On the other hand, even without such intentions, current Dutch policies urge for a swift increase in renewable energy production, which will affect the Northern Netherlands. It is thus clear that this increase is unavoidable. It is also clear that this strategy will *also* require large-scale renewable energy initiatives and projects. But the potential of renewable energy to generate spin-offs is not only relevant when it comes to individual or small cases. This potential is also present in the case of larger projects; e.g. when a wind farm directly generates revenues for the

region. As a result, upscaling might not necessarily imply initiatives grow themselves; it is also when larger initiatives copy the basic model of creating regional spin-off that upscaling might occur. If and how such larger projects can create the kind of local support and commitment remains to be explored and tested. However, the potential for spin-offs may well play a decisive role in increasing societal support for an increase in renewable energy production.

Regional integration and resilient energy systems

When viewed from the perspective of the energy system, resilience can be associated with the current need for the system to continuously provide affordable and sufficient amounts of energy while having to integrate more volatile and unstable resources. Volatility and instability relate to many renewables that depend on weather conditions such as wind and solar energy (e.g. Kleijn and Van der Voet, 2010). As a result, it can become difficult to balance the supply of energy with the demand for energy and to keep the energy system, especially the electricity grid, stable. Taking a spatial perspective might help support the development of resilient renewable based energy systems by pursuing combinations between spatial functions and a diversification in energy systems based on local conditions. The argument of combinations between spatial functions stays close to the debate in the previous section. Instead of seeing new energy initiatives and projects as isolated from their physical and socio-economic landscape, they are instead integrated with them. The argument in this section will focus on what such integration means for the energy system itself.

As a starting point, integrated initiatives are often based on overlapping interests, which gives the initiative a multifunctional purpose (de Boer and Zuidema, 2016). Energy initiatives that unite alternative local interests tend to be less vulnerable to economic changes and social pressure (ibid). Therefore, such multifunctional initiatives can help the development of a more resilient energy system. For example, farmers use biodigesters to reduce their need to export manure, generate heat, produce gas and produce humus (Muller, 2009). The other benefits help to continue with the project even if the profit from biogas or heat reduces. In an economic sense, this means that there is more capacity to adapt to market change. Furthermore, linkages with other interests provide more funding options for the initiative. For example, solar panels on the roof of a large distribution centre could be funded by the company itself, an energy company or even individual users. Moreover, the MACREDES findings suggest the embedding of the initiative in the local economy provides investors with more social trust and support. Local commitment may open possibilities for extra investments in innovations or for bridging difficult periods with regional support. Hence, a spreading of risks can be achieved, which might reduce the vulnerability of the energy system in the face of changed economic conditions or subsidy

regimes. Furthermore, as findings from the MACREDES studies also illustrate, local involvement can also stimulate learning about the costs and benefits of local energy production by allowing for more public support for innovation of the energy system. The result is that integrated energy initiatives can become catalysts for the development of institutional networks, knowledge and support. Therefore, integrating energy initiatives might add transformative power to the current energy system from a social and institutional perspective.

A spatial perspective can also be relevant by stimulating local and regional diversification of the energy system. Local and regional diversification emerges from the fact that area-based energy initiatives draw on local or regional qualities for energy production. Initiatives make use of site-specific advantages that lead to local or regional specialisations in energy production. Some regions or localities will be specialised in solar energy, others in wind power or geothermal heat, and yet others in energy from biomass. Such diversification can also support the development of a more resilient energy system. First, spatial diversification creates improved opportunities for a stable energy supply. A more diversified system allows for the exchange of capacity between, for example, wind and solar on the one hand, and biogas and hydro energy on the other. Second, spatial diversification also helps avoid path-dependency (Martin and Simmie, 2008). After all, it creates possibilities to experiment and improve various technologies. Instead of relying on 'monocultures', the system creates alternative pathways, production opportunities, and diverse institutions. This all makes the overall system less vulnerable and more resilient.

A good international example is hydro energy from Norway, which is sought after to balance wind and solar fluctuations in Germany (Gullberg et al., 2014). Nevertheless, a truly diversified grid goes further than small scale initiatives or isolated large connections. Ideally, the harvesting of varied energy sources such as waste heat, geothermal, biomass, hydro, solar and wind are linked to each other in such a way that they can (partly) resolve the challenge of creating a more predictable supply of energy. A spatial perspective, therefore, is not just relevant in understanding how energy initiatives can be integrated with the local physical and socio-economic landscape. It is also relevant in assessing how the resilience of the (inter) national energy system can benefit from local and regional energy systems that specialise and complement each other.

During the MACREDES project, the researchers conducted a scan of fifty-five initiatives in the Northern Netherlands that feature on a national website (www.hieropgewekt.nl) functioning as a platform for local citizen based energy initiatives. Of fifty-five initiatives, forty-nine generated energy with two others in a start-up phase and four only focussing on efficiency measures. Two relevant conclusions could be drawn based on this scan. First, a strong diversity of resources was found, with initiatives using locally available potentials. Second, diversification also related to the location of the initiatives. The scan showed that solar energy is by far the dominant

resource in urban areas, with only one out of the twelve urban cases also focussing on other resources (wind in Coevorden). The rural cases also mostly use solar energy (twenty-seven of the thirty-seven) but also rely on wind (fifteen of the thirty-seven), biomass (nine of the thirty-seven) and hydro energy (one case). Although these cases are mostly small scale initiatives, they are beginning to have an impact on the overall energy system especially by showing pathways for development and change.

In the meantime, other renewable energy related developments that occurred outside of the scope of the MACREDES project took place. The development of heat networks in Groningen and Hoogezand is very concrete examples of rather big projects that use the locally available residual heat and geothermal potentials (Gemeente Groningen, 2016; Provincie Groningen, 2015). Another example of a development crucial for the region is the development of large off-shore wind farms, which are benefiting from the high wind speeds on the North Sea. They are triggering specific transformations in the energy system on land, notably in the Eemshaven harbour (North Netherlands). The building and maintenance of wind farms attract economic activities, while the wind farms are also fuelling the development of large data centres (in Eemshaven) that use the wind energy. Furthermore, these wind farms are also triggering research into liquid natural gas for buffering and heat due to the expected highly differentiated amounts of energy generated in the face of varying weather conditions.

As is clear from these examples, the Northern Netherlands is exploring a variety of resources based on regional and site-specific potentials. Consequently, the developments traced in the Northern Netherlands both show the emergence of multifunctional initiatives and systems *and* of spatial diversification. Such diversification is relevant for reducing the dependency of initiatives on only energy and of the region on only a limited set of resources. It is too early to tell if the Northern Netherlands is indeed contributing towards the development of what can be considered a resilient energy system. But what is clear is that in drawing on local and regional potentials, the development of a renewable-based energy system in the Northern Netherlands does show signs of the kind of diversity required for a resilient energy system

A reflection

Although celebrated by widespread societal support, the shift towards a more sustainable energy system is contested when its large-scale spatial consequences manifest themselves. As a result, it is easy to consider this shift to be problematic for regions and localities, often simplistically summarised as the so-called NIMBY effect. While a sustainable energy system will have large and possibly undesirable spatial consequences, this chapter argued that spatial planners also need to look beyond these undesirable consequences. With the help of the notion of ‘resilience’, this chapter proposed a complementary set of arguments to do so.

First, a resilience lens helps to view renewable energy as a possible solution for local or regional socio-economic challenges. Renewable energy has the potential to give a region transformative power and increase its livability, i.e. it can create new jobs, support services and open new economic development models. As such, it can contribute to a region's resilience by supporting or revitalising its main functionalities in the face larger global and regional trends. For such a contribution to become manifest, however, a resilience perspective does refer to a dynamic interplay between the material energy system and its societal embedding. This perspective suggests that energy initiatives should be well-integrated within the physical and socio-economic landscape.

Second, the integration of the energy system in the physical and socio-economic landscape might also support the resilience of the energy system itself. A resilient energy system is both able to balance supply and demand (energy security) and to transform towards a completely different structure and resource basis without losing its main functionalities: a stable flow of affordable energy. Linking energy initiatives with a set of local socio-economic interests is a means of gaining resources, generating commitment and hence, spreading and decreasing risks. While this supports the vitality of individual initiatives, spatial diversification might further increase the energy system's resilience. Local and regional diversification follows energy initiatives drawing on local and regional qualities for energy production. The resulting specialisation creates improved opportunities for creating a stable energy supply by having complementary resources, while it also can help avoid path-dependency. Therefore, it holds opportunities for giving the energy system more vitality and transformative power.

Clearly, this chapter conveys an optimistic message. It is, however, not a message without nuances. Integration of energy initiatives in their physical and socio-economic landscapes is not always easy or widely supported. Therefore, the desired speed of implementing renewable energy projects might be incompatible with careful integration and embedding in these physical and socio-economic landscapes. Such integration might increase the resilience of regions and the energy system. But it remains difficult to establish whether such integration will achieve greater resilience. The purpose of this chapter is also not to convey any of these messages. Instead, the message is that understanding the relevance of integrating energy initiatives in their physical and socio-economic landscapes offers interesting opportunities, which the notion of resilience can help to demonstrate.

Note

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