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New interaction paths in the energy landscape: the role of local energy initiatives

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ABSTRACT

Energy transition is an encompassing process which not only involves the energy system but also the landscape in which the energy system is embedded. Renewable energy is triggering new interactions with local landscapes in physical, socio-economic and institutional senses. We capture these interactions using the energy landscape concept, which expresses the interdependence of the energy system with the landscape. We aim to understand whether and how local energy initiatives facilitate this interdependency so as to see if local energy initiatives can be considered focal points in energy transition. We analyse how emerging local energy initiatives link different interests, land uses and activities within their energy practices and show how these facilitate interactions between various physical and social systems across multiple spatial scales. The paper concludes with several suggestions on how spatial planners and policy-makers can use the insights from the findings to support energy transition.

KEYWORDS

Energy landscape; transition; system interaction; linking; local energy initiative

1. Introduction

European Union member states are increasing the share of renewable energy in their national energy provision, including in order to meet EU climate targets (Eurostat, 2016; European Commission, 2014). Increasing the share of renewable energy has spatial consequences for landscapes, such as competing land uses, decreasing environmental quality (Stoeglehner, Neugebauer, Erker, & Narodoslowsky, 2016; van der Horst & Vermeylen, 2011) or the large-scale transformation of cultural landscapes triggering political debate (e.g. Wolsink, 2010; Leibenath & Otto, 2013). Research and policy may learn from local energy initiatives that accommodate renewable energy in the landscape (Sengers & Raven, 2015; Hansen & Coenen, 2014; De Boer & Zuidema, 2015b). Studying the evolving relationship between landscape and energy from a spatial perspective can spur the creation of new visions for spatial planning and energy policies (Nadaï & van der Horst, 2010). This research follows up on research publications addressing the spatiality of local energy initiatives and their contribution to the development and social acceptance of renewables (e.g. Seyfang & Haxeltine, 2012; Rydin, Turcu, Guy, & Austin, 2013; Walker, Hunter, Devine-Wright, Evans, & Fay, 2007; Wolsink, 2012; Wiersma & Devine-Wright, 2014). This paper assesses our hypothesis that local energy initiatives are focal points in energy transition, implying that such initiatives are nodes where developments and innovations in the energy system can be directly linked to other physical and social systems through the practices of these initiatives.

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The recent rise of affordable renewable technologies opened up possibilities for decentralised energy generation on a relatively small scale. These technologies include wind turbines, solar panels and bio-digesters, which have resulted in the swift rise of small-scale energy initiatives instigated by local citizens or entrepreneurs (Arentsen & Bellekom, 2014). Many of these local initiatives benefit from local conditions, ranging from topography and resources (Stremke & Van den Dobbelsteen, 2014; Stoeglehner et al., 2016), to social support and demand (Wiersma & Devine-Wright, 2014) and economic opportunities (De Boer & Zuidema, 2015b). Furthermore, these local initiatives often permit generated energy or financial benefits to be distributed locally (Hoppe, Bressers, & Lulofs, 2015; Spijkerboer, Trell, & Zuidema, 2016). A range of local activities can therefore co-benefit from local energy initiatives, such as farming, recreation, industry or construction to name but a few. In other words, the actions and aspects related to generating and/or facilitating renewable energy—‘low carbon practices’ (e.g. Middlemiss & Parrish, 2010)—often requires links with actors and artefacts in the energy system and other physical and social systems. Local energy initiatives can contribute to an area-based development facilitating a local connection between innovation in the energy system and developments in other societal sectors. If so, we propose to frame these initiatives as focal points in a wide societal transformation process surrounding the emergence of renewable energy and low carbon practices—a process known as an energy transition (Verbong & Geels, 2008).

On the basis of studying the interactions and links in seven local energy initiatives, we examine whether local energy initiatives can indeed be considered focal points in energy transition. The next section presents the theoretical framework, including conceptualisations of the energy landscape and the area-based niche for studying the relevance of local initiatives. With the help of this framework, we analyse ‘artefact-actor networks’ (Reinhardt, Moi, & Varlemann, 2009) of seven local initiatives to trace how they connect different interests, land uses and activities within their low carbon practices and reveal how these facilitate interactions between various physical and social systems across multiple spatial scales.

2. Theoretical framework

2.1. Transitions

The term energy transition often refers to the transformation of the fossil fuel-based energy system into a more sustainable low carbon energy system as part of a wider societal transition process (e.g. Verbong & Geels, 2008; Smil, 2010). A transition is a complex and long-term innovation process during which a system transforms in interaction with other systems and finds a new dynamic equilibrium (Geels, 2011). During a transition process, the coherence of the existing system weakens and actors and artefacts from the existing system and other systems realign (Geels, 2011). The links between systems and scales are crucial in the process of realignment since they allow information, resources and matter to circulate via new paths through the systems (Cash et al., 2006). Such information exchange enables systems to adapt mutually to changed conditions through positive feedback between systems and may thus engender new co-evolutionary paths (Norgaard, 1984). Hence, the shift from fossil fuel-based energy systems to low carbon energy systems is part of a wider sustainability transition process which encompasses several evolving systems on multiple scales. This shift relates to physical systems such as ecosystems, transport infrastructure or water by, for example, using biomass, electric vehicles or hydroelectricity. It also relates to many social and institutional systems, such as through emerging energy cooperatives, altered investment opportunities for energy companies, regulatory changes for exchanging energy between households or the creation of jobs in green energy. These are just some examples pointing to the many interactions occurring between the energy system and various physical and social systems due to innovation processes. These interactions also take place at many different scales, ranging from individual households to geopolitical debates. To make these interactions tangible and better understand energy transitions, we adopt a local landscape perspective, since it reveals these interactions within the context of people’s daily environments.

2.2. Changing energy landscapes

Landscapes are not simply a physical canvas for human activities or a territory for the spatial structure of governance (Olwig, 2007). Landscapes are also cultural, supporting multiple functions and services (e.g. Naveh, 2001; Bolliger et al., 2011), and changing over time (Plieninger & Bieling, 2012). What is conventionally called a landscape, is described by the European Landscape Convention as ‘an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors’ (Council of Europe, 2000). The daily practices and perceptions of the people shape the physical and social landscape (Olwig, 2007). Landscapes can differ in scale, partly overlap or be nested into one another: from a locality, to a region such as Andalusia, to Europe as a large-scale landscape (Görg, 2007; Olwig, 2007; Mitchell, 2001). This perspective on the landscape contrasts with the use of landscape in the literature on socio-technical transitions. There, the landscape forms the macro-level in a multilevel perspective on innovation trajectories in society, encompassing the levels of regime and niche. The landscape level is a wider exogenous environment with deep structures which cannot be changed at will by actors, but is influencing regime and niche developments (Geels, 2005).

For our research objective, we rather stay close to the description of the European Landscape Convention, since it highlights that actions and interactions shape the landscape. Different practices, actions and interactions establish links which shape and intertwine the systems of the landscape. We regard the landscape to be the synthetic expression of social and physical systems—composed of actors and artefacts—which are interacting within and across different spatial scales. In this description, the term landscape is interpreted both geographically as an area and metaphorically as a complex system. This perspective on the landscape is used for our conceptualisation of the energy landscape.

The energy landscape concept has already been used to describe landscapes physically imprinted by the energy system, such as an energy landscape dominated by wind farms or an energy landscape where coal, fossil oil or natural gas are extracted from the physical landscape (Thayer & Freeman, 1987; Pasqualetti, 2013; Bridge et al., 2013).¹ In this research, the energy landscape concept is enriched further with our perspective on the landscape as a complex system. Other extended conceptualisations of energy landscapes can be found in the work of, for example, Stoeglehner et al. (2016) and Stremke and Van den Dobbelsteen (2014). The landscape provides us with a lens to see how the energy system is intertwined and interacting with many alternative systems. That is, the energy landscape is a holistic combination of the energy system with other social and physical systems in a spatial manifestation. Distinguished are the six energy landscape systems and four scales (see Figure 1).

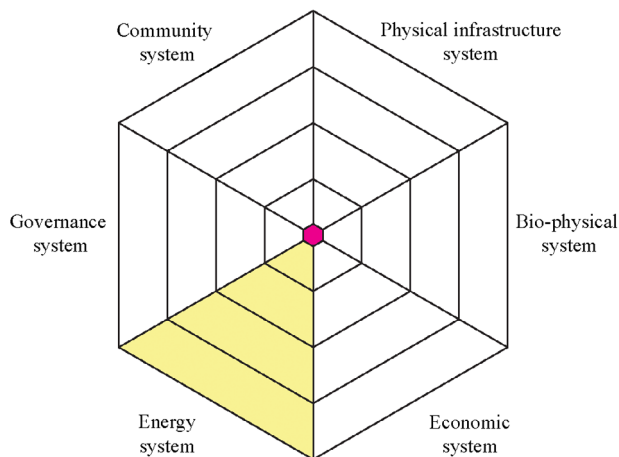


Figure 1. Conceptualisation of the energy landscape as the synthetic expression of several systems and scales. Six systems and four scales are distinguished.

2.2.1. Systems and scales of energy landscapes

We identify six different systems of the energy landscape: the energy, community, governance, economic, bio-physical and physical infrastructure systems. The six energy landscape systems are linked and interacting. Therefore, a change or innovation can impact more than one system. For instance, an institutional innovation can impact only the governance system, but if the innovation is also relevant for the energy system it can also impact the energy system. The energy system, in this framing, is composed of components that link or partly overlap with the other five systems. We operationalised these systems in Table 1, indicating in greater detail what we consider them to refer to.

In addition to identifying six systems, we also consider energy landscapes as multi-scalar. The six energy landscape systems are also linked and interacting within and across four different scales (see Figure 1). The local energy landscape scale is defined as the local physical and socio-economic energy potentials of an area in relation to local practices and institutions which give it a critical mass and make it into an entity (cf. Hospers, 2005; Paasi, 2011). The regional scale is defined by regional potentials in relation to regional institutions. In the same way also the national and global scales are defined. The links between the systems and scales are crucial because they condition possible interactions, dynamics and regime shifts (Cash et al., 2006). This research focuses on the local scale: much implementation is done at the local scale and local community interests and rights to the landscape may conflict with superordinate goals and interests in low carbon energy, which might in turn result in social resistance and NIMBY attitudes towards renewable technologies (van der Horst & Vermeulen, 2011; Wüstenhagen, Wolsink, & Bürer, 2007). On the local scale also energy initiatives play a role in accommodating and implementing renewable energy projects (De Boer & Zuidema, 2015b). From their unique position in the energy landscape, these initiatives are actively exploring and establishing links with multiple systems at various scales through their daily low carbon practices.

2.3. Area-based niche initiatives

To understand the role of energy initiatives in energy transition, a spatial perspective on the development of initiatives is considered useful (Sengers & Raven, 2015; Hansen & Coenen, 2014). The development of energy initiatives can be considered as occurring in 'niches' (Kemp, Schot, & Hoogma, 1998; Schot, Hoogma, & Elzen, 1994). Niches are locations where innovation regarding the development of an alternative and low carbon energy system occurs. Niches can be highly diverse, ranging from electric cars and smart grids to regional biofuel strategies and low carbon practices (Schot & Geels, 2008; De Boer & Zuidema, 2015b). In general, niches are created through shielding, nurturing and empowerment (Smith & Raven, 2012; Kern, Verhees, Raven, & Smith, 2015). A niche provides greater freedom for energy innovations and for initiatives to experiment and improvise, as a result of which, variation and deviation from the dominant practices in the energy system can occur.

Niches which can be defined by their unique environmental surroundings are described as area-based niches (De Boer & Zuidema, 2015b). An area-based niche is characterised by local actors and artefacts (e.g. resources, information, infrastructure, documents) located in the local landscape, creating

Table 1. Identifying the systems of the energy landscape. *(cf. Alanne & Saari, 2006; Bridge et al., 2013).

Operationalisation of the systems of the energy landscape	
Energy System	Confined to activities and aspects directly related to extracting, transporting, storing, generating, transmitting, distributing and using energy from different resources*
Physical Infrastructure System	Built environment, transport, infrastructure
Bio-physical System	Land use, ecology, morphology, water, natural resources
Community System	Identity, culture, acceptance
Economic System	Trade, finance
Governance System	Public institutions, laws, rules, norms

both opportunities and constraints for local initiatives to develop. Initiatives developing in area-based niches differ from non-area based initiatives, such as a national energy distribution cooperative, in the sense that the development of area-based niche initiatives is explicitly interdependent with physical, socio-economic and institutional conditions in the local landscape. Hence, a big project, such as a wind farm, can still be area-based.

An area-based niche initiative may, for example, develop a collective solar installation on a public building rooftop in the neighbourhood. For instance, the initiative links among others with the governance system for the municipal zoning plan, with the physical infrastructure system for the rooftops, with the economic system for funding, with (un)supportive citizens of the community system, with solar resources of the bio-physical system and with energy network operators in the energy system. By linking with local actors and artefacts the initiative adopts a position in the local energy landscape and also links the energy system to several systems in the energy landscape. Each initiative is then regarded as a node in the energy landscape, where several systems are tied together through the initiative's activity. Our aim is to investigate whether local energy initiatives actually function as such nodes and can be considered focal points in energy transition.

3. Method

This paper presents empirical evidence from seven local energy initiatives in the Netherlands. The case selection is based on two main criteria: (i) they should cover a broad range of different renewables to avoid bias in our research and (ii) the initiative should have developed at least one project. The selected initiatives (Table 2) are civic–market organisations (profit or non-profit), initiated by citizens, entrepreneurs or both. The analytical framework focuses on the links between the energy initiatives and various systems and scales, and—in a next step—determining whether the links, established due to an initiative's low carbon practice, result in any initial changes to the energy landscape.

3.1. Mapping of links

To assess the links between the initiatives and the energy landscape systems and scales, we analysed their 'artefact-actor networks' (Reinhardt et al., 2009). The artefact–actor networks allowed us to map not only the actors in their social networks, but also the artefacts, consisting of information, resources and matter, in their networks. The determination of the initiatives' artefact–actor networks was based on data from policy documents, reports, data from the initiatives (i.e. background information, newsletters and website documents) and semi-structured interviews with active members in the organisation of the initiatives. The networks are screenshots captured at the time of the interviews in 2014/2015. The networks are mapped as 'ego networks,' with the individual initiative positioned in the centre of the network (Wellman, 1983 in: Prell, 2012, p. 118). The initiative is mapped as a node tying together several systems and scales through the initiative's practice.

The analysis was conducted in five steps and documented (De Boer & Zuidema, 2015a):

- (1) Identification of the links established through each initiative's low carbon practice with different actors and artefacts. The result is a diagram of the actors and artefacts related to a single initiative's practice.
- (2) Analysis of individual link qualities to assess whether linked actors/artefacts are relevant to supporting the emergence of the initiative and/or its capacity to develop successful projects. We distinguish between weak and strong links and between dependency and co-dependency links (see Table 3). The dependency/co-dependency link indicates whether the interaction matters particularly for the initiative. A co-dependency link indicates that the connection is not only important for the initiative, but also for another actor or artefact. The evaluation of the link strengths is based on the typology of Nooteboom and Gilsing (Nooteboom & Gilsing, 2004; Gilsing & Nooteboom, 2006), who analysed organisational innovation networks for



Table 2. Design and characteristics of the seven selected initiatives.

Initiative	EnergiePon	'tHaantje	Windvogel	BergenEnergie	Grunneger Power	MorgenGroene Energie	DeRamplaan
Established Initiator Organisation Renewables Additional activities	2006–2013 Farmer Company Bio-energy	2008–2013 Farmer Company Bio-energy	1991 Citizen collective Cooperative Wind energy Facilitation of participation in German solar fields	2012 Citizen collective Cooperative Solar energy	2011 Citizen collective Cooperative Solar energy Facilitation of individual uptake	2010 Citizen collective Cooperative Solar energy Facilitation of individual uptake	2011 Citizen collective Cooperative Solar energy Facilitation of individual uptake and energy conservation
Date of interview	21 Oct 2014	19 Dec 2014	19 Dec 2014 24 Dec 2014	10 Jan 2015	09 Mar 2015	23 Feb 2015	12 Mar 2015
Interviewee	Responsible employee	Farmer and brother	Project + windmill operating member	Board member	PCR project member	Board member	Board member

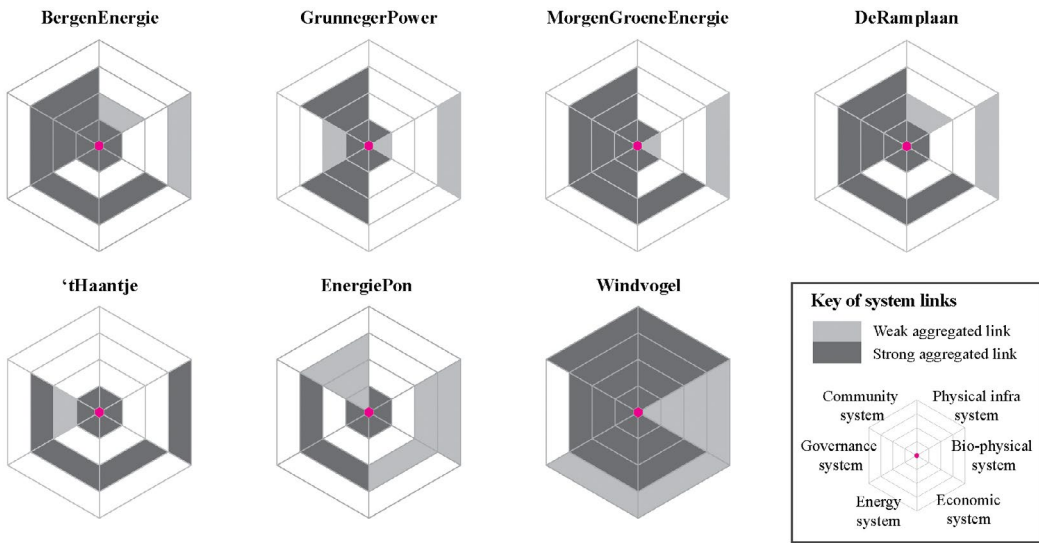


Figure 2. Aggregated artefact-actor network figures for the seven initiatives mapped onto the systems and scales of the energy landscape (see also Figure 1). The aggregated link strengths are assigned according to a summation of the individual link qualities per system scale.

Table 3. Link types, dimensions of link strength and the operationalisation. The descriptions with an * are derived from Nootboom & Gilsing, 2004 and Gilsing & Nootboom, 2006. The other descriptions are added.

Link type	Link strength	Dimensions of link strength	Operationalisation
Dependency	Strong	Formal control*	Formal control by an authority or through a contract*
		Crucial	Required for practice of the initiative and its development
Co-dependency	Weak	Supportive	Supportive but not crucial
	Strong	Trust/mutual openness*	The presence thereof*
		Scope*	3 or more issues
		Duration*	2–5 years or more*
Weak	Weak	Frequency of interaction*	Daily or weekly*
		Specific investment in mutual understanding*	The presence thereof*
		Scope*	1–2 issues
		Duration*	Less than 2 years*
		Frequency of interaction*	Monthly or less frequent*

understanding a firm’s capacity for situated action. Their typology is operationalised here so as to allow for coding of actors and artefacts via ATLAS.ti software and to identify the individual link qualities (see Table 3).

- Identification of the tying together of several systems and scales in an initiative’s practice. All individual links with an actor or artefact (step 1) were coded with a ‘system’ and ‘scale’ code (super-codes). With help of queries in ATLAS.ti software, the relationships (co-occurrence/adjacency) between systems and scales in single actions/aspects of an initiative’s practice were identified. This allowed us to identify how each initiative’s practice linked horizontally (across systems) and vertically (across scales). Low carbon practices can require links with multiple systems, thus tying the systems together and facilitating horizontal interaction. In theory, cross-system links can facilitate the mutual adaptation of the six systems by allowing innovations in the energy system to interact with other social or physical systems (Cash et al., 2006). Practices can also establish links across scales. Vertical interaction can signify the flow of

resources, matter and information across scales (Havlin, Stanley, Bashan, Gao, & Kenett, 2015). Such vertical links thus penetrate the systems on several scales and may therefore facilitate the adaptation of the systems to renewable energy practices across all scales.

- (4) Identification of the aggregate link strength per 'system scale.' For each system we wanted to see how strong an initiative's practice is related to it per scale (see Figure 2). We distinguished between 6 systems and 4 scales, and thus 24 system scales are identified. To each of the 24 system scales an aggregated score is assigned based on the strength of links between an initiative's practice and that system scale. The aggregate link strength expresses the combined strength of individual links to actors and artefacts located in a specific system scale. A weak aggregate link is found if at least one weak link and at most one strong individual link are identified per system scale; whereas strong aggregate links are composed of at least two individual strong links per system scale.
- (5) The fifth and final step was an additional round of in-depth analysis at a more generic level to establish how the newly developed low carbon practices of the energy initiatives studied impact their local energy landscapes. Rather than only studying the potential of linking systems and scales which permit a flow of resources, matter and information, this last step means assessing whether this flow is already causing some initial tangible changes in the local energy landscape. Doing so means adding value to our analysis of link strengths by also indicating whether the links contribute to change and hence, if these links indeed matter. If so, these local initiatives are already showing themselves to be among those nodes contributing to changes in the energy system in relation to other physical and social systems. In other words, they would then be among the nodes we can regard as focal points in energy transition.

4. Findings

4.1. Cross-system interaction

Figure 2 shows that each initiative is linked to all six energy landscape systems. With help of ATLAS, we also found that the initiatives tie together two or more systems within some of their practices; that is, several systems need to change at the same time for such a practice to exist. Deeper content analysis also indicated that the tying together of systems applies to all systems and is not restricted to specific combinations (e.g. the governance and community systems). This indicates that the initiatives' low carbon practices crosslink several systems, creating new interaction paths across multiple systems in the energy landscape.

This also shows that these initiatives are manifesting multifaceted practices in their area-based niches, which are about much more than producing megawatts. The bio-energy initiative 'tHaantje is a good example: The energy system (1) is linked through an innovative form of renewable energy generation (in this case the fermentation of residual biomass in a bio-digester) and through local energy exchange (using the electricity and heat generated partly for the farm and transporting the residual heat to the local public swimming pool). The physical infrastructure system (2) is included through the installation of a bio-digester and heat pipes for the local swimming pool. The bio-physical system (3) is influenced through a contribution to sustainable agriculture and sustainable environment use (by intensifying the food production cycle through integration of renewable energy generation, by supplying the bio-digester's residual digestate to the local agricultural fields as fertiliser instead of pure manure, and by reducing CO₂ emissions to the environment from biogas and digestate). The community system (4) is taken into account by investing in retaining the trust of the local community (through organising a field trip to another bio-digester before constructing the bio-digester and by dealing with complaints from neighbours due to occasional smell by stopping the use of a particular product in the bio-digester). The economic system (5) is included by enlarging the scope of the farming business (through a synergy between food production and renewable energy generation) and by stimulating

an economy for residual biomass products (through demand for co-products for the bio-digester). Finally, the governance system (6) is influenced by fuelling with its practice the ongoing discussion about the tax rules for transport and usage of residual biomass as energy resource instead of manure, and by involving the municipality in renewable energy generation for public facilities such as the local public swimming pool. The diversity of links between 'tHaantje and actors and artefacts illustrates how 'tHaantje is creating new interaction paths between the systems of the energy landscape through its practice.

Deeper content analysis indicated that the solar and wind initiatives are particularly strong in tying the energy system to the community and economic systems: for example, the links with the local community are not just in terms of customer relations, but also for investments and participation in the initiative. The result is also the creation of economic links which enable the initiative to rely on a stable business case for generating energy cooperatively and not for profit. The strong link between energy, community and economic systems is most evident in the case of the Windvogel initiative, which also seems to stem from its long existence (since 1991).

4.2. Cross-scalar interaction

The links we identified between systems show a rich and varied pattern of links between multiple scales (Figure 2). The seven initiatives all have links at the local and national scales of the energy landscape, six initiatives have links at the regional scale and four initiatives have links at the global scale. The presence of links with multiple scales means that the initiatives have cross-scale links, which facilitate the percolation of new information across the scales of the energy landscape (Cash et al., 2006; Havlin et al., 2015).

Links at local and national scales appear to be most prevalent. The thorough linking with the local scale indicates that the initiatives develop low carbon practices in interdependence with the local potentials of the various energy landscape systems. Of the seven initiatives, the two bio-energy initiatives were the least well connected at the larger scales. This could be because we found them less inclined than the solar and wind cooperatives to cooperate with other initiatives and organisations and to lobby for institutional changes. The farmers are running the bio-digester alongside their farms. For example, EnergiePon began its bio-digester initiative because: 'We looked to broaden our agricultural activities; to add a second line of revenue for risk diversification' (Interview with EnergiePon in 2014).

The strong links identified at the national scale might stem from the need to align the area-based niche practices with the system 'regimes' in the energy landscape. In the Netherlands, social systems have a coherent regime structure at a national level (e.g. Verbong & Geels, 2008). Links with the systems of energy, community and governance at the national scale are most often characterised as strong. This indicates that the initiatives create new cross-scale interaction paths particularly in these three systems. Strong links are, for example, found in umbrella organisations which emerged from collaborations between initiatives. The energy supply cooperatives Duurzame Energie Unie (DE Unie) and Noordelijk Lokaal Duurzaam (NLD) were both established by energy initiatives; De Unie operates at the national level and NLD operates at the regional level in the Northern Netherlands. An important national community network which emerged from the low carbon practices of energy initiatives is the Hier Opgewekt platform. This platform shares information and lessons from initiatives and organises collective events. The solar and wind initiatives also actively influence the energy regime by lobbying for change in governance and energy systems at a national level. Through these national structures and lobbying activities, the aggregate link strengths of the solar and wind initiatives with the energy, community and governance system increases at higher scales and will create new cross-scale interaction paths particularly between these systems.

4.3. Integrating low carbon practices into the energy landscape

Links created by the energy initiatives' low carbon practices have the potential to alter the energy landscape. We have also identified in our research several ways in which they do indeed create change in the energy landscape. Physically, the initiatives' practices illustrate that they facilitate and focus on locally available resources (suitable rooftops, biomass) to develop their projects. They are also obviously physically altering the energy landscape through the adoption of new renewable technologies. Access to physical resources is therefore often directly linked to spatial planning regulations or land ownership. A key example of a co-dependency relation was identified in the GrunnegerPower initiative, where a housing corporation needed their knowledge to pursue a solar project, while GrunnegerPower wanted to stimulate the uptake of solar PV panels on private rooftops in the city of Groningen: 'We have been asked by Nijestee [the housing corporation] to, well, to approach neighbourhoods where they have houses for rent to see if people want to have solar panels. If so, these people will face an increase in house rent, but this increase will be less than what they would save on energy costs.' (Interview with GrunnegerPower in 2015). The quote illustrates not only the interdependence of linked systems (energy, physical, community, governance), but also that linking them depends on local actors and circumstances. The effect is that the initiatives integrate physical aspects of their low carbon practices into the energy system through links with local actors, such as participating citizens and the owners of buildings with suitable rooftops or suitable land. Artefacts of other systems which had previously not been an integrated part of the energy system, are now being linked.

By working through local actors and circumstances, the energy initiatives are also incorporating their low carbon practices within the community and local economy. Five of the seven initiatives are small-scale cooperatives with a business model oriented towards local collective ownership of renewable energy installations. Earnings are not taken out, but are reinvested as much as possible into the upscaling of local production capacity in the area-based niche. Only the two bio-digester initiatives were also focused on profit-making and had corporate backing. In addition to redistributing finances locally, these practices encourage further social practices among local actors committed to the initiative. These activities include participating in regional support groups (BergenEnergie, DeRamplaan, GrunnegerPower, MorgenGroeneEnergie and Windvogel), sharing experiences and mutual learning (BergenEnergie, DeRamplaan, GrunnegerPower, MorgenGroeneEnergie, Windvogel and EnergiePon), networking and building coalitions (BergenEnergie, DeRamplaan, GrunnegerPower, MorgenGroeneEnergie and Windvogel) and activating the local knowledge, skills and time of volunteers (BergenEnergie, DeRamplaan, GrunnegerPower, MorgenGroeneEnergie and Windvogel): 'Of course this is a prosperous neighbourhood in Haarlem. There are highly skilled people here, people who want [collective solar energy]. Such as this lawyer here. Do I know how many hours I already spent at his kitchen table? I'll bring a bottle of wine along. I enjoy doing this.' (Interview with DeRamplaan in 2015).

The social practices are not limited to the scope of citizens or civil society but also create new institutions and engage existing institutional actors such as municipalities. The initiatives institutionalise their practices in the form of foundations, companies or cooperatives. Regulatory struggles often accompany the institutionalisation of their practices and it is no surprise that five of the seven initiatives are active in lobbying for regulatory changes. Formal agencies are also often involved in actually establishing an initiative: that is, the Ministry of Economic Affairs, the tax authorities and the municipality. Municipalities are particularly often actively engaged, either by contributing resources such as financial support or expertise, or by providing spatial resources such as the rooftops of municipal buildings: 'There is plenty of suitable rooftop surface. [The rooftop of the neighbourhood centre Blixem] was one of the most suitable.' (Interview with MorgenGroeneEnergie in 2015). The municipality even allows them to use municipal rooftops free of charge, since: 'the alternative to the municipality is also zero. Eindhoven therefore said, and that offer is still open, you can use any public roof free of charge. Tell me when you need it.'

This analysis shows a few things: first of all, how the selected initiatives depend on and are fostered by local physical conditions and local social and economic capital. Secondly, the initiatives invest in increasing the local social and economic capital. Thirdly, how the low carbon practices of these initiatives

integrate artefacts and actors of other systems into the energy system, having not been a part of that system previously. Furthermore, their practices suggest to foster key processes for sustainability transitions, such as networking, coalition building, experimenting and learning, as discussed by various scholars (e.g. Berkes, 2009; Nevens, Frantzeskaki, Gorissen, & Loorbach, 2013). Combined, the initiatives studied contribute area-based innovation and initial changes of the energy landscape.

5. Discussion and conclusions

This paper presented an area-based approach to analyse the role of local energy initiatives in energy transition. The analysis of the links between initiatives and their contexts suggests that local energy initiatives can influence energy transition on the basis of the following three arguments: the initiatives (i) create new interaction paths in the energy landscape within and across the six systems; (ii) create new interaction paths in the energy landscape within and across the four scales; and (iii) noticeably contribute to some initial changes in the energy landscape. Since the initiatives tie systems and scales together in an area-based niche, the initiatives can also be considered relevant focal points in energy transition.

The findings indicate that the potential role of local energy initiatives for energy transition as focal point stems from their multifaceted practices which ties actors and artefacts from several systems and scales together. This explanation is supported by other research, indicating that the multiple objectives of local energy initiatives typically result in multifaceted practices which spur innovation—as also observed elsewhere in the Netherlands and other countries such as the UK and Germany (Hielscher, Seyfang, & Smith, 2011; Seyfang, Park, & Smith, 2013; Hoppe et al., 2015). Further research is called for to compare the linking of local energy initiatives with the linking of other actors, such as conventional fossil oil companies or large-scale wind farm developers, and to compare their respective contribution to change of the energy landscape with help of a longitudinal analysis.

Regarding the validity of the findings, two methodological issues are relevant to mention. Firstly, for constructing the link maps of the initiatives, semi-structured interviews were conducted next to desk research. The data we could gather in the interview time were limited, as was the data available through desk research. It is possible that more links could have been identified if a more extensive empirical research was conducted. However, it is not to be expected that important and strong links were not mentioned in the interviews, since such links are easily identified and the interview topic was not politically salient. Secondly, the data were coded and classified into systems and scales manually by the authors. It is possible that others would have classified certain links in other categories.

In the light of the landscape literature, the findings on the initiatives indicate that daily practices indeed contribute to shaping the physical and social landscape as Olwig (2007) described. This is the result of the interaction of the initiatives with physical artefacts and social actors in their environmental surroundings. However, whether also perceptions of people shape the landscape as Olwig (2007) described, cannot be disclosed with our research approach, since the perception of people about their local landscapes has not been studied. In a similar way, the findings on the interaction of artefacts and actors seem to confirm that the landscape is 'an area' and 'the result of the action and interaction of natural and/or human factors' as the European Landscape Convention (Council of Europe, 2000) described. However, whether this also changed the *character* of the landscape 'as perceived by people' as the Landscape Convention described, would require additional research. Rather, the area-based approach to the energy landscape of this research, provided an entry point to connect the geographical landscape to a metaphorical landscape; an energy landscape composed of several systems and scales surrounding the area-based niche. Such a metaphorical landscape composed of systems seems close to the metaphorical use of the landscape level in transitions research (Geels, 2005). Arguably, the strength of the concept energy landscape is that it allows for both geographical and metaphorical uses of the term landscape.

The multifaceted practices cut across the systems and scales of the energy landscape. By tying systems and scales together in the initiative's area-based niche, information, resources and matter can

flow via new paths through systems and scales. The links between the initiative and several systems at several scales facilitate the percolation of information related to low carbon practices throughout the systems and scales of the energy landscape. Since the interaction of local initiatives with their contexts is not just local, but is reaching out to higher scales of the energy landscape, local initiatives can play a bigger role for energy transition than you might expect on the basis of their local practices. The interaction within and across systems and scales in response to the initiatives' low carbon practices could thus engender co-evolutionary pathways which are considered necessary for a transition towards a low carbon energy system (e.g. Geels, 2005).

These practices mean that local energy initiatives are relevant focal points for spatial planners and policy-makers who aim to pursue a low carbon energy landscape. Firstly, the regulatory struggles experienced by energy initiatives illustrate that the current institutional setting is not adapted to their practices, which link so many systems and scales together in a single node. Planners and policy-makers can foster the emergence of local energy initiatives by creating procedures and regulations, such as subsidies and permits, which condition the linking across several systems and scales. This may enable not only the spreading and upscaling of the low carbon practices that these local energy initiatives develop, but also of synergies between the systems in the energy landscape. Secondly, ideas of area-specific/place-based planning (e.g. Barca, McCann, & Rodríguez-Pose, 2012) and shared-governance may be considered, which highlight the importance of collaboration with local actors for learning, coalition-building and establishing synergies. These ideas could facilitate the collaboration with energy initiatives and other local actors for accommodating low carbon energy within the energy landscape. Finally, the challenge of supporting energy transition through spatial planning can be facilitated with our conceptualisation of the energy landscape. Lessons can be drawn from the initiatives about the kind of links needed in the energy landscape for an energy transition. Our conceptualisation could help focus on intertwining actors and artefacts within and across several systems and scales in order to engender co-evolutionary pathways of change.

Note

1. In geography, the first appearance of the concept energy landscape was arguably the wind energy landscape by Thayer and Freeman (1987). Outside the field of geography, the concept was first used to describe the effect of shade from horticulture in terms of high- or low-energy landscapes on conserving energy in homes (Buffington, 1979) and since the 1980s in protein physics for describing the energetics of protein folding as an energy landscape (Bryngelson, Onuchic, Socci, & Wolynes, 1995).

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