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Exploring the transition potential of renewable energy communities

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ABSTRACT

Renewable energy communities are grassroots initiatives that invest in 'clean energy' in order to meet consumption needs and environmental goals and thereby – often unwittingly – conduce to the spread of renewables. Our aim in the present study is to explore the potential of renewable energy communities in the Netherlands, as social niches, to contribute to transitions in the energy system. To do so, we propose three proxies for measuring the transition potential of social niches, based on proxies for technological innovations derived from the literature. In addition, we reinterpret the notion of niches and the way transition occurs by arguing that niches are complex systems in which both technological and social innovations develop simultaneously and that during a transition entire niches link up with the regime. Furthermore, we make a distinction between internally and externally oriented niches based on their orientation and application focus. We use a comparative case study analysis complemented by a systematic literature and documentary review to show that these communities are already changing the Dutch energy system, by connecting to regime actors. Their further advancement depends on strengthening their links to established actors, but also on providing a favorable regulatory framework.

1. Introduction

Transitions, that is, large scale transformations of a societal subsystem, offer a specific way to conceptualize futures: as long-term processes which involve radical shifts to novel configurations, and mobilise multiple actors (Verbong & Loorbach, 2012). In transition studies, these processes are typically assumed to have an explicitly normative orientation, focusing on the elusive concept of sustainability: for instance energy transitions have been advocated to address multiple challenges that the energy system faces, such as rapid depletion of resources, air pollution, greenhouse gas emissions, energy poverty and nuclear risks (Markard, Raven, & Truffer, 2012). The literature is less clear about the agents of this energy transition, and the concrete activities that can lead to transitions, even though several methods are advocated, such as strategic niche management (Schot & Geels, 2008) and transition management (Loorbach & Rotmans, 2010), which both build on the multi-level perspective (MLP). However, these transition theories have been criticized for, among other reasons, neglecting agency

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(Geels & Schot, 2007; Hoffman, 2013; Smith, Stirling, & Berkhout, 2005; Vasileiadou & Safarzyńska, 2010) and putting too much emphasis on technological niches (Berkhout, Smith, & Stirling, 2004; Geels, 2005), even though some more recent work has tried to address both challenges (Neuvonen et al., 2014). In addition, grassroots initiatives have been somewhat neglected as potential niches (Seyfang, Hielscher, Hargreaves, Martiskainen, & Smith, 2014) in which both technological and social innovations can develop (Seyfang & Smith, 2007).

In this article we introduce a special type of grassroots initiative, namely renewable energy communities (RECs), which can be drivers of energy transitions. Such communities produce or invest in the production of renewable energy to cover their own energy needs, and they have become quite numerous over the last decade in many western countries[*]. Exploring the transition potential of such communities enables us to also take a new perspective on sustainability transitions into account, focusing not on the technological aspects, but on social aspects and the agents behind sustainability transitions. As such, we view niche activity as fundamental in bringing about such transitions.

The question we address in this paper is to what extent renewable energy communities, as social niches, have the potential to scale up and contribute to energy transitions. To answer this question, we introduce three proxies for measuring the transition potential of social innovations, based on Geels and Schot's (2007) four proxies for measuring the transition potential of technological innovations, and we examine some of these communities. For our analysis, we use the results of a comparative case study, which focuses on four different cases in the Netherlands. We provide an overview of the state of RECs in the Netherlands, from both demand side and supply side perspectives, examining all the services, as well as legislation and policies in force that are related to them. In addition, through our cases we illustrate the heterogeneity of communities with regard to their locations, size, technologies and motivations.

Thereby we contribute to transition studies, by focusing on elements that are rarely taken into account, namely: demand side factors as well as the role of civil society in transitions. We further elaborate the notion of niches, in order to provide a comprehensive answer on how social innovations evolve and transform the incumbent energy system. Thus, besides studying the state of renewable energy initiatives in the Netherlands from the transitions perspective, we also contribute to a better understanding of sustainability transitions.

2. Theoretical framework

2.1. Multi-level perspective

To study the transition potential of renewable energy communities we use the framework of the multi-level perspective (MLP), which helps us gain a better understanding of socio-technical (ST) transitions, how innovations emerge and how they shift the incumbent regime toward sustainability. The MLP distinguishes between three interdependent system levels through which transition occurs: the landscape, the regime and the niche levels. The three socio-technical levels are forming a nested hierarchy and their co-evolution is necessary for transition. According to the traditional or niche-driven typology of transitions (Quitzau, Jensen, Elle, & Hoffmann, 2013), the regime is in favor of incremental changes, which reinforce the dominance of current actors and technologies; therefore only radical changes can induce transition (Elzen & Wieczorek, 2005). When mismatches occur at landscape level or within the regime 'windows of opportunity' arise, where radical innovations (innovations that are fundamentally different from solutions used by the incumbent regime and that consist in a high degree of new knowledge (Dewar & Dutton, 1986)) can break through and enter the meso-level of the ST system.

Accordingly, sometime after new radical technologies have emerged in niches, they can leave these protected spaces, take over from the incumbents and, together with wider changes, form a new regime (Geels, 2004). This process takes place step by step, when changes in one element of the regime (e.g. the emergence of a new technology) induce changes in other elements, thereby reconfiguring the entire system. Consequently, new regimes may grow out of old ones (van den Ende & Kemp, 1999).

2.1.1. Landscape

The macro or landscape level represents external processes and factors that influence the regime, and it is beyond the control of the meso-level's actors. A distinction can be made between slow changes (such as macro-economic or macro-political developments, cultural or demographic changes, climate change) and relatively rapid developments that can create an external shock to the regime (such as wars, oil or economic crises, floods, extreme droughts, etc.) (Geels, 2005). Changes at the landscape level either reinforce the incumbent trajectories or put pressure on the regime. This pressure destabilizes the regime's structure and creates windows of opportunity, where radical innovations can break through (Geels, 2002).

[*] http://www.rescoop.eu/rescoop-map

2.1.2. Regime

The socio-technical regime is a semi-coherent set of rules put into practice by different social groups and located between the landscape and niche levels (Geels, 2002). Within the socio-technical regime several sub-regimes can be found (science regime, policy regime, socio-cultural regime and the users, markets and distribution networks regime), which represent different social groups and which are aligned to each other by rules. The ST regime, however, does not include the entirety of these regimes; it is rather a grammar or rule set among them (Geels, 2004). In contrast, Safarzyńska, Frenken, and van den Bergh (2012) define the regime as a combination of tangible and intangible elements which encompass besides rules also material artifacts. Alkemade, Frenken, Hekkert, and Schwoon (2009) describe the regime as an interdependent complex system composed of numerous combinations of subsystems. They argue that it is built up from several interdependent subsystems combined in different ways, which determine the fitness of the regime; all possible combinations of subsystems form the design space of the regime.

Thus, within the socio-technical regime, several sub-regimes representing different social groups are linked to each other by a semi-coherent set of rules. The rules that connect them determine the development of innovations that, according to Geels (2002), at the regime level are merely of an incremental nature. This provides stability to the regime, which is resistant to radical change.

Transition scholars agree that the regime is characterized by path dependence and lock-in (Unruh, 2000), which reinforce the dominance of the incumbent actors, technologies, rules, institutions, practices and infrastructure, thereby stabilizing it.

2.1.3. Niches

Niches form the micro-level of the socio-technical system; they provide protected spaces for innovations (Geels, 2004). Niches create special conditions for new technologies, which would not be able to succeed under market circumstances due to their low technical or economic performance. The niche actors are assumed to develop innovations with the intention that they will be used in the regime or even that they become the dominant technologies in the regime (Geels, 2011).

Nevertheless, the MLP theory has been criticized by several scholars (Kern, 2012; Markard & Truffer, 2008; Smith, Voß, & Grin, 2010), among other reasons, for focusing exclusively on technology and neglecting thereby social and cultural aspects in transition (Geels, 2005) and for referring to innovations as technical artifacts without considering other options, such as social or grassroots innovations (Seyfang et al., 2010). The MLP underplays the effects of social and cultural aspects that co-evolve with technologies during a transition (Genus & Coles, 2008). Addressing these criticisms, recent Strategic Niche Management (SNM) literature makes a distinction between market niches (small market segments), technological niches (a sort of 'laboratories' for experimenting with new technologies) and social niches, which refer to specific social groups, such as NGOs, governmental organizations or local communities that develop new methods and solutions for their own social problems (Witkamp, Raven, & Royakkers, 2011). A social innovation that develops in a social niche is thus not simply an artifact as a technology, "... but a new way of doing business and solving a social problem driven by an emerging social group" (Alkemade et al., 2009 [21 p. 672]). Technological innovations in this respect are not at the center of the niche, but they rather serve as tools for addressing social needs. Renewable energy communities can thus also be regarded as social niches that introduce social innovations in the electricity market, because they combine production and consumption in the household segment, which results in new forms of organizations, business models and institutions (Arentsen & Bellekom, 2014; Huijben & Verbong, 2013).

Another shortcoming of much early MLP work is the assumption that all niches have the same purpose, and that the intention of niche actors is to induce transition. Geels and Raven (2006 [23 p.379]) argue that the niche actors "... are willing to invest resources (money, people) in projects, if they have a shared, positive expectation of a new technology". Indeed in much early MLP and SNM work, the expectation is that niche actors develop innovations, which would break through in the regime at a later stage (Raven, 2012). However, it is also possible that niche actors do not have the primary aim of 'sending' the technology into the regime.

Building on this, we argue that niches can differ with respect to their actors and their purposes. Niches created by market actors who want to invent and develop new technologies for later regime use are different from social groups which have specific needs that cannot be satisfied by incumbent regime products. This latter groups' (such as grassroots communities or the army) purpose with the niche creation is to nurture innovations that are able to meet their special needs, and it is possible that they only aim at internal use of the innovation. Consequently, a distinction can be made according to the orientation focus of niches, thereby defining *externally* and *internally oriented niches*. Furthermore, we can also differentiate them regarding their application focus. The *externally oriented niches* are organized around a technological innovation and the other components of the niche are subordinated to it. Contrarily, in the *internally oriented niches* the emphasis is not on the technology itself: technologies serve more as tools that actors use for their special purposes. In this case social innovations can play as important a role as the new technologies. This distinction between internally and externally oriented niches fits well the distinction of Witkamp et al. (2011), in that most social niches are internally oriented, whereas market and technological niches are typically externally oriented.

In Section 3, we analyze renewable energy communities, which, as we will argue, form an internally oriented niche. These communities aim for local clean energy production and they are driven by a common social need, namely to produce energy independently, and by different values, such as environment protection, patriotism by supporting the local economy, or the value of working for the community. Hence their primary goal is to meet these expectations and

innovations (both technical and social innovations) are the tools serving these purposes. Thus they have no direct aspiration to develop innovations for later regime use, but only do this for internal utilization. Consequently, RECs constitute an internally oriented, social niche. Even though internally oriented, RECs still have the potential to enter the regime and contribute to energy transitions, for instance through a trajectory of emergent transformation of the regime, configuration pathways, or even technological substitution (Geels & Schot, 2007). Indeed Smith et al. (2005), when describing different transition contexts, suggest that regime transformation may be unintended, and uncoordinated—a contingent outcome of historical processes. We now turn to examine the transition potential of RECs as social niches, by introducing three proxies based on previous studies.

2.2. Transition potential

In order to answer our research question, first we have to define proxies according to which we are able to assess the transition potential of social innovations. Geels and Schot (2007) introduced four proxies for technological innovations. The proxies are the following: ''(a) learning processes have stabilised in a dominant design, (b) powerful actors have joined the support network, (c) price/performance [ratios] have improved and there are strong expectations of further improvement (e.g. learning curves) and (d) the innovation is used in market niches, which cumulatively amount to more than 5% market share'' (Geels & Schot, 2007). Even though they are certainly useful, they are still oriented towards technological innovations. In case of social innovations the first two proxies are still relevant, but they have to be reinterpreted in terms of the social novelties. In addition, we introduce a third proxy, namely the heterogeneity of the niche that, as we will argue, also influences the transition potential. These proxies will be applied too in RECs in Section 3.

2.2.1. Stabilized learning processes at global system scale

Geels and Schot's (2007) niche interpretation is based on the MLP definition that sees niches as laboratories where technological innovations develop that leave this protected space when transition occurs. However, for assessing the potential of RECs to lead to transition, we need to avoid the exclusively technological focus at the niche level. Indeed RECs are not about developing a technological innovation, but introduce social innovations, new energy production practices, new behaviors for supporting and managing social groups and new solutions for solving energy autonomy problems. In order to include social and cultural elements in our interpretation of transition, we need a different understanding of niches. We see niches rather as complex systems that consist of all the system elements which can be found in the regime, for instance financial network, suppliers, producers, users, even if they are less developed and not articulated that well.

In other words: in niches certain social groups can develop innovations, not only technological, but also social innovations: new strategies and practices that strengthen civil society and meet social goals (Mulgan et al., 2007). In contrast to the incumbent regime actors, these social groups have a special interest in the innovation and that is why they are willing to invest money, time or energy and take also the risk of failure. Since the innovation might not survive in market circumstances, they have to create the necessary physical and social infrastructure. Thereby a whole new system develops with all the system elements, similar to the socio-technical regime. Niche actors form the user and distributor network, which is built up around the innovations. The practices they use and the patterns they establish provide the socio-cultural elements of the new system. In case the niche reaches a certain size with a large number of actors or generates special features that cannot be regulated by the incumbent rules, or due to the strong advocacy power of the niche actors, the government can be expected to establish new policies specifically targeting them.

Geels and Raven (2006) conceptualize niches as proto-regimes that have a structure similar to the regime, although they consider only the developing network among similar local niches that share the knowledge and practices with each other thereby forming a global niche (with 'global' in this context referring to the whole socio-technical system). Similar to our suggestion of niches as complex systems, Raven (2012) modeled the development of the niche from local to global niche-level in five steps, starting with (1) formation of local groups and (2) experimenting with socio-technical innovations, followed by (3) sharing of knowledge and practices with other local groups that lead to (4) the formulation of generic rules and lessons at the global niche-level, resulting in (5) stable and institutionalized forms thereby creating a proto-regime. Markard and Truffer (2008) also claim that niches are protected spaces, which are similar to the regime in their structure; although the scale of aggregation and stability is much lower in this case.

In summary, niches at local scale that share goals, experiences, practices and knowledge can be considered as one global niche, which thereby becomes a proto-regime (Hielscher et al., 2011). Thus according to our interpretation of Geels and Schot's first proxy (Geels & Schot, 2007), relevant indicators for measuring the transition potential of social innovations are the common knowledge and goals, as well as the generic rules and lessons that local niches share at the global scale of the socio-technical system.

2.2.2. Support by powerful regime actors

As the MLP theory describes it: transition is a complex process, which requires transformations at all three system levels. Pressure on the regime level provoked by either external landscape processes or internal regime processes opens windows of opportunity where innovations can break through and become dominant (Geels, 2004). Yet, it is not explained what happens

to all the other dimensions of the niche when the innovation leaves the protected space and enters the regime. Do they disappear?

This question implies another interpretation of transition: as we discussed above, we see niches as complex systems; when transition occurs the elements of this complex system establish links to incumbent social groups—niches are thus able to influence and change regime elements through the networks they create and form. Consequently, the entire niche that represents the rule set of new social groups is able to enter the ST regime by creating links between its sub-elements and sub-regimes, thereby destabilizing and shifting these parts of the regime. Moreover, Quitzau et al. (2013) claim that such link up is not just a one sided process, but that in some cases incumbent actors initiate the modification of already existing practices and rules, by this means creating space for radical innovations. This process may trigger changes in the entire ST system; however, it does not necessarily lead to its complete transformation.

As Geels and Schot (2007) also suggest, to assess the transition potential of a niche, it is also important to examine the capacity of a niche to build many and strong links to the sub-regimes and thus gain the support of powerful regime actors, for instance, financial institutions, or policy makers. The more and the stronger links (i.e. financial support, information exchange, education, political lobbying, etc.) the niche is able to set up, the stronger its position becomes in the ST regime, which is more likely to result in a successful transition.

Consequently, the breakthrough of the niche and transition can take place, if the niche is able to attract a large number of regime actors and to create strong links with social groups in the sub-regimes. By this means the niche is partly building on the existing regime, but at the same time it alters it and shifts it in a new direction. Therefore we can use as an indicator for the second proxy the types, amounts and/or strength of links between niche and regime actors.

2.2.3. Heterogeneity

In addition to the first two proxies to assess the transition potential of social niches based on Geels and Schot (2007), we introduce a third proxy: the heterogeneity of the niche. We argue that heterogeneity is a prerequisite for these communities to have the potential for scaling up (Seyfang & Smith, 2007).

Certainly, social groups that are different from the incumbent regime actors, because they share different values or social needs, can grow to their maximum capacity (Seyfang & Smith, 2006). However, without attracting more actors from the regime, they will never break out of the niche level. Seyfang and Smith (2007) distinguish two types of grassroots innovations. The first one does not seek to transform the regime and remains in the grassroots niche and the other one can diffuse and change the regime (Seyfang & Smith, 2006). Grassroots innovations that position themselves in opposition to the incumbent regime and share a specific ideology, thereby forming homogeneous groups, have difficulties scaling up and attracting a wide range of actors from mainstream society. Therefore, the sharing of a homogeneous ideology as motivation behind the formation of the niche leads to difficulties in scaling up. On the other hand, those grassroots communities which can create a new 'system of provision', can generate transformation in production and consumption patterns and can create new institutions that provide better solutions for a large variety of actors within the regime, have the capacity for transition. We expect that niches that are heterogeneous enough in terms of the variety of the actors, their motivations, the innovations they use (e.g., within the broad category of RECs, different groups can use wind, solar, biomass or other technologies depending on their special needs and resources) and the conditions they are operating under, have the potential for regime transformation.

This argument about the criterion of the heterogeneity of niches for determining transition potential relates to the suggestion by Hoogma, Kemp, Schot, and Truffer (2002) that the breadth of the niche actor networks is important for learning to occur: networks dominated by regime insiders hinder second-order learning and niche development. Raven (2012) also points to the important role of a diversity of actors and local sites in Danish wind energy niche building. Therefore, with respect to RECs as social niches, the proxy of heterogeneity can be understood in two different ways:

(1) heterogeneity of the communities regarding their size, location, the technology they use—since these are the most important characteristics of renewable energy communities;
(2) heterogeneity of the members in terms of their motivations, education or financial status—which relate to the ideological homogeneity described elsewhere (Seyfang & Smith, 2006).

In summary, the proxies and their indicators for measuring the transition potential of social niches are the following:

The three proxies we introduce are treated as analytically distinct, but they are actually mutually influencing each other, in a feedback loop: for instance, the more heterogeneous the niches are, the more actors of the regime it can draw, and the stronger the networking across the niches is as well. In addition, the more heterogeneous the niches are, the stronger are the learning effects. There may also be negative feedback loops: the niche networking and learning process may endanger innovation, as it could lead to some sort of convergence, or closure of technological and behavioral solutions across the niches. However, the heterogeneity of the niches prevents such a convergence, and can ensure that learning leads to different and not uniform technological and behavioral solutions.

3. Analysis

3.1. Methodology

The empirical analysis is based on systematic literature and documentary review including reports and websites of organizations that focus on RECs in the Netherlands, collected in the period 2012–2013. This data was then examined using the different indicators outlined in Table 1 above.

In addition, to assess the proxy of heterogeneity, we conducted four case studies in the Netherlands based on 22 semi-structured interviews with members of RECs, both with the frontrunners, who initiated and invested more time and effort in these projects, and with average members, whose contribution was smaller. In each case we had a contact person, who helped us to get in touch with other community members, so we could do face-to-face interviews usually by visiting people at their homes. The interview guide covered, among other things, the personal motivations for participating in a joint investment project, the way they organized the procurement of the technologies, the barriers they faced, the partners they cooperated with and the institutional help they received. In addition to the community members, we also interviewed companies and local municipalities that helped the communities.

Thus, we use global niche-level data to assess learning processes and support from regime actors, while we use the case study material to assess heterogeneity. The latter was deemed necessary to delve into the motivations of individuals, which could help us assess whether the communities had mainly ideological reasons or not. Table 2 (below) clarifies the type of data we analyzed for each proxy, and their accompanying indicators.

The scope conditions for our research population were: (1) the community that invested in renewable energy is located in the Netherlands; (2) the investment is a citizen initiative; (3) the members of the initial investment community (people who bought the technology) live in the same location/region; and (4) all the members of the investment community are shareholders in all or at least one of the technologies. We made a distribution-based case selection, since diverse cases of the population will better reflect the full variety of cases. Consequently, we chose four cases from different locations (village, small town and city), with different sizes and with different technologies and resources (wind, solar, biogas and thermal water).

The selected cases are the following: (1) TexelEnergie, which grew into an energy delivering and producing company from a local citizen initiative, and which today has more than 3000 shareholders; (2) a houseboat neighborhood in the area Amsterdam Zuid that conducted collective procurement of solar PVs; (3) a collective procurement of solar PVs in a dwelling house in the city of Leeuwarden; and (4) a community in the town Culemborg, which took over the local heating company and now provides heating to the district of Eva-Lanxmeer in the town.

3.2. To what extent do RECs share stabilized learning processes, forming thereby a global niche?

For assessing the transition potential of RECs we start with exploring how RECs at local scale network with each other. Since we want to show how separate communities connect, learn from each other, use the same practices and join for a common goal, thereby forming one global niche, in this sub-section we provide a broader picture of them based on the literature and documentary review we did.

Citizen initiatives dealing with energy are rooted back to the end of the 80s in the Netherlands. There are no precise data on the number of Dutch RECs; however, we can estimate that it lies somewhere between 150–300 (Schwencke, in press). Although RECs usually work independently and try to develop their business plans for the procurement and installation of the renewable technology on their own, today there are already several platforms, networks and organizations that provide help for them and maintain websites, publish newsletters and organize workshops or education clubs (*HIER opgewekt*, *Nieuwe Nuts Innovatie Netwerk*, *Wij krijgen kippen*, *LDEB*, *Rescoop*, *Organisatie voor duurzame energie*, *E-decentraal*, *Stichting ODE* and *Energie Plus*). Through these platforms communities can learn from each other and be up to date about all the important aspects and news that are necessary for their establishment and operation. In this way separate communities get to know each other, form a social network and learn how to adopt the best practices and how to cope with problems.

Table 1
Proxies for assessing transition potential and accompanying indicators.

	Proxy	Indicators
1	**Stabilized learning processes and generic rules** that all the similar local niches share at the global system scale	-Common knowledge and goals or projects -Generic rules and lessons -Events, associations and platforms for networking
2	**Support of powerful regime actors** through links with sub-regimes that strengthen the collaboration between niche and regime actors	-Links with powerful regime actors from different sub-regimes -Strength and/or breadth of links
3	**Heterogeneity of the global niche** with respect to its communities and members	-Community heterogeneity: size, location, technology -Member heterogeneity: motivations, education, financial status, age

Table 2
Proxies for assessing transition potential, accompanying indicators and the data used.

	Proxy	Indicators	Data used
1	**Stabilized learning processes and generic rules** that all the similar local niches share at the global system scale	-Common knowledge and goals or projects -Generic rules and lessons -Events, associations and platforms for networking	-Global niche-level: Document analysis, based on annual reports, website documentation, legal documents, consultancy reports, minutes of workshops and various events
2	**Support of powerful regime actors** through links with sub-regimes that strengthen the collaboration between niche and regime actors	-Links with powerful regime actors from different sub-regimes -Strength and/or breadth of links	-Global niche-level: Document analysis, based on annual reports, website documentation, legal documents, consultancy reports, minutes of workshops and various events -Four case studies
3	**Heterogeneity of the global niche** with respect to its communities and members	-Community heterogeneity: size, location, technology -Member heterogeneity: motivations, education, financial status, age	-Four case studies (interviews and document analysis)

Moreover, there are several campaigns for collective procurement, which aim to incentivize people to buy solar PVs or windmill shares collectively (*Windvogel*, *Zeeuwind*, *Urgenda*, *Betere Wereld*, *Natuur en Milieu*, *Vereniging Eigen Huis*, *ZonEffect*, *MetdeZon*, *Zutphense Energie Transitie* and *SolarBlitz*). *Nudge*, for example, has a specific campaign, in which they are looking for so-called district mayors, people who would gather local citizens and organize the procurement of solar PVs for them with help from *Nudge*, thereby facilitating the creation of new RECs.

Other organizations (e.g. *Zon op Nederland*) facilitate communities whose members have no space for installing solar PVs on their own properties, to collaborate with farmers or institutions (schools, offices) that can have their roofs rented by the community. One example is *Energie van boer en buur*, a citizen initiative which, together with farmers, invests in solar PVs that are installed on the stables and sheds of the farmers. In its first version citizens contributed €250 to the project, for which they got vouchers in the value of €300 for which they could buy products from the farmers. In the second version of *Energie van boer en buur* there are 27 farms involved throughout the country and the community members invest €300 in exchange for shares and electricity supply (Schwencke, in press). In many cases these campaigns and organizations grew out of local initiatives, and solutions or procedures that a renewable energy community used once pass on to the others. In this manner they create patterns and new practices that become knowledge capital of the niche.

However, the most important and striking example showing that these communities form a global niche and share common goals, is the organized lobby work aimed at the government for the extension of the so-called 'saldering' law. Currently, people are not allowed to supply their own electricity without paying VAT and energy tax, if it is not produced behind their own meters. It means that, in case the electricity installation is not located on the property of the owner, but somewhere else, and the produced electricity is fed into the grid, the person has to pay VAT and energy tax on top of the electricity price that he could sell the energy for, when he buys it back. In case the electricity is produced on the owner's property, the producer is exempt from the taxes and VAT up to 5000 kWh per year. This is called 'saldering' (which can be translated as: 'balancing'). However, the regulation cannot be applied either on individual investments in case they lack space for the installation on their own property, or on collective energy production. Therefore, several RECs, together with networking organizations such as the *Wij krijgen kippen*, *Windvogel*, *Klimaatverbond* and *Amsterdam Stadsdeel Zuid*, and with the support of companies (e.g. *Greenchoice*, *Liander* and *ASN*) and university professors wrote a petition and lobbied extensively for the expansion of the *saldering* law to also include collective self-supply[†].

Reviewing all these examples we conclude that RECs in the Netherlands can indeed be regarded as one global niche, through stable learning processes organized by several platforms, which encompass all the elements that can be found in the ST regime. They share common knowledge and goals and they become the locus of social innovations in the form of new practices and behavioral patterns.

3.3. To what extent do RECs have the support of powerful regime actors through links with sub-regimes?

To collect examples for the links that RECs have established with sub-regimes and for the support they have gained from regime actors we used both the data we collected through reports and websites of organizations that deal with RECs in the Netherlands, and also the data from our interviews.

In general we can state that RECs in the Netherlands have already created several links with sub-regimes. There are numerous national and provincial measures to support the establishment of such communities or help their operation,

[†] http://www.wijkrijgenkippen.nl/wp-content/uploads/2011/04/Green-Deal-verruimde-saldering-13-april-def.pdf

suggesting that regional and, to an extent, national authorities are supporting RECs. Green Deals are especially targeting them by eliminating obstacles. Firstly, the national government provides financial help for such initiatives through the MKB+ (*midden en kleinbedrijf*—small and medium business) Innovation Fund and tax deduction for research and development. Secondly, the government helps as mediator in matchmaking and negotiating with all parties involved in community projects. Finally, it tries to reduce unnecessary administrative burden and other legal obstacles. In addition, at provincial and local level we also find cases where the government contributes to the realization of community projects. The municipality of Amsterdam, for example, started a pilot project that provides an alternative solution for the lack of collective *saldering* law. The residents of an apartment complex can do virtual *saldering* for the electricity produced by their solar PVs set up on their roof.

And not only the government supports RECs, but also companies see the potential in this niche and establish links with it. *Greenchoice* and *Aliander*, for example, offer specific leases and loans, they help in the administration of local energy cooperatives, or also find alternative solutions for collective *saldering*. *Windvogel* supports local energy initiatives financially. *Trianel*, *Eneco* and *Anode* offer support services, act as intermediaries, use their formal and informal networks in lobbying for self-supply or make Green Deals with the communities. Moreover, in case a community is not able to organize the project itself and needs additional help, there are also several consultancies that are specifically helping local renewable energy projects, such as *Relocal*, *C8 foundation* and *Eversheds Faasen*. Finally, there are several banks, like *Triodos bank, Rabobank* and *ASN bank*, that give special loans and also services. *Rabobank* has specialists that support energy cooperations and *Triodos* organizes a master class about financial models for energy initiatives.

In our cases we also saw many examples of cooperation with regime actors. In Culemborg the local municipality invested €3000 in the Thermo Bello project and it also gave a financial guarantee to the bank for the loan (€70,000); thereby the community could get a two percent lower interest rate from the bank. The alderman helped the community to lobby at the provincial level; thereby the Province of Gelderland supported the necessary expansion of the pipelines for the distribution of the heat with €150,000. In the case of the dwelling house in Leeuwarden, the local government provided an expert who helped the community realize the project. When the residents from the houseboat area from Amsterdam wanted to invest in solar PVs, the technology supplier saw the potential in a community project and offered reduced prices, if the people did collective procurement. Finally, the community in Texel cooperated with a local energy company whose professional help was crucial for the realization of such a project.

As we see, there are different links established with the regime. The policy sub-regime regards RECs important enough to create policies for their support, and actors from different governmental levels provide financial and professional help for the investments. There are also actors from the market, distribution and financial sub-regimes that see the potential in these communities and help their establishment and operation by providing loans, support services, or by using their official and unofficial networks for lobbying in their favor to the government. Finally, NGOs and associations that operate in the socio-cultural sub-regime and try to change the carbon dependency of the ST regime from the inside, view RECs as a potential alternative to the fossil based energy system and therefore they support them and set them as examples for incumbent regime actors.

3.4. To what extent are RECs heterogeneous in terms of actors, technologies and conditions under which they operate?

Using the third proxy and its indicators for determining the transition potential of RECs we turn our focus to the level of heterogeneity regarding the communities (size, location and technology) and their members (motivations, education, financial status and age). The assessment of this proxy mostly relies on the data we collected in our cases.

We found that the communities were different in their size (ranging from small communities with a few members to large communities having 3000 members), in their location (an island, a house-boat neighborhood in Amsterdam, a district of a small town or a dwelling house), and in the technology they use (solar PVs, water pumps, wind mills and a starting project on a biomass power plant).

Case 1. The biggest community studied is located in Texel, an island in the north of Holland with a population of 13,644 inhabitants. Around one fourth of the inhabitants are members of the renewable energy community, which has grown into an energy company. TexelEnergie delivers renewable energy, electricity and gas to businesses and private clients in Texel and in the rest of the Netherlands. TexelEnergie buys and sells not only renewable energy, but also produces it from solar PVs and windmills. Currently the company is also working on a biomass and a smart-grid project. The idea of TexelEnergie was conceived by three local citizens who wanted to support the local economy and help the island to become sustainable. After the involvement of nine other residents, they started the energy initiative in 2007. The news spread on the island and by the end of the first year 600 people joined the project; now there are 3000 shareholders of the company.

Case 2. A house boat neighborhood in Amsterdam Zuid constitutes the second renewable energy community studied, which has 50 members. Four local people started the project in 2008, when they wanted to buy solar PVs on their own, but they got an offer from a supplier that, in case they bought PVs in large quantities, they could get them at a reduced price. That is why the four initial citizens involved other people from the neighborhood, who found the option of environment friendly energy production attractive, and the project became a big success. Therefore, the collective procurement was repeated in the two following years.

Case 3. Our third case is a residential community in a dwelling house in Leeuwarden. Eleven households from the building participated in the project, which was initiated by two residents who wanted to make use of the large roof by installing solar PVs. The energy they produce is used by the whole building (association of the owners) and not by individual households; the rest of the energy is sold to the grid. Their main motivation was producing clean energy to protect the environment; besides that, they found it "exciting" to work together and they wanted to gain some profit too.

Case 4. Our final case is different from the previous ones in the sense that the community produces heat and not electricity from renewable energy. Thermo Bello is a district heating company owned by residents in the district EVA Lanxmeer, which is located in Culemborg, a small town near Utrecht. The story of Thermo Bello started in 2006, when Vitens, a public water company wanted to sell its subsidiary, a local heating system. The company distributed heat that is produced in the process of cooling down drinking water. The director of Vitens wanted to sell the heating system as soon as possible. Since there was no big company interested in this system at that time, even though he offered it much under market price, he also asked the local municipality and the association of house owners whether they wanted to buy it. Although the municipality didn't show any interest, there were four residents who saw potential in it and decided to investigate the option of setting up a local energy company and taking over the heating system. Sixty-eight people from the neighborhood participated in the project and contributed either financially or actively to the process. They had diverse motivations. Firstly, they were afraid that Vitens would sell the heating system to a big company, which would then increase the heating price and not give the residents any control. Secondly, they saw it as a challenge and they found it exciting to realize such a project. Finally, they also had ecological reasons. Through a well-managed local community company they could save a lot of energy, which is good for the environment.

Our cases show also heterogeneity in terms of their members. Firstly, we found individuals with heterogeneous motivations in each of the cases. Most of the people claimed that the protection of the environment was their main intention for participating in the project, but also the expected financial benefits played an important role in their decision. Besides that, people who actively participated in the organization process found it a good opportunity to get to know their neighbors and do an inspiring and creative project with them. Furthermore, newcomers found it a great opportunity to get accepted by the community and it made their integration easier.

Secondly, each case is rather heterogeneous in terms of the education level, financial capital and age of the people involved. The community in Amsterdam Zuid is the most striking example of this heterogeneity, with, on the one hand, old, mostly lower educated working-class residents that moved to the house-boats neighborhood in the 60s and 70s, because they did not want to fit in the framework provided by mainstream society. On the other hand, the community also includes a second generation, rather wealthy intellectuals that could afford to live in luxury house-boats in the capital of the Netherlands, when the price of houseboats went up in the last decades.

The variety of conditions (location and size of the community), type of people involved (regarding their age, education and financial capital), motivations and technologies shows that the niche of RECs is heterogeneous, encompassing diverse groups and different people. Consequently, participating in a renewable energy project at community level can be an option for many people. Thus we have evidence to claim that RECs also meet the requirements of the third proxy.

4. Conclusions

The aim of this article was to explore the transition potential of renewable energy communities, as social niches, by using and further elaborating the analytical framework of the multi-level perspective. To do so, we introduced three proxies and accompanying indicators, extending earlier theoretical work (Geels & Schot, 2007), to study the transition potential of social innovations and thereby social niches. The first proxy is the generic rules and lessons learned at the global system scale that make similar but separate local niches to compose one global niche. In the case of RECs in the Netherlands we showed that they indeed network and learn from each other and have all the system elements of the regime, thereby forming a proto-regime. The second proxy is the support of powerful actors and links built up with sub-regimes. We described how RECs attract numerous regime actors in the Netherlands, such as the government at the local and provincial level, financial institutions and companies; in such a way RECs thus create useful links to the regime. The third proxy that we introduced is the heterogeneity of the niche regarding its actors, their motivations, the technologies they use and the conditions they are operating under. The more heterogeneous the niche is – which is the case for the examples of RECs in the Netherlands discussed in this article – the more likely it can expand and become an influential part of the regime.

These three proxies of transition potential for social niches have been also discussed in earlier work (Geels & Schot, 2007; Hoogma et al., 2002; Raven, 2012), albeit not as systematically, or explicitly. The interrelation among these three elements can result either in positive feedback loops, reinforcing the transition potential (the more heterogeneous, the more learning potential and so on). But it may also result in hindering the transition potential (for instance, the more support from regime actors, the higher the pressure for closure towards traditional solutions and behaviors). Further work is necessary to clarify the interrelations among these three elements, and the different types of transition pathways that result from different types of relations among them. Aside from elaborating the notion of transition potential of social niches, we aimed to make further contributions to transition theory. We reinterpreted the notion of niches and transition paying special attention to social

innovations and their role in sustainability transitions. Building on earlier work (Geels & Raven, 2006; Markard & Truffer, 2008; Raven, 2012), we argued that niches are not just protected spaces for the development of innovations, but they constitute complex systems themselves, containing elements similar to those of the regime (actors, rules, material artifacts, practices, etc.). Such a conceptualization can also help mainstream the use of methodological tools, such as agent-based modeling, or social network analysis, in studies of niche dynamics; in fact previous work has used such tools, with very interesting results (Caniëls & Romijn, 2008; Lopolito, Morone, & Sisto, 2011; Safarzyńska & van den Bergh, 2012).

Furthermore, transition does not necessarily mean a complete shift to another regime, since the ST regime itself is not a unitary whole, but rather an interlinked system of several sub-regimes (Genus & Coles, 2008; Witkamp et al., 2011). Thus, changes in some segments do not necessarily lead to the whole transformation of the regime and both technical and social innovations can coexist with incumbent technologies and practices. In addition, each sub-regime is further fragmented by different social groups that have different interests and orientations. Links between diverse social groups from diverse sub-regimes compose the structure of the regime and during transition new links are established with niches, which thereby become a new segment of the entire system.

Such a diagnosis relates to specific future trajectories of niche–regime interactions. Following the typology introduced in previous work (Geels & Schot, 2007), we believe that the situation of RECs in the Netherlands resembles that of a *reconfiguration pathway*: innovations developed initially in niches, which are adopted by parts of the regime as they solve local problems, or, create new (business) opportunities, we can add. This adoption by the regime may, in the beginning, leave the basic regime rules unchanged, but as regime actors explore new combinations, and pressures from the landscape add up, such a process can lead to major transformation and regime change (ibid.).

We made a distinction between *internally* and *externally* oriented niches based on their orientation and application focus arguing that the former do not primarily intend to develop innovations for later regime use, but rather to meet internal purposes without having the intention to induce transition. The lack of intention, however, does not necessarily prevent these niches from contributing to sustainability transitions. RECs can be considered as an internally oriented niche that, even without primarily aiming at transition, can build up links with the incumbent regime, and thus have the capacity to scale-up and trigger changes. Although this process does not inevitably lead to a complete regime shift, RECs have the potential for becoming an important part of the current energy system and play a role in the transition toward a sustainable market-economy.

Besides defining their orientation and application focus, we also claimed that RECs are social niches, where new practices, consumer and producer behaviors develop, thereby changing the traditional way of energy production and the role of civil society in the energy transition. Although the emphasis here is on the social innovations, while technological innovations serve more as tools to meet internal needs, both innovations are present and nurtured by the communities that create adequate conditions for them, which are different from market expectations. In this regard, we see differences between social and technological innovations. While technological innovations developing in market or technological niches always entail the emergence of social innovations, such as new practices, generic rules and lessons, if social innovations are in the focus of the niche development, this process does not necessarily require the presence of technological innovations (e.g. bio-agricultural communities, community development) too.

Even though in this article we provided an overview of these communities in the particular institutional and governance setting of the Netherlands, we have not specifically focused on the influence of institutions and governmental policies on the transition potential of RECs; this remains a point for further research. As a final remark, we have to note here that in case RECs spread in the regime and a very large number of communities decide to invest in renewables, it may result in problems in the operation of the electricity grid. The current energy system is tailored to centralized and large-scale energy production, which is not yet able to bear and balance fluctuating energy supply (Lund, 2007). That is why without restructuring the whole system the large spread of renewables and thereby RECs is impossible in the future. The concept of 'smart grid' could provide a possible solution for this problem (Grijalva & Tariq, 2011). Further empirical investigation can explore how the development of a 'smart grid system' could help the spread of RECs either in case of one national or several local 'smart grid' projects.

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