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Local niche experimentation in energy transitions: A theoretical and empirical exploration of proximity advantages and disadvantages

Lars Coenen [a,*], Rob Raven [b,1], Geert Verbong [b,1]

[a] Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE), Lund University, Sölvegatan 16, Lund SE 223 62, Sweden
[b] Eindhoven University of Technology, Department of Industrial Engineering and Innovation Sciences, PO Box 513, 5600 MB Eindhoven, The Netherlands

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A B S T R A C T

This paper discusses how the approach of Strategic Niche Management (SNM) relates to proximity advantages in innovation processes as identified in the geography of innovation literature. The latter claims that the locations where innovation emerge and thrive are not coincidental, but that they follow certain patterns and explanatory logics. Such specific attention for explaining locations is not explicitly present in SNM, although this literature makes claims about the importance of experimentation in local settings, and local and global dynamics. Hence a confrontation of both literatures is thought to be promising. The paper draws on a theoretical discussion and a case study about aquifer thermal energy storage to conclude (1) that there is sufficient evidence for proximity dimensions in niche development; (2) that taking proximity dimensions seriously in SNM helps to unpack processes of upscaling and aggregation; (3) that literature on proximity and innovation can benefit from a more agency-based and dynamic perspective on proximity advantages; and (4) that there is a bias in proximity literature towards advantages of proximity while neglecting potential disadvantages for innovation, aggregation and upscaling.

1. Introduction

In the face of major sustainability challenges for the 21st century, such as climate change and rising oil prices, there is currently a lot of attention in Europe for securing a sustainable energy society. This ambition requires a transition from fossil fuels towards various sustainable energy technologies such as biofuels, fuel-cells, photovoltaics, wind-energy, etc. A transition refers to a fundamental change in the fulfillment of societal needs that unfolds in the course of 25–50 years. It entails dynamic interaction and co-evolution of new technologies, changes in markets, user practices, policy and cultural discourses, and governing institutions [1,2]. At present there is a lot of uncertainty how the energy transition will unfold and, whether and how, this transition can be governed.

In the face of this uncertainty transition scholars advocate niche experimentation to play a crucial role [3]. It refers to the creation, development and controlled phase-out of protected spaces for the development and use of promising technologies by means of experimentation in a societal context with the aim of learning about the desirability of the new technology and enhancing the further development and rate of application of the new technology [4]. Translated to policy practice, the Strategic Niche Management (SNM) approach suggests a governance perspective to mainstream emerging sustainability innovations through niche experimentation and consecutive upscaling (Raven et al., forthcoming). While niche experimentation are often enacted in a local or urban setting (e.g. urban transport systems based on biogas), surprisingly little attention has

* Corresponding author. Fax: +46 46 222 41 61.
E-mail addresses: lars.coenen@circle.lu.se (L. Coenen), g.p.j.verbong@tue.nl (G. Verbong).
[1] Fax: +31 40 244 4602.

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been paid to the spatial dimensions of SNM nor at the agglomeration or clustering effects that may arise in these local contexts.

Introducing the hitherto unchartered fields of economic geography and regional studies, the objective of the paper is to gain a better understanding under which conditions actors that participate in SNM can leverage the 'regional advantages' [5] which might take place in these localities for niche experimentation and upscaling. It offers a conceptual synthesis of key concepts in the geographical literature on innovation, i.e. clusters, agglomerations and regional innovation systems, on the one hand, and the literature on niche experimentation and SNM on the other. The usefulness of this synthesis will be illustrated with a case from the energy domain (energy storage in aquifers). The remainder of the paper will first introduce SNM and regional innovation respectively, followed by a synthesis of these disparate bodies of literature. This is followed by the case illustration, after which the conclusions of this paper are presented.

2. Strategic Niche Management: key lessons and challenges

The origins of Strategic Niche Management can be traced back to the early 1990s. Driven by the observation that many sustainable technologies never leave the showrooms – or worse, remain on the shelves of laboratories as proto-types – Schot et al. [6] and Kemp et al. [7] performed research on early market experimentation with electric vehicles to understand why. Building upon evolutionary theories of technological change the argumentation goes that dominant technologies have become locked-in into stable 'socio-technical regimes': cognitive, normative and regulatory rules that guide technological change along incremental trajectories. Regimes are embedded in wider 'landscape' trends and events such as globalization, urbanization, wars, environmental disasters and international policy agreements. To explain radical innovation, scholars such as Schot [8] and Rip [9] developed a quasi-evolutionary perspective on technological change arguing that variation is not completely blind but that technology actors anticipate future selection environments and actively try to shape them in favour of new innovations. Early market experimentation such as demonstration projects were identified as critical loci where selection environment actors and variation environment actors meet, exchange views and ideas, learn and adjust their preferences, expectations, routines and habits. They also found that 'protection' of such 'societal experiments' – explicitly using experimentation as a concept to refer to the uncertainty and learning dimensions of such activities – was crucial, because prevailing regimes would otherwise reject those innovations and prevent them from becoming mature. Hence, experimentation in technological niches – intentionally, but partially protected spaces with subsidies and other public (or private) supportive measures – were identified as a crucial step in maturing innovations and regime shifts towards sustainability. Adding insights from social constructionist approaches and Technology Assessment, an iterative process of articulating expectations, setting up and breaking down protection, social network building, experimentation, learning and wider diffusion as a process of branching into new market niches and eventually mainstream markets was thought to be typical and desirable for governing sustainability transitions. In retrospect, several SNM scholars have criticised the initial, bottom-up, experimental focus of SNM. Hoogma et al. [10] conclude the following:

> "We were certainly over-optimistic about the potential of SNM as a tool for transition. […]. The positive circles of feedback by which a technology comes into its own and escapes a technological niche are far weaker than expected and appear to take longer than expected (5 years or more). […] The experiments did not make actors change their strategies and invest in the further major development of a technology."

Indeed, a critical challenge that SNM is facing concerns how the process from the initial 'niche' to a large-scale transformation can be accelerated [1].

Recent contributions on SNM have started to address this challenge by introducing a (non-spatial) local and global dimension of niches. Building upon Law and Callon [11], Hard [12], Disco and van der Meulen [13] and Deuten [14] and a long-term case study on biogas development in the Netherlands, Geels and Raven [15] developed a stylized model of the niche development process. The local dimension in the model relates to experimentation with a variety of novel technologies generating hands-on and contextualised knowledge and locally applicable lessons. The global dimension (not to be mistaken by the geographical connation of the word global) refers to an emerging field or proto-regime supported by a network of actors that is concerned with defining de-contextualised, shared rules such as problem agendas, search heuristics and abstract theories and models independent of their local context. The relations between the local and global dimensions are not easily managed, but require dedicated work and aggregation activities. Similarly, while the emerging field at the global dimension is potentially a valuable resource for local networks and experimentation, global to local coordination is also not a linear and straightforward process [16].

As illustrated in figure Fig. 1 the local-global dimensions play an important role in conceptualizing upscaling of niche experiments. Upscaling is defined as increasing the scale, scope and intensity of niches experiments by building a constituency behind a new (sustainable) technology, setting in motion interactive learning processes and institutional coordination and adaptation, which helps to create the necessary conditions for the successful diffusion and development of those technologies [7]. However, we remain wary that the local-global dimensions might remain only metaphorical if no 'proper' spatial connotations are in place. The present lack of geography in SNM prevents it from capturing how combinations of institutional, entrepreneurial and innovative processes and heterogeneous networks co-evolve and coalesce into more stable configurations that can challenge existing regimes. Indeed, grounding SNM in a spatial context will force it to address the question how and why experiments are performing differently in different geographical settings