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Towards a spatial perspective on sustainability transitions

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Towards a spatial perspective on sustainability transitions

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In the past decade, the literature on transitions towards sustainable socio-technical systems has made a considerable contribution in understanding the complex and multi-dimensional shifts considered necessary to adapt societies and economies to sustainable modes of production and consumption. However, transition analyses have often neglected where transitions take place, and the geographical configurations and dynamics of the networks within which transition evolve. An explicit analysis of the geography of transitions contributes to the extant transitions literature in a variety of ways. Firstly it provides a contextualization and reflection on the limited territorial sensitivity of existing transitions analysis. The majority of empirical studies have been conducted in a small number of countries, and primarily the Netherlands, UK or Scandinavia, with an increasing interest in Asian countries. Secondly, it explicitly acknowledges and investigates a variety of transition pathways. Thirdly, it encompasses not only greater emphasis but also better conceptual and theoretical devices for understanding the international, trans-local nature of transition dynamics. Drawing on recent insights from economic geography, this paper seeks to improve existing transition theory by (1) creating a conceptual framework for better understanding geographical dimensions of sustainability transitions, and (2) beginning to highlight some of the boundary conditions and tensions for geographically-sensitive transition analyses.

Keywords: transitions studies, economic geography, territorial innovation systems, multi-scalarity, geographies of transitions.

Towards a spatial perspective on sustainability transitions

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1. Introduction: the need for spatial analyses of sustainability transitions

Since the 1970s, environment and energy related problems have moved to centre stage for many political, business and research agendas. The notion of sustainable development has emerged as the dominant global discourse of ecological change, whilst the concept of ecological modernization has been most explicit in pointing to R&D and innovation as crucial instruments to solve - or at least abate - the environmental crisis without abandoning possibilities for technological progress (Langhelle, 2000). In contrast to more radical 'green' approaches such as deep ecology, ecological modernization describes how industrial societies might adapt to fit within the earth's ecological carrying capacity using better scientific knowledge, technical progress, economic growth and democratic decision-making (Huber, 2008; Jänicke, 2008; Hajer, 1995; Mol and Sonnenfeld, 2000). Whilst ecological modernization has broadened its focus over time, it remains criticized for singularly focusing on a 'technical fix' through clean technologies (York and Rosa, 2003). Ecological modernization theory has only been partially able to explain why, when and where certain technological changes have (or not) occurred (Gibbs, 2006) and, thus, is subject to criticism for technological determinism. Its theoretical purchase is limited to providing a meta-narrative: it is ill-equipped to make explanatory, let alone predictive, claims about the direction, rate and constituents of technological change. In response to this, the concept of socio-technical transitions has emphasized the social construction of technology alongside the interactive and evolutionary nature of innovation processes.

In the past decade, the literature on transitions within sustainable socio-technical systems has made a considerable contribution towards understanding the complex and multi-dimensional shifts considered necessary to adapt societies and economies to sustainable modes of production and consumption in areas such as transport, energy, housing, agriculture and food,

communication and health-care (Rochracher 2001; Jacobsson and Bergek 2004; Smith, Stirling, and Berkhout, 2005; Geels 2005; Hekkert et al. 2007). Transition is here understood as shifts or 'system innovations' between distinctive socio-technical configurations encompassing not only new technologies but also corresponding changes in markets, user practices, policy & cultural discourses and governing institutions (Geels, Hekkert and Jacobsson, 2008). Geels and Schot (2010) characterise transitions according to the following characteristics: (1) co-evolution and multiple changes in socio-technical systems or configurations, (2) multi-actor interactions between social groups including firms, user groups, scientific communities, policy makers, social movements and special interest groups, (3) 'radical' change in terms of scope of change (not speed), (4) long-term processes over 40-50 year periods.

Arguably the best-known example of a transition concerns the decarbonization of energy and transport systems, whilst other examples can be found in agriculture in terms of biodiversity and food security, or waste management and urban development. One of transition analysis's strengths has been its capacity to deal with structure-agency duality via evolutionary long-term trajectories of socio-technical change. However, we argue that what is gained in a historical treatment has – to our geographical sensibilities – come at the expense of a neglect of geographical factors. In particular, transition analyses have overlooked where transitions take place, and the geographical configurations and dynamics of the wider networks within which transition evolve. This has the undesirable effect of reducing comparability between places, and emphasizing the particular rather than the general features of each case. This frames individual cases as unique, which in turn inhibits particular transition analyses coalescing into a coherent body of theory.

An explicit analysis of the geography of transitions contributes to the existent transitions literature in various ways. Firstly it provides a contextualization and reflection on the limited territorial sensitivity of existing transitions analysis. The majority of empirical studies have been conducted in a small number of countries, primarily the Netherlands, UK or Scandinavia (see editorial), with an increasing interest in Asian countries (Berkhout et al., 2009; Berkhout et al., 2010). Secondly, it explicitly acknowledges and investigates multiple transition pathways (Geels and Schot, 2007). Thirdly, it encompasses not only greater emphasis but also better conceptual and theoretical devices for understanding the international, trans-local nature of transition dynamics.

Following Amin (2002) and Bathelt & Gluckler (2003), our view of space is relational: distance between actors affects how they interact – but distance has to be understood as more than the 'as-the-crow-flies' route on a map. Regular interactions between distant actors can build up into more solid connections, pathways, institutions and networks which in turn can support further 'remote' relationships. These networks define and create spaces with their own institutional arrangements, power relations, governance institutions and dynamics, which offer 'proximity' between actors (Boschma, 2005). There may be many different mechanisms and relationships through which these networks build up which are relevant in understanding a particular situation. What a geographical analysis brings to understanding any phenomenon in a particular place – such as a transition – is an appreciation of the importance of these overlapping relationships and networks, alongside providing a set of conceptual tools for understanding their place-specific impacts.

Our objective with this paper is to unpick and make explicit the relational and institutional geographies, the network spaces already implicit within transition analyses by introducing and including concepts and theory from economic geography. We emphasize economic

geography, because it is a sub-discipline primarily concerned with mapping and explaining the uneven geographical landscape of innovation and technological change. Geographers have already made comments, contributions and critiques on transition studies (e.g. Hodson and Marvin, 2009; Cooke, 2009; Truffer, 2008; Shove and Walker, 2007) but to date none of these have specifically juxtaposed insights on the geography of innovation with that of socio-technical transitions. More specifically, we explore how economic geography could offer useful conceptual tools to investigate how the wider network configurations within which territorial transition dynamics are embedded, and the institutional environments and arrangements particular to those territories, come together to shape these 'transition spaces'.

Drawing on recent insights from relational and institutional economic geography, and following our critique of the spatiality of transitions, we therefore seek to improve existing transition theory by (1) creating a conceptual framework for better understanding geographical dimensions of sustainability transitions, and (2) beginning to highlight some boundary conditions and tensions for geographically-sensitive transition analyses. To do so, we adopt the following structure. In the second section, we review and further specify the lack of spatial sensitivity in the analytical framework of transition analyses. Section three followings, outlining how notions borrowed from institutional economic geography, in particular 'institutional embedding', reveals an additional (more general) dimension to particular local transition trajectories. In section four, we discuss how one relational economic geography approach, multi-scalarity, augments transition studies highlighting transitions' multiple geographies. We conclude drawing together the main arguments of the paper, with the aim of stimulating debate and articulation of a new research agenda.

2. Missing or naïve conceptualizations of space in sustainability transitions

Two conceptual frameworks have been analytically dominant in researching innovation dynamics in sustainability transition processes, namely Technological Innovation Systems (TIS) and the Multi-Level Perspective (MLP). Both approaches conceptualize socio-technical systems as semi-coherently interrelated sets of actors, networks institutions and technologies/artifacts. The innovation systems concept as applied to sustainability transitions has been principally concerned with emerging new technologies and their potential contribution to future sustainability, whereas MLP has been more strongly oriented toward reconstructing historical processes of sectoral change. The discussion in the literature remains open as to whether the two approaches are compatible (Markard and Truffer, 2008) or whether they build on fundamentally different - and ultimately irreconcilable - ontological assumptions (Geels, 2010). For the purpose of our argument, we maintain that with regard to conceptualizations of space, both approaches suffer from – although to differing degrees – similar shortcomings.

2.1 Technological Innovation Systems (TIS)

The technological innovation systems (TIS) approach is akin to the national (NIS), regional (RIS) and sectoral innovation system (SIS) approaches being rooted in industrial dynamics and evolutionary economics. At its root lies an attempt to explain competitive advantage of specific nations, regions, or sectors in terms of the interplay of context-specific actors, technologies and institutional infrastructures. The preferred methodological approach - especially in the national (NIS) and regional (RIS) tradition - built on comparative analyses of national and regional institutional structures in order to analyze conditions for innovation success as a major indicator of increasingly globalized market economies' competitive advantage. As national, regional and sectoral innovation systems concepts are primarily concerned with prevailing actors, networks and institutional structures, their core focus lies

on identifying factors influencing capabilities for generating new technologies, products and services at a higher pace and with superior quality. Whether or not these activities lead to radically different (and better performing) socio-technical configurations is rarely in the focus of these studies (Geels 2004; Metcalfe and Ramlogan, 2008).

The technological innovation systems approach, in contrast, focuses primarily on emerging actor constellations, networks and institutional structures and primarily seeks to analyze potentially radically new socio-technical configurations that cross-cut established sectoral and spatial delimitations (e.g. electrical vehicles). As TISs mature, they may drive fundamental restructuring in established sectoral structures (e.g. Tushman and Anderson, 1986). From such a perspective, transitions emerge through market penetration by new technologies and products, crowding out established technologies. Sustainability transitions are therefore characterized by substantially enhanced ecological efficiency within new socio-technological configurations. Less emphasis has been placed on exploring the interplay between these emerging socio-technological configurations and how established sectors react to these alternatives (see Dolata 2009 for an exception and more explicitly on this topic Rohracher and Weber, this volume). Nevertheless, because a number of eco-efficient technologies have been highly successful and been adapted by 'traditional' sectors, the TIS literature has historically been able to contribute substantively to sustainability transitions research (Markard and Truffer, 2008).

It might appear at first sight paradoxical to criticize an innovation system concept for inadequately addressing its spatial dimensions. The NIS concept was initially developed to emphasize the role of "national" differences in explaining economic success, in contrast to dominant neo-classical economics that assumed spatially- and institutionally-indifferent market processes (Lundvall, 2007). However, there was nothing particularly "national" in the

national innovation system (NIS) approach, that level serving primarily as a convenient way of distinguishing relevant institutional and actor-related structures. A major motivation for choosing this particular geographical level was support from the OECD to inform economic and industrial policy in member countries from an Innovation Studies background (Lundvall 2007; Sharif 2006). Consequently, the spatial dimension essentially was conflated into a specific geographical scale, without further problematization.

Many of the variants of innovation system concepts that subsequently emerged chose specifically to respond to critiques of this problematic spatial contextualization of innovation processes[1] (see Carlsson and Stankiewicz, 1991 for TIS example). Beside their more general claim that technological systems could span several regions or countries, early TIS contributions developed an elaborate argument about the broad spectrum of geographical patterns potentially associated with specific technologies and industries' different life cycles. In their seminal paper, Carlsson and Stankiewicz even alluded to the possibility of space being relational in stating that a TIS's geographical localization was also influenced by both the availability of locally produced resources, alongside access to markets and knowledge spaces on a global scale. This line of argument was later further elaborated with regard to internationalization tendencies in R&D, and correspondingly the question of whether there was a tendency of Technological Innovation Systems to become increasingly global in their scope (Carlsson, 2006).

However, despite these very considered starting points, much of the subsequent conceptual and empirical work remained primarily focused on describing TIS as spatially undifferentiated entities, exemplified by the reference to the "global opportunity sets" to which all actors potentially had access (see Carlsson et al 2002; Bergek et al 2008).

[1] The RIS concept has taken this critique most serious and deals most explicitly with the spatial organization of innovation processes (Asheim and Coenen, 2005; Cooke, 2005).

Empirically, contributions often focused primarily on TIS structures in a single country (*inter alia* Hillman et al 2008, Negro and Hekkert 2008, Jacobsson and Lauber 2006) or undertook comparative analyses of TIS structures in order to determine the relative importance of specific national framework conditions - principally conceptualized as promoting or hindering factors (Carlsson et al 2002). The spatial dimension became further downplayed in a recent turn favoring increasingly functional descriptions of innovation systems emphasizing their dynamic nature (see Bergek et al 2008; Hekkert et al 2007 for an overview). The functional approach risks overemphasizing 'universal' (abstract) mechanisms as causal explanations for innovation at the expense of (real) embedded actor strategies and institutional structures.

More specifically, we see two related problems emerging through the absence of an effective conceptualization of space (i) an insufficient elaboration of coupling structures between TIS and sectoral and spatial context systems (Rohracher et al submitted), and (ii) an underconceptualization of relationships between different sub-system structures. In particular this concerns the spatial structuring of Technological Innovation Systems, for instance in order to decide when a technological innovation system may be truly said to have a "global" dimension (see Binz and Truffer 2010, Carlsson 2006).

Understanding how TISs are coupled to particular spatial contexts would augment current understandings by making the very particular analyses currently found in much TIS literature far more general and comparable in their scope. Much TIS literature does deal with the issue of coupling, but regards it as primarily contextual, in the sense of hindering or furthering 'external' circumstances. Without explicitly elaborating why actors in particular TISs choose to pursue their activities in particular regional and national contexts, it is very difficult to isolate individual success factors. In general, technological systems' structures (actors,

institutions, networks) highlight resources, competencies and synergies provided by actors operating in specific locales or regions, whilst often overlooking that these local resources are produced in much wider economic, business, political and organizational networks, hierarchies and markets.

From the TIS starting point, what is arguably lost is an understanding of the co-evolution of technologies and institutional structures, especially in early transition phases and concerning radical alternative system shifts. The substantial uncertainties that exist under these circumstances often depend on specific combinations of supportive conditions (such as cultural predispositions, professional competencies, specific research and education facilities) that play a supporting role where there is sufficient coherence between individual elements. For example, political support for specific technologies may depend on the existence of specific, localized constituencies that support the introduction of policies and provide early market contexts (see also Dewald and Truffer, 2010). A TIS analysis adds little analytically to this relatively simple story, and indeed runs the risk of obscuring a clear set of spatially-particular causal relationships in search of a broad-brush 'system' explanation. But system explanations do not always add value: in the photovoltaic sector, an elaborate system explanation adds little value to a purely actor incentive-based explanation of national industry development (e.g. feed-in tariffs for renewable energy). So, rephrasing Carlsson and Stankiewicz's original argument (1991), we contend that a spatially naïve TIS concept runs the risk of obscuring simple, place-specific causal relationships behind a more general systems analysis, that in turn lacks explanatory power.

The second critique relates to the internal structuration of technological innovation systems. We question whether it is appropriate to assume the existence of a homogenous "global opportunity set" to which all actors have potentially equal access, suggesting alternatively

that sometimes it might make more sense to consider largely disconnected TISs existing in parallel in different countries and regions. Under which conditions might it make sense to talk about a European TIS in biogas, a German PV TIS or a global membrane technology TIS? These questions have not yet been tackled in any depth in the literature, but this must equally not be reduced to attempting to find "the" appropriate geographical scale on which a TIS is "actually" located. Rather, different elements may operate at and across different scales and derive specific resources and power from their ability to interconnect different regional, national and/or global structures. Context conditions defined in different national and regional locations may create a highly variegated "landscape" of supporting and hindering forces that influence where specific TIS structures can develop and mature. Actors may also consciously try to influence these context conditions in order to support their favored technological trajectories.

This is of particular importance for transition studies when considering global development processes for specific sustainable transitions. Much related literature still strongly favors a 'diffusion' model, where innovations are assumed to start in industrialized countries and slowly trickle down the development gradient into emerging economies and finally developing countries. Conversely, there is increasing evidence that transition-relevant activities are also originating in emerging economies (Fisher, this issue; Wieczorek et al, 2009; Berkhout et al. 2009) and that transition processes could show much more complex geographies (as in the leapfrogging discussion, see Binz and Truffer, 2009).

One possible reason why the TIS literature has not more explicitly elaborated a differentiated conception of space may perhaps be that it pursued a strong urge to inform (primarily national) technology policy – a trend particularly emphasized in the later turn towards functional system description. Ironically, we observe that the intellectual trajectory of TIS

research, which started with a strong geographical critique of the predominant national innovation system approaches, twenty years later was forced to defend itself against a very similar set of critical comments. We therefore conclude that it is time for a more elaborate geographical framework.

2.2 Multi-level perspective

The Multi-Level Perspective (MLP) can be regarded as a hybrid theoretical framework bridging science & technology studies and evolutionary economics, drawing extensively on institutional analysis as a middle-ground spanning these traditions. A central tenet in MLP is the stabilizing influence of a socio-technical regime, defined as "the coherent complex of scientific knowledge, engineering practices, production process technologies, product characteristics, skills and procedures, established user needs, regulatory requirements, institutions and infrastructures" (Rip and Kemp, 1998, p. 338). By its very nature a regime seeks to retain its configuration and resists system innovation. In contrast, 'niches' act as 'incubation spaces' dominated by uncertainty and experimental disorder. These are "protected spaces in which actors learn about novel technologies and their uses" (Geels, 2002, p. 365) and that nurture novelty and protect radical innovations against mainstream market selection. The MLP perspective has been applied empirically in various historical cases that include hygienic reform of waste water disposal in late 19th century Netherlands (Geels, 2006), the transition from horse-drawn carriages to automobiles in the US 1870-1930 (Geels, 2005) and the recent emergence of renewable energy in the Netherlands (Verbong et al., 2008).

Due to its explicit emphasis on semi-coherent institutional structures (Geels 2002) or societal embedding (inherited from earlier Strategic Niche Management literature, Hoogma et al 2002) the MLP approach does not fall foul of providing insufficient attention to the societal

embeddedness of socio-technical systems. In particular, in empirical applications to historical transitions, 'local' context conditions are allowed to play a major explanatory role. However thus far, there has been little explicit treatment of specific local institutional - as opposed to sectoral or technological - coherences.

Drawing on a apparently geographical metaphor, Geels and Raven (2006) place niche development trajectories into a 'local-global' perspective. Here, local niche experiments evolve to the global level as local outcomes are aggregated into more generic lessons and rules, thus allowing for more (global) actors to be enrolled and previous expectations to be adjusted. Geels and Raven (2006) maintain that the terms local and global should not be mistaken for its geographical connotations as they argue that there is no territoriality or scale tied to these levels. This is potentially confusing, particularly at early stages in the transition: 'global' activities may be very localized in the 'places-to-be' for particular transitions, with global actors coming to a locality to construct new transition experiments[2].

Perhaps more importantly, a key issue in transition studies relates to the question of agency, and the conditions under which particular kinds of interventions by individual actors can trigger more structural evolutions (Genus, and Coles 2008; Gibbs, 2006). Transition studies ultimately relates to paradigmatic innovation (rather than incremental or radical, *cf.* Bailey & Wilson, 2009) making agency absolutely central to its analysis. Transitions studies distinguish different levels at which innovation activities comprising 'transition' take place, but these are not geographical scales (*inter alia* Geels & Kemp, 2000; Rip & Schot, 2002; Geels & Deuten, 2006). Geels & Kemp (2000) distinguish between macro-, meso- and

[2] As an illustration one can consider the (hypothetical) case of Melbourne being the first place where new structures for a sustainable urban water infrastructure will become apparent (i.e. Melbourne "produces" the transition). As a consequence, much of what would be referred to as "global" aspects of this transition process in other parts of the world would most likely be tied to the pioneering city of Melbourne (i.e. the transition defines the city as a central hub in a global network).

micro- levels of activity, corresponding to landscapes, regimes and niches. Rip & Schot (2002) highlight that progress co-evolves along these different levels as technologies progress along maturity curves. Geels & Deuten (2006) argue that the global scale is constructed as localized innovation networks evolve into inter-local, trans-local and finally global networks, paralleled by the emergence of higher-level epistemic communities shaping those technologies and innovations' evolution. In these approaches, individual actors can and do make a difference to shaping innovations. At the same time, they allow higher levels to influence and shape the outcomes of those innovations. This captures conceptually what seems to us to be the self-evident fact that transitions evolve at many levels simultaneously, and those levels are to some degree inter-dependent.

But we re-iterate the point that these levels are not geographical in their nature; rather they are conceptual related to the maturity of the technological system. At the same time, we want to reiterate that we think that the MLP approach could benefit from dealing with geographical levels (we here use the term 'scale' to refer to a geographical level), in short that we want the multi-level perspective to also be a multi-scalar perspective. But why does this matter? The issue is that that similar phenomena operating at different geographical levels can look very different, whilst represent the same underlying process. This allows greater comparison between what at first sight appear very different situations, something which we think clearly has value in addressing the previously-identified problem of a lack of comparability in transition analyses.

A geographical scale is a level at which significant relationships exist between actors: these relationships acquire a dynamic of their own through repeated interaction and that dynamic is distinctive from interactions at different scales. In innovation, for example, tacit knowledge exchange is a key process for knowledge spill-overs which support capital accumulation and

economic growth (Gibbons *et al.*, 1994). At both scales, the underlying process is the same, people exchanging tacit knowledge in ways that expedites innovation. But tacit knowledge spillover looks very different at different geographical scales; for the sake of argument we distinguish the local and the international. At the local scale, repeated informal face-to-face interaction (such as in canteens, social meetings) is an important mechanism (Storper and Venables, 2004), whilst at the international scale, 'epistemic community building' processes (through university education, journals, conferences *cf.* Haas, 1992) are important, providing people with sufficient cognate proximity to exchange tacit knowledge at a distance.

The emergence of feed-in tariffs for renewable energy in the UK is a good example of multi-scalarity in energy transitions: a national regulation has been promulgated, which has had to wrestle with three spatial scales:-

- the European scale, based on macro-regulation and European law, specifically European Commission and Council pressure on the UK government to hit its renewable energy targets
- the national scale, a competition of renewables options against nuclear options within a tight, nuclear dominated policy network, and
- the local scale, technical considerations in connecting intermittent generating capacity to an ageing grid system designed to transport energy from nuclear reactors and hydro-power plans in the North West to the South East of Britain, dependent on (often febrile) local politics.

The national scale has by no means been the lead or structuring agent in this process (an assumption often made by transition theories); there has been a complex and ongoing interaction between those levels – and the interests of politicians, electricity companies, consultants, residents – necessary to reach the apparently simple point where a householder with a windmill or solar panels is paid for the energy fed back into the grid.

Yet, we argue that multi-level perspectives are not yet multi-scalar in the sense of dealing with a single process which appears different at distinct scales. The niche and the regime are effectively the same scale, a regime differing from a niche simply in terms of being more stable and pervasive (Schot and Geels, 2007). The 'landscape' is something totally different, an exogenous background against which niches and regimes compete for hegemony. So rather than representing three distinct scales, the multi-level approach distinguishes a single scale of activity where niche and regime compete – and one background, the landscape. Our argument is that this treatment has obscured the fact that there are also processes operating at different geographical scales, and that better understanding these provides a better – in terms of being more transferrable – understanding of the transition. Our supposition is that this problem arose because many examples were drawn from places from successful regions with globally-active actors. But for regions or nations lacking these strong global relationships, nor active and powerful in global spaces, transitions can be much trickier.

We argue that effective comparative transition analysis should how the locality is positioned with networks operating at these three scales to better explain why transitions work (or do not) in particular contexts. Transition approaches, by looking at everything that occurs in a local transition, ignore the fact that different activities and resources are subject in differing amounts to external pressures or local control. There is a growing need to understand how external pressures, or tensions between external and local actors, influence changes in local socio-technology systems. We come back to the point that Geels & Deuten's central transition mechanism is an build-up of local actors which constellate to become 'global' in their scope. But some of those actors may be themselves ;global' in the sense of their centers of gravity and power lying elsewhere. It seems self-evidently useful to us to understand the impacts that these wider networks have, in shaping the aggregation process of niches

becoming regimes, and from that to deduce new insights into what controls the pace and direction of transitions.

It is indeed possible to think of 'level' and 'scale' as two dimensions along which transitions can be classified. The origin and development of a transition in wind energy is often traced back to the emergence and (relatively) wide-spread usage of wind turbines in Denmark. Many processes that facilitated the early development of this niche can be considered as local, e.g. user-producer learning and co-development of technology between testing institutions and manufacturers. However, the built-up of critical momentum in this local niche cannot be disentangled from parallel developments in the (ultimately failing) competing US wind turbine industry and the regulatory induced California wind gold rush. from which Danish wind turbine manufacturers eventually substantially profited (Garud and Karnøe, 2003). This study shows that right from the start there are both local and global dimensions to the development of a niche, with each having different constituents and dynamics. It is similarly possible to identify both local and global dimensions of a regime. When considering the electricity regime in the Netherlands, various elements are more or less nationally specific, such as the discovery and exploitation of domestic natural gas or the ambivalent position towards nuclear energy. On these dimensions, the Dutch energy system differs substantially from for example the Swedish or Danish systems. At the same time there are more general developments in the electricity regime, such as in increasing liberalization and privatization in the energy sector, which are parts of an EU induced trend.

The examples above clarify our two critiques of multi-level approaches to transitions. The first is that transitions approaches focus on a single niche-regime scale, conceptually permitting actors to interact yet overlooking important differences between scales (Murdoch, 1998; Law, 2004), and effort and conflicts involved in particular real transitions. The second

point is a weak treatment of the 'global', reducing it to an external and by implication unchallengeable force, and ignoring that "global networks are not super-lunar objects made of something different to sub-lunar local relations" (R. G. Smith, 2003, p. 36). These two problems are profoundly unsatisfactory to us because we are aware that the 'global' is made everywhere (Gibson-Graham, 1992), global production networks have a particular territoriality, and local actors – even weaker ones – have autonomy to challenge this situation.

If one thinks of the global cut flower business, the sector is controlled through a localized cluster with global reach around Aalsmeer in the Netherlands (Hughes, 2000; Den Hertog et al., 2001). Regulations, market outcomes, institutions and local learning within this very tightly spatially-focused cluster have global consequences, constituting the global regime of cut-flower production. Different territories have different relationships with this cluster node, and different power to shape the regime. Even indentured laborers in Uganda's rose industry were able to campaign for fairer employment terms by enrolling consumer groups to pressure Western supermarkets to exclusively sell fairly traded roses, evoking Valentine's Day as a suitable occasion to pay a fair price for flowers (cf. Whatmore & Thorne, 1997). Supposedly powerless local actors have shaped the wider landscape of cut flower production (creating new employment norms) mediated through a complex multi-scalar network emanating from - but not controlled in - Aalsmeer. We therefore argue that a more substantial treatment of this issue of multi-scalarity is necessary in order to be able to conceptualize multi-level transitions in a more robust and generalizable manner.

2.3 The key lines of a geographical critique of transition studies

Summarizing our discussion of two major strands of transitions concepts, we claim that the neglect of a differentiated conception of space may have once been understandable and even acceptable at the point of the early development phase of transition concepts. Following the

maturing of the field, however, better elaborating a differentiated conception of seems necessary and even urgent. We maintain that there are two interrelated problems requiring solution prior to the development of a fair conceptualization of space in transitions processes: the institutional embeddedness of technological development processes within specific territorial spaces, and an explicit multi-scalar conception of technological trajectories.

3. Grounding sustainability transitions: institutions, embeddedness and change

Both TIS and MLP approaches rely heavily on institutions in their conceptual vocabulary. Institutions are a defining element of a TIS, a system as a whole constituted by "a dynamic network of agents interacting in a specific economic/industrial area under a particular institutional infrastructure and involved in the generation, diffusion, and utilization of technology" (Carlsson and Stankiewicz, 1991, p. 93). This institutional infrastructure remains however largely unspecified, often loosely referred to as the written and unwritten 'rules of the game' (Edquist and Johnson, 1997). In comparison, the MLP framework is more elaborate with regard to different kinds of institutions (regulative, normative, cognitive) and their domains (technology and products, science, policy, socio-cultural, users, markets and distribution networks) (Geels, 2004). However, both TIS and MLP treat institutional frameworks' geographical dimension implicitly and, thus fail to specify the spatial ranges over which relevant institutions operate, leaving institutional structures to seemingly float freely across a boundless, global plane (Geels and Deuten, 2006). Conversely, empirical analyses of transitions demarcate systems implicitly at the national level (e.g. the evolution of biofuels in Sweden and the Netherlands (Hillman et al., 2008) or the Dutch electricity regime (Raven, 2006)). To provide a more systematic and rigorous account of why, for what reason and where certain concatenations of institutional, entrepreneurial and innovative interactions comprising transition spaces occur, we argue that transitions approaches need as a first step to

develop a better theoretical framing of the institutional contexts within which transition paths evolve. We contend that institutional economic geography offers insights and notions to achieve precisely that end.

In Martin's (2000, p. 79) words, institutional accounts of economic geography acknowledge that "economic activity is socially and institutionally situated: it cannot be explained by reference to atomistic individual motives alone, but has to be understood as enmeshed in wider structures of social, economic, and political rules, procedures and convention". Its interpretation still allows for considerable analytical flexibility, where institutions can be approached both as single rules that more or less independently influence social and economic behaviour, but also as semi-coherent arrangements that are mutually dependent and exert a specific influence through their interplay. That notwithstanding, economic geographers have drawn extensively on institutional analysis to successfully explain geographically uneven technology development, diffusion and innovation (Amin and Cohendet, 2004; Asheim and Coenen, 2006; Boschma, 2005; Cooke and Morgan, 1998; Florida, 1995; Gertler, 2004; Maskell and Malmberg; 1999; Saxenian, 1994; Storper, 1997). The basic tenet in these analyses is that institutions enable and constrain innovation in spatially differentiated ways.

Adding an institutional economic geography perspective to transition analyses opens up fundamental questions regarding the extent and in what ways are processes of geographically uneven transition pathways shaped and mediated by institutional structures which both regulate and promote those processes ? As also noted by other geographers (Hodson and Marvin, 2010; Cooke, 2009; Shove and Walker, 2007) transition analysis have been limited in theorizing varieties of transition pathways in different geographical contexts even though recent contributions (e.g. Berkhout et al. (2009) have started to 'export' the MLP to Asian

countries. There is thus a need for a conceptual vocabulary to be added to transition analyses in order to better contextualize them in 'real spaces'. To address this gap we draw on the notions of institutional embeddedness which underlines that purposive action is interdependent on systems of social relations (Granovetter, 1985).

Literatures on regional and national innovation systems have already used the notion of 'embeddedness' to explain successfully how different territorial institutional environments favor certain innovation activities and technological development paths over others. Archetypal examples includes the high degree of public-private coordination conducive to joint industry-university research in Sweden, in contrast to the local community/ industrial district mode of coordination conducive to user-producer learning in Denmark (Edquist and Lundvall, 1993). Analyses of regional innovation systems have perhaps been even more pronounced in identifying distinct local institutional environments conducive to innovation. Saxenian's (1994) comparison between Route 128 and Silicon Valley serves to exemplify how technological breakthrough in ICT is underpinned by region-specific institutional environments based on decentralization and cooperation (found in Silicon Valley) whereas a culture of independency and self-sufficiency stifled most innovative activity in the case of Route 128.

In theoretical terms, explanations for distinct national or regional institutional advantage in terms of innovation and technology development offer three concepts that help to spatially embed transition analyses: (1) *comparative institutional advantage* (2) *institutional thickness* to facilitate analyses and comparisons across and between spatial contexts and (3) *institutional entrepreneurship* to conceptualize localized institutional change. Firstly, the notion of comparative institutional advantage originated from the 'Varieties of Capitalism' school, and has attracted much attention in terms of explaining why some countries provide

better framework conditions for firms to engage in radical innovation than others. These advantages are explained in terms of the availability of institutional complementarities[3]. Two institutions are seen as complementary when the enhancement of one assists provision of the other (Amable, 2003). The Varieties of Capitalism school suggests that nations with a particular type of coordination in one domain of the political economy (e.g. financial system) tend to develop complementary practices in other domains as well (e.g. employment relations) (Hall and Soskice, 2001). Following this logic implies a particular geography to various kinds of institutional practices across nations. As a central thesis to the Varieties of Capitalism School, it is argued that coordinated market economies (such as found in Germany, Japan and Scandinavia) offer institutional advantages in supporting incremental innovation based on complementarities between close inter-firm as well as public-private collaboration, high-levels of industry-specific technical skills, secure employment and a financial system able to supply long-term ('patient') capital. This can be contrasted with liberal market economies (such as the UK and US) offering institutional advantages for radical innovation in fast-moving technology sectors based on high rates of labor mobility, inter-firm relations primarily based on markets, equity markets with dispersed shareholders and venture capital. The 'institutional freedom' found in liberal market economies allows firms to continuously adjust and restructure in light of new market opportunities. Even though the dichotomous model hinted at by the Varieties of Capitalism school has been roundly criticized for its scanty theoretical analyses, and cases becoming stylized portrayals of stereotypes (Peck, 2005), it offers a valuable approach to analyze institutional systems as localized ensembles of mutually reinforcing sets of institutions (Asheim and Coenen, 2006).

[3] It should be noted that the idea of institutional complementarities also has a tradition in the national and regional innovation systems literature. But, compared to the Varieties of Capitalism literature, the choice of institutional features is more ad-hoc and remains unspecific how various institutions interconnect and co-evolve (Lundvall, 1998).

Particularly for transition analyses, it offers a place-specific explanatory (and potentially predictive) framework for analyzing radical, path-breaking innovation.

Secondly, the notion of institutional thickness originating in regional studies offers considerable theoretical purchase in explaining why some regions lead and some lag behind in terms of innovative performance. The notion of institutional thickness explains comparative performance of governance bodies in terms of their ability to work together locally, and persuade or compel sufficient external agents to support their activities. These capacities build up in particular places over time, and can be referred to as the 'institutional thickness of a place'. Institutional thickness explains why some places are good at developing complex economic development projects and others not. Whilst there is no assumption that the territory has agency in any meaningful sense, a shorthand can sometimes be used of the 'locality as an agent', an institutional environment with much experience of co-operation where it is more likely that innovative experiments may succeed (Cox & Mair, 1991). Amin and Thrift (1995) also highlight that an important element of institutional thickness is institutional reproductive capacity with well-defined structures of domination, coalition-building and collective representation that minimize sectionalism and inter-institutional conflict (i.e. structures conducive to institutional complementarity. Finally, this results in the emergence of a common sense of purpose, shared expectations or vision around a widely-held agenda. Institutional thickness is problematic in the sense of being difficult to operationalize ex ante (Henry & Pinch, 2001). Its strength lies in explaining how localities can seek to influence external 'global' forces and secure successful economic change – including transitions – in the face of pressures to compromise and 'race to the bottom' in competing (Cooke and Morgan, 1998; Morgan, 1997, Hudson, 1999). In so doing, there is a striking parallel with Strategic Niche Management approaches regarding how the 'small'

responds in the face of 'big' challenges, both approaches emphasizing networking and inter-organizational learning processes as explicit policy strategies.

Thirdly, the concept of institutional entrepreneurship acknowledges the dynamic quality and changing nature of institutional embeddedness (in contrast to the static emphasis in the latter two concepts of continuity and conformity of actors). It refers to 'activities of actors who have an interest in particular institutional arrangements and who leverage resources to create new institutions or to transform existing ones' (Maguire et al., 2004). Institutional entrepreneurship connects to the broader structure-agency debate, also known as the paradox of embedded agency, explained thus by Garud et al. (2007, p. 961): "if actors are embedded in an institutional field and subject to regulative, normative and cognitive processes that structure their cognitions, define their interests and produce their identities, how are they able to envision new practices and then subsequently get others to adopt them?" The notion of institutional entrepreneurship has recently entered the vocabulary of Varieties of Capitalism not only to account for institutional change but also to make sense of local deviation from national structures (Crouch and Voelzkow, 2009). Their study of the German economy's institutional framework through the lens of four localized sectors draws attention to how institutional deviation from and incoherence with a prevailing (in this case national) regime gives rise to institutional innovation and reform. According to Crouch and Voelzkow (2009) decoupling from a national production system can take place either by a local differentiation that develops its own governance mode, or by reaching beyond the national context to access resources globally.

The notion of institutional entrepreneurship could certainly be used to better understand the urban strategies to shape transition pathways. Typically, local governments, and cities in particular, see themselves as important actors at the forefront of developing and

implementing new socio-technical configurations (Hodson and Marvin, 2010). Cities and regions are places where interactions between different transition dynamics take place and thus synergies and hindrances between different technological transformations may become apparent. Finally, cities and regions also are major nodes in wider networks of actors that may simultaneously develop their local resources and access and influence resources at different spatial scales (R.G. Smith, 2003)

4. Multi-level, multi-scalar sustainability transitions

Just as transition approaches rely heavily on institutions in their vocabulary, there is equally the recurrence of notions of scale, emerging unselfconsciously in stories told about 'the transition'. However, both TIS and MLP tend of privilege patterns in time over space, probably as a result of disciplinary origins. Juxtaposition of events over time in a narrative creates implicit causality between events where no causality is warranted (e.g. the simple process of innovation diffusion becomes proof of what Geels & Deuten (2006) call their stage of 'inter-localization' as part of the pathway towards transition). These supposed causalities are then generalized into theories (e.g. aggregation), where categories are developed (e.g. 'globalised') and used to explain causalities. These causalities make particular spatial frames – scales – outcomes of temporal processes without having a strong understanding of how the scales themselves shape actors' behavior (a key criterion for scale as set out in section 2 above). These causalities are primarily an artifact of the way that researchers have chosen to tell their stories. Three conceptual tools have emerged in the economic geography of innovation concerning multi-scalar systems which we argue can be applied to transition studies to resolve these problems, namely (1) the socio-spatial construction of scale, (2) relational approaches to economic geography, and (3) avoiding scalar hierarchies.

Firstly, scale is not something which exists 'out there', waiting to be discovered by objective researchers, but rather it is constructed by social actors pursuing their goals within spatial frameworks (Jonas, 2006). External forces are always locally 'made': they cannot be conceptualized as being global and ontologically superior to local actors, nor do they have autonomous agency outside of actors (Larner & LeHeron, 2002). Some actors are more powerful than others, with power relating to capacity to draw on resources in networks across multiple scales. A set of debates within economic geography have recognized explicitly both this role of actors in the construction of scales, and the reality of actors seeking to look after their own interests within the networks that matter to them (such as corporate structures) and not those convenient to either political actors or indeed researchers studying those phenomena (Swyngedouw, 1992; 1997; Cox, 1998; DeFillipis, 1999; Baeten et al., 1999; Brenner, 2001; Lindseth, 2006).

The emphasis in these analyses is on the dynamics of the construction of scale through an ongoing process of struggle. 'Small' (local) actors can achieve power if they can access resources across wider networks, just as Ugandan rose growers sought to enroll Western Valentine's Day consumers in their campaign for employment justice (Whatmore & Thorne, 1997; Cox, 1998; Whatmore, 2002). The European scale of renewable energy had to be 'constructed' at the European level creating a situation (within the European Council) where targets were possible, then the European Commission setting those targets in negotiation with Member States. The Commission then enforced countries to adhere to those targets, with member States finally adapting their own regulatory environments to attempt to satisfy the Commission. Only then did it become salient in some member states, playing a role in the emergence of feed-in tariffs in the UK, as previously noted but not in Denmark or Germany where local/ national action had created the possibility and the reality of feed-in tariffs.

Transition studies to our minds elides too simplistically between stages of progress of technologies and their scales. We argue that it is necessary that transitions studies demonstrate how local relationships have deepened the degree of control (niche→regime) or broadened the strategic coupling of external actors to local networks (local→ global) (cf. Lindseth, 2006). But the epistemological focus needs to return to the processes by which innovative niches construct and sustain these wider and deeper networks.

The second issue relates to 'the relational turn' in economic geography (Boggs & Rantsi, 2003)[4]. Balthelt notes, "[the relational] approach allows us to analyze the consequences of global interdependencies and their relation to processes of local concentration and specialization" (2006, p. 224), something valuable here for understanding the multiple scales of multi-level transitions. The basis of a relational approach is that individual actors have significant relationships (through which they seek to access resources to achieve their individual goals) that influence their behavior simultaneously at a number of different scales. Central to the relational approach is recognizing that understanding actors' behavior requires understanding the influence of <u>all</u> of those scales (and relationships). Whilst empirically, the local scale may sometimes be the strongest and most determining, this is not always the case (Massey, 1978; Cox, 1998; Henderson et al., 2002; Wolfe, 2009). This can make globally active actors particularly dependent on particular places with which they have key relationships (to which they are 'strategically coupled') to achieve their goals (see also section 2 for a related discussion on TIS) (Harvey, 1983; Cox, 1998; Gibson-Graham, 1996; Christopherson & Clark, 2007). Even global corporations are dependent on their headquarter and R&D regions for their innovative capacity (Mattes, 2006), and although they might seek to close down activities in particular regions, this at the same time increases their dependency

[4] Here we acknowledge Balthelt's (2006) point that the relational turn is not as with previous turns a shift away from a set of hegemonic towards subaltern perspectives, but rather an attempt to create a mutual understanding – conceptually/ empirically - between localised and globally-networked economic processes.

on the other regions where they have knowledge capacity (Smith et al., 2001; Hudson, 2002). These networks need not be purely economic: culture and trust are seen as important facilitators of co-operation in innovation, and trust can operate at the local scale, in particular cultures, but also at the global scale, such as through diaspora entrepreneurs (Saxenian, 2000; Henry et al., 2002).

There is a need to focus on the struggles within transition activities (see also Geels, 2010), and in particular between different interest groups each seeking to realize their own desired visions of the sustainable society which include or exclude particular actors, groups and niches, without necessarily bounding novel research studies to where particular niche experiments take place. Ideas such as Carbon Neutral Cities or Transition Towns emerged in particular urban locations, embedded within local networks and hence scales. Their promoters have since struggled to create a more globalised scale at which the concept can achieve an impact (North, 2008). As a result, carbon neutrality all too often becomes a question of offset purchase rather than behavior change, with transition towns becoming idealistic, gentrified spaces (Bailey & Wilson, 2009) rather than general abstract models answering the grand challenge of contemporary urban sustainability (Seyfang et al., this volume).

The final issue lies in a more comprehensive debunking of an ontological hierarchy between different scales (Brenner, 2001); the value of scales lies in their distinction as covering territories over which processes function in distinctively different ways rather than in delineating a power hierarchy. The global is not bigger, better or more powerful than the local – from a scalar perspective (Sayer, 1989;1991): it is important not to imply or otherwise assume this in writing transitions narratives. In relational approaches, actors' power depends

on their relationships and connections within networks across a range of scales. Places[5] can be regarded as having power constructed through the nexuses of actor-relationships which are based in that territory (Amin & Palan, 2001; Oïnas & Malecki, 2002; A. Smith 2003). Thus, places' power evolves over time both in response to changes in the networks of actors strategically coupled to the territory, and as a result of external changes in those networks (Yeung, 2009).

Thus, from the perspective of multi-scalar approaches, transition analyses need to be explicit about scale, and not accidentally make some actors seem big and powerful whilst others seem small and weak. Following Cox (1998), niche experiments can be regarded as 'spaces of dependence' between the actors, but their dynamics are in turn dependent on the wider 'spaces of opportunity' constituted by the networks and relationships within which wider technologies, but also local actors are embedded, and their relative power within those networks. Understanding the trajectory of these niche experiments, and the way that actors seek to extend their scope and depth, requires analyses of transitions that follow the stories of these relationships outwards from local niches into these wider spaces of opportunities, downwards into the deepening local control over transitions, and exploring in detail the complex interplay of these two dynamics in shaping place specific 'local' outcomes (Gibson-Graham, 2002).

These three tools come together in three concrete axioms for a socio-spatial approach to transitions, (1) scales are actively constructed through socio-spatial struggles by actors seeking to achieve their ends (2) following those relationships and struggles allows

[5] We here acknowledge that central to the relational turn that territories do not have power – power is exerted by actors connected through networks which may be more or less bound by a territory. Nevertheless, some places have dense networks and strong actors, whilst others do not, and this influences what other actors in those territories can achieve in terms of the munificence of an environment it creates for autonomous actors (*cf.* Johannissen, 1993).

interpretation of the ways within which small niche experiments become influential in wider regimes (3), and that scales are not fixed and hierarchical. Applying these multi-scalar insights from recent geographical debates to multi-level transition studies helps to nuance the concept of 'aggregation' which we believe to be central to transition studies' contribution. These tools provide greater clarity in defining the scales of transition, how aggregation functions between these scales, and to provide a more consistent understanding of agency and autonomy in transition studies. Aggregation involves both dimensions of broadening and/ or deepening in local actors relational networks – successful transitions are those in which local actors either increase the degree of local control over their situation (such as Freiburg city managed) or involve increasing numbers of external agents in their local experiments (the California Fuel Cell Partnership)..

5. Conclusion and discussion: towards a socio-spatial construction of transition paths

In this paper, we have identified two major shortcomings in the implicit treatment of geography in studies of transition processes and dynamics within the Technological Innovation Systems and Multi Level Perspective approaches. Firstly, existing analyses, drawing predominantly on single or comparative case studies, fail to explain if and how (spatial) contexts matter. Even though there is increasing interest by transition analysts into the role played by differing contexts in shaping the co-evolution of technologies, actors and institutions, context is treated at best as a passive background variable providing little causal explanation or theoretical purchase. We argue instead that adopting an explicit geographical perspective is necessary to disclose the contingencies and particularities of the various contexts where transition pathways evolve and take place in order to develop a better theoretical understanding of factors enabling or impeding these processes (Asheim, 2006; Lagendijk, 2006).

As a second, related, issue, we question the problematic usage or lack of scale in existing transition analyses. The absence of concrete territoriality in the scales of transitions (*inter alia* the global being ubiquitously 'out there' and accessible), reduce their size to the head of a pin, thereby overlooking the advantages, conflicts and tensions which arise in these wider networks within which transition processes are embedded. This blind spot may very easily lead to the naïve notion that sustainability transition may take place *anywhere*. Tying these critiques together we suggest an institutional-relational perspective that conceptualizes transitions as interdependent processes between territorialized, local and trans-local networks within the context of (changing) multi-scalar, multi-actor governance structures. In that sense, our view resonates with Coe *et al.*'s (2004) dialectic view on global networks and local clusters (see also Yeung and Peck (2003) and Gertler (2004)).

We contend that transition research would do well to take a closer look at the global networks and local clusters[6] of transition pathways in conceptual, methodological and empirical terms. Conceptually this means that transition analyses, whether through the lens of technological innovation systems or the multi level perspective, should start to explore, and partly revisit, the meaning played by particular places in the evolution of transitions. A central topic for further investigation concerns the existence of complementarity and strategic coupling effects between localized assets (technology, actors and resources) and institutions on the one hand and activities, needs and interests of trans-local actors on the other. We hypothesize that these global-local nodes may hold privileged positions in global transition networks, and make substantial contributions to transition pathways in particular localities. This allows for a differential and interconnected framework to unpack the geographies of transitions, and more specifically, it raises questions about whether certain (types of) localities can draw upon scale

[6] With clusters we refer to concrete geographic concentrations or agglomerations of actors, institutions and technologies involved in specific transitions pathways. The cluster concept (Porter, 1998) can be one of many theoretical in-road to analyze this phenomenon.

and scope effects through sheer size, highly localized concentrations of knowledge and capabilities or other intangible spillover effects. An important first step in categorizing transition places could be made by distinguishing places drawing on urbanization advantages encompassing a great (and partly related) variety of assets (see also Cooke, 2009), and those drawing on localization advantages derived from specialization in capabilities and activities (Lagendijk and Oinas, 2005). In terms of institutional structures, this framework helps to map the presence of multi-scalar institutional interdependencies, complementarities as well as incoherencies. Here it is crucial to emphasize that institutions salient to the local scale also include supra- and extra-local institutions that affect activities within the locality without necessarily having a physical presence there.

Methodologically, we point to two sets of issues. Firstly, a "local node, global network" framework helps to open up the scalar boundaries that unconsciously have been drawn in many comparative TIS and MLP case studies. An explication of the territorial setting in which these cases are embedded helps in teasing out and understanding whether geography matters. This makes clear which decisions local actors have been able to influence and to what extent have been in control of their own destiny. It allows for a more informed choice of cases and more fine-grained comparability of findings as it keeps the systemic nature (considering the way interconnected actors, institutions and technology cohere into a system) of the cases intact. Developing and refining typologies will provide a valuable concrete approach for establishing comparative research, as for example has been done successfully in the literature on regional innovation systems (Cooke, 1998; Asheim and Coenen, 2005; Tödtling and Trippl, 2005). Secondly, a "local node, global network" framework provides a useful heuristic for delineating systems, by following the network to wherever it leads, instead of setting system boundaries in an arbitrary and closed-off way. In other words,

researchers allow transitions to speak for themselves, in a manner of speaking, based the way actors themselves develop relationships over space.

Finally, at an empirical level, acknowledging the socio-spatial construction of transition paths contributes to a better transferability of findings and, thus, of practical relevance and policy advice. Unfolding the global networks and local networks involved in particular transition paths clarifies which actors are involved in its governance. In light of globalization, this suggests it would be rather naïve to try to steer transition pathways from a narrowly defined national agenda (e.g. the Dutch Energy Transition Program). Geographical reality has grown more interconnected and the global scale is developing at a rapid rate. Trans-local and trans-national network relations and institutional interdependencies need be acknowledged by policy-makers and 'transition managers' even though they may extend beyond their sphere of influence. It is therefore crucial to steer transition pathways studies back towards a solid heartland of generating empirical insights about the distinctive local conditions shaping evolutionary change, making clear at the same time the wider relations of control, dependency, competition and cooperation which influence what can be locally achieved.

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To be added.

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