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What is protective space? : reconsidering niches in transitions to sustainability

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What is protective space?
Reconsidering niches in transitions to sustainability

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What is protective space? Reconsidering niches in transitions to sustainability

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Abstract

The transitions literature emphasises the role of niches, defined as a protective space for path-breaking innovations. Surprisingly, the concept of protection has not been systematically interrogated. Our analysis identifies protection as having three functions in wider transition processes: shielding, nurturing and empowerment. Empowerment, understood as processes and mechanisms that contribute to changes in mainstream selection environments in ways favourable to the path-breaking innovation, is considered the least developed in current niche development literature. We argue that these properties need to be understood from an agency perspective, with attention for the politics involved in their realisation. The paper ends with an outlook upon two promising research avenues: 1) the reconstruction of niche development pathways in light of the present framework; 2) analyses of the diverse (political) narratives seeking to empower niches across time and space.

1. Introduction

Sustainability transitions research emphasises the role of niches as a source for path-breaking innovation. A defining characteristic of these niches is that they afford temporary '*protective space*' for the configuration and development of such innovations (Schot et al., 1994; Kemp et al., 1998). Initial protection is deemed essential, because path-breaking innovations fail to successfully compete within selection environments embedded in incumbent socio-technical regimes. Hence, the protective space is needed to shield the innovation against (some of) the prevailing selection pressures. Within this protective space, niche actors can nurture the path-breaking innovation so it becomes more robust through performance improvements and expansions in supportive socio-technical networks. Initial technology niches (e.g. the use of solar electricity in satellites, or in remote development projects) give way to more conventional market niches (such as building-integrated photovoltaic systems). As the innovation enters broader and more diverse markets, so the need for protection falls away progressively, and the innovation becomes competitive and influential in contributing to regime shifts (or transitions) towards sustainability.

That, at least, is the argument in the literature. It is therefore surprising that the concept of 'protection', so foundational to transition studies, has received little systematic attention. Even responses to criticism from Hommels *et al.* (2007; see Geels and Schot, 2007b), about the undesirability of protection in innovation, have not prompted serious reflection on what protection is, where protection comes from, who is involved in shaping protection, and how protection is transformed and declines as transitions come about.

In his paper we argue that the limited conceptualisation of niches as protective spaces has two shortcomings. First, most of the empirical and conceptual work has focussed on processes and patterns in *shielding* and *nurturing* path-breaking innovations, despite the initial problem framing of

niches as potential mechanisms in broader processes of regime shifts. This is understandable, because the foundations of niche-based approaches were developed during the 1990s, when sustainable innovations were still searching for or surviving in early niche markets.[1] Although later work, especially in the context of the multi-level perspective (Geels, 2002), has reframed the research topic and unit of analysis to understand transitions, ideas and conceptualisations of how path-breaking innovations escape their protective spaces and interact with wider regime change processes are still poorly developed (STRN, 2010). In this paper, we propose to unpack the notion of protective space by adding *empowerment* to the list of functional properties that niches have in wider transitions. In short (we will elaborate on the notion in section 4), empowerment refers to niche-influenced changes in regime selection environments in ways favourable to the path-breaking innovation.

Second, while thinking of niches as being functional in transition processes might be attractive to more managerial 'outsider' perspectives on niche development, it runs the risk of not being able to capture the 'generative forces required to initiate and then sustain an initiative' (Garud et al., 2010:761; Smith and Stirling, 2007). Therefore we will develop in the second part of the paper an 'insider' perspective that highlights the *agency* required in protective space dynamics. Moreover, as support for sustainability innovations expands and becomes more mainstream, so a greater variety of advocates will be arguing for support for *their* particular niches (Shove and Walker, 2007), but not all will enter these negotiations equally. Hence, the second part of the paper will also address the *politics* involved, with a particular focus on the role of political *narratives* in empowerment. The propositions in this part of our analysis are informed by insights from recent literature on institutional change (Phillips et al., 2004; Hardy and Maguire, 2010; Lawrence et al, 2009; Battilana et al., 2009; Garud et al., 2010; 2007; Zietsma and Lawrence, 2010; Hargrave and van den Ven, 2006) and network governance (Kooiman, 2003; Jessop, 1998, 2003)

Hence, there are two analytical questions guiding our discussion:

- How can we understand and analyse the dynamics of protective space in sustainability transitions in a more systematic way?
- How can agency and politics in protective space dynamics be captured in such a framework?

While the paper is mainly theoretical, we use examples from solar electricity (PV) to illustrate our argument in several places. The remaining part of the paper is structured as follows. We will first summarize the argument found in the literature on protective space on shielding (section 2) and nurturing (section 3). These sections will mainly draw upon existing literature on niche development and relevant insights from the technological innovation systems approach, though in a new, more systematic fashion. Section 4 will make a new contribution to sustainability transitions research by discussing empowering as a third functional property of protective space. Section 5 makes a second new contribution with a proposed framework for agency and politics in protective space dynamics. We end the paper with conclusions and outlook in section 6.

2. Shielding path-breaking innovations against mainstream selection pressures

Drawing upon evolutionary theory, a key feature of socio-technical regimes is the way they function as selection environments for the creation and retention of innovative variants (see Rip and Kemp,

[1] We refer in particular to strategic niche management (Schot et al., 1994; Kemp et al., 1998) and the technological innovation systems approach (Carlsson et al., 1991; Johnson, 1998)

1998; Geels, 2002; Smith *et al.*, 2010). Alignments and mutual interdependencies across multiple socio-technical regime dimensions generate processes of lock-in and path-dependency that privilege the historically accumulated ways of doing things. Path-breaking sustainable innovations are at a structural disadvantage within these contexts, because they are too demanding in terms of their socio-technical implications.

Early regime concepts focused predominantly on socio-cognitive processes that influence which technological developments engineers (and others, mainly in firms) deem to be feasible and worth developing (Nelson and Winter, 1977; Dosi, 1982).[2] Later conceptualisations broadened the notion of regimes to incorporate a wider set of sociological processes of selection operating beyond firms and research institutes, in an attempt to get to grips with their emergence and decline (van den Belt and Rip, 1987; Kemp, 1994; Rip, 1995; Rip and Kemp, 1998; Geels, 2002; Smith 2007):

- Established *industry structures* form a selection environment through, for example, established network relations, industry platforms, strong user-producer interactions, shared routines and heuristics, existing capabilities and resource allocation procedures. Path-breaking innovations entering the market might be rejected because they do not fit with existing industry structures and decision making processes that have emerged in co-evolution with the dominant design.
- Dominant *technologies and infrastructures* form a (material) selection environment, for example, through articulated technical standards and infrastructural arrangements, which are imposed on new innovations. Path-breaking innovations may require different standards and infrastructures in order to perform (technically and economically) optimally, and as a result are perceived as not feasible.
- Guiding principles and socio-cognitive processes in the established *knowledge base* are paradigmatic and geared towards incremental knowledge development rather than paradigmatic shifts. Path-breaking innovations are rejected because insufficient resources are attributed to new knowledge development, RD&D and so on, and academic and private research institutes perceive disincentives because of a lack of dedicated journals, conferences and research groups.
- *Markets and dominant user practices* form a selection environment through stabilised market institutions, supply and demand, price mechanisms, user preferences and routines. Path-breaking innovations have a hard time entering the market, for example, because external environmental costs are not represented in end-user prices, or because they require inconvenient user practices compared to accustomed habits.
- *Public policies and political power* form a selection environment through, for example, prevailing regulations, policy networks and relations with incumbent industries. Political power is exercised to maintain the status quo, in terms of jobs, tax base, and votes, which is a disadvantage for path-breaking innovations, because they require different policies and regulations, and even new political economies.
- The *cultural significance attached to a specific regime* forms a selection environment through, for example, its widespread symbolic representation and appreciation. Path-breaking innovations are put at a disadvantage, because they represent different cultural values and lacks widespread stabilised representations.

Hence it has been argued by various scholars in the field of evolutionary theories that path-breaking innovations tend to develop in niches that *shield* those innovations from mainstream selection

[2] In the Nelson-Winter-Dosi model, heuristics are deployed which promise, but do not guarantee, solutions to problems and opportunities (Schot, 1992). This constituted an *ex ante* mechanism for selecting among 'technological paradigms' - what Dosi (1982) called the 'direction of mutation' (p.156). Added to this is *ex post* selection between variations in markets (Dosi, 1982), broader social and economic institutions were also noted to shape innovation, but were not elaborated (Dosi, 1982; Nelson, 2008; Metcalfe, 1998).

pressures (Schot, 1992; Levintal, 1998; Basalla, 1998; Mokyr, 1990; Rip and Kemp, 1998; Glynn, 2002; Raven, 2006; See Schot and Geels, 2008 for a review of this literature). Here we define shielding as processes and mechanisms that hold at bay certain selection pressures from mainstream selection environments, and add to this literature that it is possible to make an analytical distinction between passive and active niche spaces.

Initial niches can be passive spaces where the selection pressures are felt less keenly, and in a sense precede mobilisation by advocates. These could be geographical spaces, such as regions outside the reach of centralised energy grid infrastructures, for which expanding infrastructure would entail relatively high costs or even be impossible. These remote spaces find alternative more feasible, such as solar cell applications in space in the 1960s. Advocates of decentralised energy technologies have mobilised these spaces as initial geographical application domains for developing and selling their products. But passive shielding could also entail institutional spaces not linked to specific path-breaking innovations. One example is the generic public support for materials research, which was mobilised by academic advocates to do research on solar cells in the 1970s. Another example is an environmentalist milieu with different cultural values and whose members are willing to trade-off, say, higher cost or lower performance on conventional terms, because an innovation performs better environmentally and/or is deemed to be more socially just. In the case of sustainability, environmentalists and civil society organisations have often been proactive early adopters of a variety of sustainability innovations (Truffer, 2003; Smith, 2007). In sum, we define *passive protective spaces* as *generic* spaces that *pre-exist deliberate mobilisation* by advocates of specific innovations, but who exploit the shielding opportunities they provide.

A few scholars have also argued that niches can be constructed more actively through strategic niche management interventions (Kemp et al., 1998). Obviously technology policies play an important role in such interventions. These include classic supply-side measures for counter-acting cost differentials or performance characteristics (e.g. regulations, tariffs, and taxes), but also demand-side measures that try to alter preferences (e.g. quotas, public purchasing, information campaigns, market segmentation). For example, between 2008 and 2011 specific public policies provided financial investment support for Dutch households to purchase solar cells for their rooftops, as have other OECD governments. Active shielding could also entail specific interventions originating from non-policy actors. Examples are private initiatives such as the establishment of R&D programs in firms seeking to expand their product portfolio over the longer term to include, for example, solar cells in a wider portfolio of energy generating technologies; or bottom-up, civil-society initiatives such as solar cell cooperatives like 'Wij-willen-zon' established in the Netherlands in 2011 to bulk-buy solar cells at lower prices.[3] Instead of searching (or waiting) for the right context conditions, active shielding policies are about an encompassing approach to re-conditioning the selection environment. In sum, we define *active protective spaces* as those spaces that are the result of *deliberate and strategic creation* by advocates of *specific* path-breaking innovations to shield regime selection pressures.

Table 1 provides a summary of the different regime dimensions, selection pressures, the logic of the need for protection and some examples of active and passive protection. It is important to note here that the different protective examples do not necessarily shield a single selection pressure. Indeed, we believe effective protective measures work across multiple dimensions of selection pressure.

[3] 'We-want-sun' is a Dutch foundation established in 2010 to enable the uptake of solar energy without public support. The first 5000 solar panels have been installed in 2011.

Table 1: socio-technical selection pressures and protective space

Regime dimension	**Selection pressures**	**Logic of the need for protective space**	**Example of passive protective space**	**Example of active protective space**
Industry structure	Organisational networks, industry platforms, user-producer networks, shared industry routines, labour force, capabilities, etc	*Industrial protection:* Path-breaking innovations do not fit into established industry structures; need for new capabilities; different user-producer relations and business models; shifts in resource allocation procedures	Firms outside the incumbent energy regime, such as farmers, who are interested in becoming producers of green electricity	Annual industry PV meetings; establishment of solar cell industry platform
Technologies and infrastructures	Technical standards, infrastructural requirements, etc	*Technological protection:* Prevailing technical standards and infrastructural requirements can disadvantage path-breaking innovations, which require different standards and infrastructures to technically and economically perform effectively and efficiently	Rural areas out of reach of centralised electricity networks are a distinct selection environment for decentralized electricity production and infrastructures	Private initiative for the development of specific norms and standards for solar cells
Knowledge base	Formal research programs and groups, review procedures and preferences of established journals, paradigms, etc	*Socio-cognitive protection:* Prevailing knowledge development is paradigmatic and institutionally organised in established journals, research departments and conferences, which disadvantages knowledge development for path-breaking innovations	Generic innovation support schemes for R&D	Establishment of PV research programs and training schemes; dedicated journals and conferences; PV-specific training schemes and best practice publications
Users relations and markets	Market rules and institutions, user practices and preferences	*Market protection:* Market rules and user routines and preferences associated with the prevailing regime disadvantages path-breaking innovations, which require different ways to organise market transactions and different user routines	Demand for green energy from environmentalists willing to pay higher prices and accept lower performance	Investment program to lower prices of PV cells for households;

Public policies and political power	Administrative regulations, policy goals, power relationships, policy guiding principles, etc	*Political protection:* Existing policies are optimised for the status-quo, which is enforced by political powers; regulations create a disadvantageous selection environment for path-breaking innovations	Outsider policy entrepreneurs with diverging political views	Promises and claims about solar cells in political programs; or white papers
Cultural significance and associations of the regime	Media laws and preferences, symbolic meanings of technologies, cultural value of innovation, etc	*Cultural protection:* Widespread cultural legitimacy and symbolic representation associated with the prevailing regime disadvantages path-breaking innovations representing different values	Prevailing environmental values of dedicated social groups such as environmentalists or civil society groups	New media discourses linking PV technologies with high-tech values in society

In sum, the literature notes how mainstream selection environments hinders path-breaking innovations. Because selection environments are multi-dimensional, path-breaking innovations require multi-dimensional forms of protection. These might be deliberately created spaces through innovation-specific public or private interventions (active) or generic spaces pre-existing mobilisation by advocates of specific innovations (passive). Whether passive or active, the function of such protective spaces in transitions to sustainability is to provide an environment where regime selection pressures are held off in a way that allows path-breaking innovations to be nurtured and further developed.

3. Nurturing path-breaking innovations in protective spaces

Whenever and wherever shields are mobilised or established, the space that becomes available provides an opportunity to nurture a path-breaking innovation. We define nurturing as processes and mechanisms that support the development of the path-breaking innovation. Ideas about nurturing emerging innovations in niches have been dealt with at length elsewhere in the literature. Here we provide a brief summary of two frameworks, i.e the strategic niche management approach and the technological innovation systems approach. We summarise the TIS approach here for two reasons. First, the strategic niche management approach has until now focused on experimental projects as the main space for nurturing path-breaking innovations.[4] The TIS approach has a more elaborate framework of mechanisms, processes and spaces for nurturing (Markard and Truffer, 2008). Second, as we will argue below, the framework developed here can contribute to expanding both these key frameworks in transition studies with the concept of empowerment.

The key niche nurturing processes in the strategic niche management literatures are: assisting learning processes, articulating expectations, and helping networking processes. A review of case studies (Schot and Geels, 2008) suggests that: a) expectations contribute to successful furthering of the novelty when they are robust (shared by many actors), specific, and of high quality (substantiated by ongoing projects); b) social networks contribute when their membership is broad (plural perspectives) and deep (substantial resource commitments by members); and c) learning processes are broad, covering issues on a variety of socio-technical dimensions, not only accumulating facts, data and first-order lessons, but also generating second-order learning about alternative ways of valuing and supporting the niche (ibid; Hoogma *et al.*, 2002).

The current niche literature focuses on 'experiments' as key arenas for nurturing (Kemp et al., 1998). Experiments can be defined as 'initiatives that embody a highly novel socio-technical configuration likely to lead to substantial sustainability gains' (Berkhout et al., 2010). The path-breaking innovation is conceptualised to develop through the above relations operating across these located socio-technical experiments (Geels and Raven, 2006). Dedicated intermediating work is needed for interactive learning to take place, expectations to develop, and supportive networks to build (Raven *et al.*, 2008; Smith, 2007). Niche theory currently claims that, in time, an innovation-specific proto-regime emerges that shields and nurtures that innovation more actively. In the current literature this process is considered to operate on two levels (figure 1). 'Local' relates to experimentation in specific places with local contexts, supported by local networks, and generating lessons accordingly. 'Global' refers to an emerging institutional field or proto-regime supported by a network of actors that is concerned with knowledge exchange and resource flows transcending local contexts. This

[4] The focus on experiments as main space for nurturing is because of the initial problem framing of strategic niche management research, which was interested in why many environmental innovations never make it to the market (Schot and Geels, 2008). Experimental projects in real-life contexts were seen to be critical in bridging the infamous Valley of Death by bringing together actors from variation and selection environment in shared networking and learning activities.

field is constituted by actors such as industry platforms, user-groups and other intermediary organisations and operate partly autonomous from local experiments (Grin, 2010).[5]

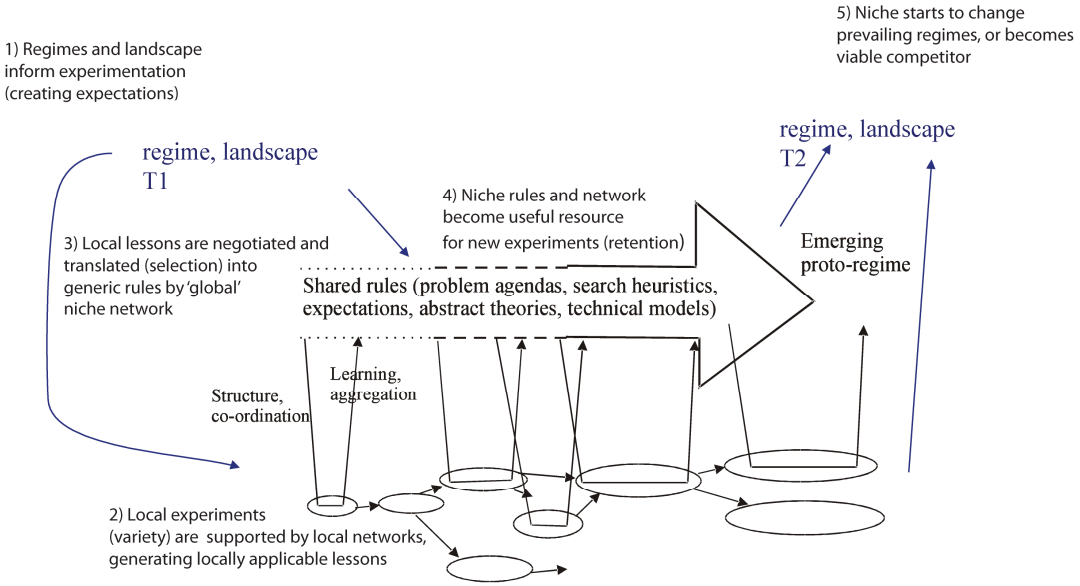

Figure 1: local-level and global-level niche development processes (adapted from Geels and Raven, 2006)

Recently the literature on technological innovation systems (TIS) has further increased our understanding of nurturing path-breaking innovations from a systemic perspective. A TIS analysis usually involves the identification of an emerging system in terms of its actors, networks and institutions; an analysis of the 'functions' or 'processes' occurring within that system in terms of knowledge development, resource mobilisation, market formation, influence on the direction of search, legitimation, entrepreneurial experimentation and development of positive externalities; and on the basis of these analyses a normative assessment of the performance of the emerging system, critical inducement and blocking mechanisms, and key policy issues (Bergek et al., 2008).

The TIS approach distinguishes between two main stages of system evolution (Jacobsson and Bergek, 2004). The 'formative stage' is characterised by relatively long development periods (rarely shorter than a decade), substantial (technological and market) uncertainties, underdeveloped price/performance ratios of products, relatively small volumes of production and economic activities (compared to estimated potentials), unarticulated demand and an absence of self-reinforcing features (Bergek et al., 2008). In this phase technology-specific systemic structures (actors, networks, and institutions) need to be put in place and aligned. Dedicated knowledge creation, (early) market experimentation and formation, entry of firms and gaining wider legitimacy for the technology through the formation of advocacy coalitions are at the heart of the formative stage. This

[5] The dynamics in fig. 1 can be stylised as follows (Raven, forthcoming). First, regime dynamics and wider dynamics in the 'socio-technical landscape' (Rip and Kemp, 1998) inform experimentation through the creation of new expectations and new social networks. This can include firm-level initiatives to apply innovations in market niches or distributed grassroots initiatives by civil society starting in specific locations, but also targeted initiatives through for example an industry platform or targeted policy program. Second, emerging local networks experiment with novel socio-technical configurations and learn how to make that configuration work within a specific place. Third, (some participants in) local networks perform work (e.g. participate in knowledge workshops, meetings with policy makers, meet with other interested actors, exchange experiences with other projects) and local lessons may aggregate into trans-local rules. These (initially often ad-hoc) experiences can translate into norms and rules that become applicable across specific locations (e.g. through the publication of manuals or an adaptation in policy and regulations). Fourth, the emerging proto-regime becomes a useful resource for subsequent experiments in new locations or application domains. This, in turn, may generate a new cycle of local re-framing and learning, aggregation and coordination. Fifth, when sustained over sufficiently long periods of time, such cycles result in a stabilised proto-regime that can start to influence prevailing regimes and become a viable competing socio-technical configuration.

formative stage can be considered to cover a similar stage and dynamic as the emergence and stabilisation of a global niche shown in figure 1. The formative stage needs to be followed by a 'growth stage', in which 'the focus shifts to system expansion and large-scale technology diffusion through the formation of bridging markets and subsequently mass markets' (Bergek et al., 2008:420). The dynamics of this stage has received less attention in the TIS literature compared to the formative stage, although progress is being made through the concepts of positive feedback loops, cumulative causation and identification of different 'motors', which are about identifying patterns in interactions between functions that set the stage for a subsequent growth stage (Jacobsson, 2008; Suurs, 2009).

While the TIS framework provides a detailed framework for understanding *nurturing* of innovations, the actual success of innovations is mainly regarded as a consequence of the performance of the innovation system itself. As such, it is 'inward looking, and does not pay much attention to the system's environment' (Markard and Truffer, 2008:610). Consequently, from the perspective developed in this paper, it can be argued that TIS approaches do not pay much attention to the *shielding* of emerging innovation systems against mainstream selection pressures, and is only able to study the internal consequences of dynamics in the wider selection environment upon an emerging system. In other words, it is not able to highlight the interplay between the wider selection environment of an emerging system and internal system dynamics as an endogenous explanation in the emergence of that system. Similarly, one might expect, despite its distinction between a formative stage and a growth stage, a TIS analysis will find it difficult to explain mass-market diffusion of path-breaking innovations, because that would inevitably involve many interactions between an emerging system and its environment. In other words, 'an innovation systems approach is myopic with regard to the explanation of technological transitions' (Markard and Truffer: 2008:610).

However, the same is also true for the niche literature: it is unclear precisely how proto-regimes compete and transform incumbent regimes. Some TIS scholars have highlighted the importance of (institutional and political) dynamics in the *empowering* of path-breaking innovations (Jacobsson and Lauber, 2006; Hellsmark, 2010). It is here that both the strategic niche management and TIS literatures need to develop their theory, and where we offer an initial analytical contribution.

4. Empowering path-breaking innovations

Here we define empowering as the processes and mechanisms that change mainstream selection environments in ways favourable to the path-breaking innovation. There is currently some confusion in the niche literature regarding protective spaces and the transformation of selection environments. On the one hand, protective spaces are 'temporary' sites that are conditional upon improvements to the innovation being nurtured in that space. Innovations are nurtured into sufficiently robust forms that become competitive under conventional, incumbent regime terms, and so the protective shields can be removed. On the other hand, institutionalisation of niche practices is also advocated in the strategic niche management literature, which suggests some features of the niche space persist as new norms and routines in a transformed regime. In both cases, the protective space has to empower the innovation, but in two different ways; something that their conflation in the existing literature overlooks (Hoogma et al., 2002). These two types of empowerment are:

1. The protective shields are **removed** in relation to performance improvements of the path-breaking innovation to compete under existing regime selection pressures (i.e. the innovation evolves and adapts to **fit and conform** to prevailing regimes). The innovation

becomes a new element in on otherwise unchanged regime, as such, its 'path-breaking' potential is lost and 'transition' is deferred.

2. The protective shields and niche practices are **institutionalised** as part of a new, re-configured regime largely based on new (sustainability) criteria originally made manifest in the niche (i.e. the innovation **stretches and transforms** prevailing regimes).

Below we will elaborate on these two types of empowerment.

4.1 Empowering to fit and conform

Fit and conform empowerment makes the path-breaking innovation competitive with mainstream socio-technical practices in otherwise unchanged selection environments. An innovation that is originally perceived as potentially path-breaking becomes incremental in terms of its broader socio-technical implications. This is not a problem on narrow socio-economic terms, because the cumulative economic impact of incremental innovations is considered large, if not larger than more disrupting forms of innovation (Lundvall, 1992; Fagerberg, 2006). From the perspective of transitions to sustainability, however, there are at least two challenges related to fit and conform empowerment.

First, ironically, the processes in protective spaces that enable innovations to become more competitive in conventional regime terms, such as improved alignment with existing industrial norms or structures, can actually by quite disempowering in terms of sustainability. There is always pressure for sustainable path-breaking innovations to become competitive on the more narrow economic, technological, organisational and other criteria of existing markets, compared to the broader sustainability values that might originally have motivated the innovative effort, but which remain externalities in conventional markets. Moreover, even if cost reductions are realised while maintaining sustainability performance improvements, rebound effects and economic growth can counteract these performance improvements in the long run (van den Bergh, 2011; Jackson, 2009). As such the sustainability of the innovation itself is often reduced through this pressure to fit and conform.

Second, providers of protective shields might find it challenging to govern the performance improvements that allow protections to be removed. This is most vividly illustrated in the infant industry literature (Chang, 2002; Bell, 2006; Cimoli *et al.*, 2009; Gallagher, 2006; Jacobsson and Alam, 1994; Bastos and Cooper, 1995), whose concern for protective spaces are shared with niche-based approaches to sustainability (Caniels and Romijn, 2008). In this literature, the nurturing of infant industries to maturity involves their initial protection with a view to accumulating innovation capabilities that allow the (subsequently unprotected) sector to compete internationally. The more disappointing experiences with import-substituting industrialisation, however, show that protected industries might be captured by those interested in perpetuating the rents accruing to under-performing firms in that space, without further improving the capability for competitive innovation. Historical experience indicates how difficult it can be for governments to credibly compel protected firms to learn and acquire new innovative capabilities, and that even well-intended governments can find it hard to independently withdraw public protection from infant industries that are not improving (Schrank, 1997). This might be because those industries have become politically significant constituencies for them to be abandoned (e.g. important for the labour and/or capital interests upon whom government elites are dependent).

A complementary to fit and conform empowerment in the context of sustainability transitions is, therefore, the development of 1) institutional reforms that transform incumbent regimes; and 2)

political capacity to avoid protective space becoming captured by sectional interests, and to ensure protection stimulates the dynamic accumulation of innovative capabilities for sustainable development (Wade, 1990; Nill and Kemp, 2009).

4.2 Empowering to stretch and transform

It is this risk of protective space becoming an institution that shields poor innovation that underpins the critique of niche approaches made by Hommels *et al.* (2007). Historical experience suggests protection is ever-present, however, and the challenge is to empower niches to open up debate about where public support should rest in innovative activity. The protectionism that has dogged attempts at infant industrialisation finds a parallel in sustainability transitions in terms of historically institutionalised protection in incumbent regimes. Current fossil energy regimes, for example, have 'protection' institutionalised within them.[6] Though perhaps originally institutionalised for good reasons at the time (e.g. cheap fossil fuels as a way to further economic development and social welfare), those regime privileges effectively hinder development of alternatives under the changed circumstances of societies being threatened by climate change or other sustainability problems.

These institutionalised regime privileges imply a second form of empowering, i.e. stretch and transform. In this case, empowering innovations aims to undermine incumbent regimes and transmit niche-derived institutional reforms into re-configured regimes. The process and content of stretching and transforming will not be entirely internal to the niche, but will rely upon other processes of change within the regime and in the broader society and economy. Important considerations here are the general influence that sustainability advocates have in the institutionalisation of environmental values and social justice in society and in their influence over political economy. Stretch and transform empowerment will include 'control' policies applied to regime actors and which seek to introduce environmental regulations, fiscal measures or quotas, and that incline them more favourably towards investment in niche solutions. Empowered niches play a role in those politics as emblems for more sustainable alternatives, and as such they can inform processes of institutional reforms, even if they rarely drive those processes (Smith *et al.*, 2005).

It is possible to observe this process as niches mature and become more established. So, for example, representatives of the solar energy industry demand that infrastructure investments are made on their terms, and in places that suit the location of their solar installations, rather than refurbishment or expansion of grids under the norms of the existing electricity system. Similarly, the solar industry is pressing for reforms to electricity markets that fit the technical and operational characteristics of solar energy socio-technical configurations, such as the system-level management of intermittent sources of supply. Successful niches will create capabilities and attract resources that empower participation in heated political debates over the future shape of institutional selection pressures such as these. A well known example of stretch and transform empowerment is the German feed-in tariff, which 'may well be seen as the first sign of a breach into an old structure' (Jacobsson and Lauber, 2006:272), and is the outcome of networks of (industrial, administrative and grassroots) advocates of green electricity innovations being able to accumulate political power to overcome the defensive strategies of the established network of German utilities, the Ministry of Economic Affairs and DG Competition (Dewald and Truffer, forthcoming).

Such institutionalisation of niche practices is advocated in the strategic niche management and TIS literature, but the processes of institutionalisation have not been systematically interrogated (Smith

[6] Although estimations differ widely, energy regimes have been reported to benefit from various direct and active protection in the form of subsidies and other public policies (Steenblik, 1995). Recently, the International Energy Agency estimated that global fossil fuel consumption subsidies amounted to $312 billion in 2009 compared to $57 billion for renewable energy. Research funding for fossil fuels over the past 10 years has mounted to $22 billion, compared to $17 billion for renewable energy and energy efficiency and $56 billion for nuclear energy research (IEA, 2011). More generally it has been estimated that between 1994 and 1998 over US$ 1 trillion was spent worldwide on subsidies that potentially harm the natural environment (van Beers and van den Bergh, 2009).

and Stirling, 2010). Reforming institutions or creating new institutions requires power, expressed through the mobilisation of material and nonmaterial resources, and collective action capable of shaping norms, standards and routines (Rhodes and Marsh, 1992; Smith *et al.*, 2005; Avelino and Rotmans, 2009). On our terms, we can see that institutionalisation actually involves transforming *multiple* selection environment dimensions in many different sites where socio-technical innovation takes place such as industry platforms, laboratories, experimental projects, policy arena's, markets, etc. That means institutional changes that re-order selection environments hitherto constituted by regime infrastructures, industrial organisation, knowledge production, search heuristics, user relations and markets, and cultural presumptions (table 1). We discuss the possibilities and limits for sustainability niches to exercise such agency in the next section.

5. Agency, politics and narratives in protective space dynamics

So far, we have identified three functions of protective space – shielding, nurturing and empowering. Seeing protective space as something functional to the imperatives of niche development, and that ought to shield, nurture and empower in certain ways for sustainability transitions, appears reasonable from a managerial or outsider perspective (Garud et al., 2010; Smith and Stirling, 2007).

However, empirical research demonstrates how challenging it is to develop these functions in practice: ideas for how protective space *ought* to operate soon encounter confounding and conflicted realities (Lovell, 2007; Voss *et al.*, 2009). An empirical focus on niche actors, and 'the melee of real-life dynamics, interactions, and of everyday practice' (Leach *et al.*, 2007: 24; Hughes, 1983), soon indicates why any protections secured often tend to be incomplete or insufficient, from the perspective of niche advocates and strategic managers, and as a result have consequences for the development of socio-technical alternatives that fall short of their ideal (Smith, 2007; Romijn *et al.*, 2010). Analysing and theorising the dynamics of niche-based approaches to sustainability transitions has to be complemented with an insider perspective that emphasises the embedded agency of actors involved in both niche construction and regime reproduction (Garud et al, 2010; (Zietsma and Lawrence, 2010; Smith and Stirling, 2007). Moreover, such a perspective also has to be politically informed, because, ultimately, niche agency results from advocates within different institutional positions and unequal access to resources influencing powerful actors more usually associated with incumbent regimes. Niche solutions have to come to present a realistic resolution to instabilities, conflicts and tensions experienced by actors within regimes; such that institutionalising niche outcomes, rather than continuing with the routines in the wider socio-technical regime, becomes accepted by a sufficiently powerful coalition capable of bringing the changes about. Niche protection is about power and antagonisms, and it is this that makes it political (Mouffe, 1996).

So, in this section we explore how agency and politics play out in shielding, nurturing and empowerment. We define agency as the realisation of the capacity of actors to translate their potential for action into actual practice (Scott, 2006). We see agency as the result of a collective and embedded capacity and hence developed and reproduced through actor networks and within the context of emerging structures (Garud et al., 2010). Finally, we explore what this means for the politics of niche protection, in which collective industrial and public policy support is secured for niches in the context of historically powerful incumbent regimes. Following recent literature on institutional change and network governance we will focus on narratives as a key political strategy to argue for empowering institutional reforms. Empowerment receives the most attention here, as this is the least developed part of the dynamics of protective spaces.

5.1 Agency in shielding, nurturing and empowerment

As discussed in section two, path-breaking innovations usually require some sort of *shielding* to prevent premature rejection as a result of mainstream multi-dimensional selection pressures. From an agency perspective, shielding results from the actual realisation of the collective capacity of niche advocates to set in motion processes that negate regime selection pressures. This includes holding off selection pressures in the various dimensions of the regime selection environment identified in table 1. The actual realisation of this capacity is enabled and constrained by dynamics in the broader regime and landscape processes, which provides a dynamic context for niche advocates. As such, agency in shielding involves a range of outward oriented negotiations and interventions from niche advocates to convince others to provide sites and resources to the niche. This includes global niche advocates negotiating expectations and making deals with potential partners to mobilise prior favourable sites (i.e. passive spaces) for local projects (Raven et al., 2008; Raven et al., forthcoming). Niche advocates might also raise promising expectations and lobby and bargain for the creation of active spaces for generating resource flows from policy-makers, funders, investors and businesses directly into the niche. Examples with solar photovoltaics include lobbying for implementation of a public policy investment program for solar cell applications (to hold off market selection pressures) or making promises about future efficiency improvements and market potential (to hold off industrial selection pressures for short-term profitability). In sum, agency for shielding involves actors establishing the protective boundaries to initiate experimental projects.

From an agency perspective, *nurturing* results from the collective capacity of niche advocates to improve and further the development of a path-breaking innovation within a shielded space. Hence, agency in nurturing processes is mainly inward-oriented and different from the more outward-oriented agency in shielding and empowerment.[7] The protective space itself forms the (emerging) context within which niche advocates strategically operate. The current literature provides a host of insights about the processes and functions involved in successfully nurturing path-breaking innovations (see section 3). Locally, networks of actors negotiate design and outcomes of specific projects in markets, firms, policy arenas, R&D departments and so on, and produce and make sense of locally applicable lessons (Law and Callon, 1994). Globally, agency is the result of a collective act through the formation of heterogeneous networks that support the exchange and interpretation of specific lessons and experiences across local projects, negotiating the codification and standardisation of that knowledge; negotiating which are the most appropriate evaluative criteria; and so on, all of which can be seen as the emergence of an alternative multi-dimensional selection environment. In sum, agency for nurturing involves actors influencing the interpretation of experimental outcomes, networking with other projects and key resource providers, and preparing results to further secure investments in subsequent developments of the niche.

In contrast to shielding and nurturing, *empowerment* results from the collective capacity of niche advocates to change mainstream selection environments in ways favourable to the path-breaking innovation. Even more so than in shielding and nurturing, agency in empowerment is a collective effort enabled and constrained by wider regime and landscape processes. In particular in the case of stretch and transform empowerment, niche actors must mobilise allies and key constituents in their quest to adapt and diffuse beneficial institutional reforms in and across different regime dimensions. Different actors need to be persuaded to go along with institutional reforms in return for some promised return or goal in the future, such as the development department in a firm, or a social enterprise consisting of environmental entrepreneurs and investors, or a research consortium, or lead users, or a government department that hopes the niche may eventually deliver on a policy

[7] The difference is best explained with an example, say investment grants for solar cells. In the case of shielding agency relates to convincing policy actors through a collaborative effort fellow advocates to decide positively for the implementation of such scheme. Agency in nurturing, on the other hand, relates to strategically networking and comparing, negotiating and drawing lessons from projects supported by the subsidy scheme. Agency in empowerment then is the collective action to insert positive results from nurturing into broader debates on feed-in tariffs or infrastruture connection regulations.

goal. The relations of commitment and exchange will differ according to the way each of these actors perceives their interests, the centrality of their resources for niche development, and whether theirs is an actively engaged or passively facilitating role in further socio-technical development (Law and Callon, 1994; Smith and Stirling, 2007).

In practice, the capacities of actors to translate their potential for action into actual practice will be distributed unevenly. Moreover, there will be disagreements over which institutional reforms should be prioritised. There can disputes amongst advocates within a particular niche network over how best to advance future niche development, and what forms that development should take in order that the innovation will flourish. There are also contests between different niches over which should receive greater and more targeted support. All this is taking place within the context of an historically privileged and powerful regime, which historically holds the authority to arbitrate and the power to provide protective support. To this we turn in the next section and elaborate the politics of protection as a discursive process. We will focus on empowerment, because this has received the least attention in the niche literature.

5.2 The politics of empowerment as a discursive process

Shielding, nurturing and empowering are political processes, because they are characterised by the outcomes of multiple interdependencies operating through the web of negotiations identified above (Wilks and Wright, 1987; Smith *et al.*, 2005; Kooiman, 2003). Each actor participates in, responds to or counteracts an emerging niche network in different ways and with different purposes, holding different interpretations and interests in the situations across which the niche develops, and offering or withholding resources of varying significance to the future directions of niche development. Not all actors enter into these negotiations equally: some are able to exercise greater influence owing to their resource attributes, experience, institutional positions, and connections with other influential actors, all relative to the task in hand; but neither does any single actor, such as an industrial lobby, or a government department, have sufficient power to force through decisions, strategies, and implementation activities unilaterally (Stoker, 1998; Rhodes, 1997).

These politics will be most prominent in processes of stretch and transform empowerment, because here niche actors and networks are trying to realise institutional reforms from a position where privilege and power resides beyond the niche itself. To understand these processes, we note how recent literature in institutional change emphasises the significance of discursive strategies and narratives. That literature addresses a challenge of embedded agency similar to the one concerning us here: one in which change agents are trying to influence a situation in which actors' thoughts and actions are constrained by incumbent institutions (or, in our case, regimes) (Zietsma and Lawrence, 2010).

Discursive processes are considered important because they underpin both the durability and change of institutions (Philips et al., 2004). When actors engage in social action, their behaviour might be observed, interpreted and mimicked by others. This results in the 'enduring social patterns' (Zietsma and Lawrence, 2010: 189) that constitute institutions (i.e. as more and more actors mimic and converge their actions, i.e. when actors accept a shared definition of social reality, and mechanisms of conformity come into place). Obviously, direct observations 'do not easily allow for the multiple readings by multiple individuals' necessary for widely diffused social action and hence institutions (Philips et al., 2004: 638). 'Texts' such as written documents and other kinds of reports of social action accessible to others (including talk, artwork, pictures, movies, etc) allow for a far broader diffusion. As actors produce, distribute and consume texts, they enable social action to transcend the situated character of social processes and cut across separated and diverse local settings and times. In short, social action leaves traces in texts, which enable the repetitive and shared behaviours to spread across space and time, and therefore institutionalisation.

Given these discursive underpinnings, the literature locates important change processes as resting in actors strategically re-telling the past to make new sense of the present and envision alternative futures (Hardy and Maguire, 2010; Garud et al., 2010; this issue). Actors develop *narratives* in an attempt to reshape patterns of social action. Moreover, diversity in and competition between narratives is likely to exist, because in the case of emerging protective spaces institutions are weak or institutional voids might exist (Hajer and Wagenaar, 2003). In such situations, different coalitions of actors are producing narratives on the basis of different niche experiences, with different purposes, and for different audiences in different contexts. Actors produce, exchange, consume and negotiate these narratives in a variety of locations, such as trade shows, academic and professional conferences, governmental hearings, user group sessions, online-forums, the media, and other potentially influential events, where some might come to dominate, constituting institutionalisation (Lampel and Meyer, 2008; Hardy and Maguire, 2010).

In short, narratives are key political devices used by actors to argue for niche-derived (yet contested) institutional reforms. In the next section we elaborate on the main characteristics of political narratives we expect to find in any given niche empowerment process (5.3), and specify how they are different in the case of the two types of empowerment defined in section 4 (5.4).

5.3 Generic characteristics of empowerment narratives

We expect three elements to be central in political narratives on empowerment. Positive expectations about the future as a justification of the niche are a first central element in the narratives employed by niche actors seeking empowerment (Brown et al., 2000; Basalla, 1988; Battilana et al., 2009). Expectations and lessons about the niche have to be argued and mobilised in a socio-political sense, rather than only in a socio-technical sense, in order to expand, adapt or withdraw protective/institutional concessions from key actors (Konrad, 2006). Global niche networks seeking empowerment are primarily concerned about representing the innovation favourably to others and carving out a favourable context for further niche development (Law and Callon, 1994). Outward-looking discursive strategies target policy arenas, boardrooms, the media, and civil society arenas, and other places where niche advocates may find sympathetic and resourceful audiences (Roe, 1994; Fischer, 2003). Hence, multiple and flexible niche representations are tailored to specific resourceful audiences, and convey fairly simple notions of the niche to the wider social world, rather than detailed designs.[8]

Second, narratives will also need to include claims for present-day niche friendly institutional reforms (cf. the more immediate or prior tasks of securing resource flows). Empowering the niche in order to shape or influence institutional reforms involves additional ways of talking about the niche compared to expectations relating to technical developments, investment prospects, and market opportunities. Discursive strategies for institutional reforms are more likely to involve broader issues and problem frames, and relating (simplified) representations of the innovation in relation to them, as a part of a solution to broader social, environmental and economic challenges. That means niche actors inserting the niche into broader policy narratives about institutional reforms for sustainability. Such empowerment activity takes on a variety of practical forms, including the lobbying of

[8] These global networking processes, however, generate a set of contextual requirements, which effectively constitute the alternative selection environment, to which local networks have to respond to in fleshing out the detailed content of the innovation (Law and Callon, 1994). These can include expected environmental performance improvements, reductions in costs, learning effects, projected profitability, job creation and export markets, symbolic significance, professional reputation, and so forth. Success rests in the ability of niche advocates to manage the relationship between global and local networks. A high degree of socio-political attachment to the niche by the wider society has to be maintained by the global network, and a high degree of socio-technical configuring has to be sustained in the local networks. Failure to improve internal local-global network processes (figure 1) – i.e. nurture the niche – has repercussions for the credibility and legitimacy of outward oriented strategies undertaken in global-level niche networks. Poor socio-technical performance leads to diminished socio-political credibility when the requirements and interests of outside actors are no longer being met, in the case of those committing to the niche, nor successfully refuted, in the case of critics of the niche (Geels and Smit, 2000). Conversely, poor performance need not automatically lead to diminishing protection as advocates might strategically repair the results in alternative narratives, for example by reframing the initial problem definition.

politicians, participation in government task forces, media promotion and other opinion forming activities (Hajer and Wagenaar, 2003).

Third, narratives may be deployed that criticise the regime, emphasise contradictions within regime socio-technical dimensions, and emphasise the opportunities arising from alternatives. The fossil-fuel regime is re-framed away from historic associations with cheap, plentiful and convenient energy (for the final consumer, at least), for instance, in such a way that emphasises climate change, emissions reduction requirements, energy security, and so on, and tailored to the concerns of, say, insurers and investors about new risks and reduced profitability in the future. Simultaneously, renewable energy niche actors, such as photovoltaics advocates say, re-cast their niches as promising opportunities under the new context of mitigating climate change and addressing energy security. Such narratives present the niche-innovation in a favourable, problem-solving light, and serve the purpose of elaborating why it merits support from resourceful actors and eventual institutionalisation. Arguments about green jobs and growth through ecological modernisation narratives are increasingly harnessed to elaborate positive expectations for many sustainability niches (UNEP, 2011), but alternative narratives concerning new sustainability economics and politics are also available and used (Raskin *et al.*, 2002; Jackson, 2009).

In sum, the politics of niche empowerments involves the inter-related construction of narratives with a) positive expectations about the future that justify the niche to wider audiences; b) explicit claims for present-day niche friendly institutional reforms; and c) statements that re-frame the past to criticise the prevailing regime in ways that emphasise future opportunities for the innovation. In the final sub-section we explore how these narratives operate differently in relation to the fit-and-conform and stretch-and-transform patterns discussed in section 4.

5.4 Fit and conform versus stretch and transform narratives

The different forms of niche empowerment introduced in section four – fitting and conforming cf. stretching and transforming – imply two different patterns of political narratives for niche advocates, exercised in contrasting arenas.

The objective in *fitting and conforming* is to convince the wider social world that the niche can become competitive on conventional, regime criteria. That is, it will perform profitably in existing markets, and does not require *radical* changes to institutions, infrastructures, skills and knowledge bases, user relations etc. As such, the outward oriented strategic work of actors constituting the global niche is to codify and represent promising improvements in performance. Shielding measures will be represented as temporary, and nurturing processes will value lessons that direct development towards enhancing competitiveness. The audiences for this work will predominantly be related to existing industrial bodies, sponsoring government ministries, institutional investors committed to the regime, standards institutes, and so forth. The political arenas would therefore be those normal industrial and policy-making networks dedicated to the reproduction of the regime, and the representations of the niche would seek to standardise and extrapolate developments on terms familiar to those arenas. The conditions attached to increased resource flows into the niche for its further development would be along regime lines.

The objective in the *stretching and transforming* form of niche empowerment is to convince the wider world that the rules of the game need to be changed. The selection pressures constituted by the regime need to be transformed in order that niche-derived forms of sustainable production and consumption may flourish. Of course, the promise of the niche has to have considerable appeal in order to instil confidence and commitment to the broader sustainability vision which it embodies, but niche performance and legitimacy will be judged against sustainability criteria rather than the status quo. As such, the outward oriented political work of niche actors is to argue for institutional

reforms and suggest the niche could realistically make the new institutions operational and effective. Shielding measures will be represented as manifesting sustainability criteria and requiring institutionalisation, and nurturing processes will value lessons that direct development towards improving sustainability. The audiences for this work are more likely to be civil society organisations, political parties, opinion formers in the media and education, venture capital investors, sectors that might benefit in an opening and re-configuring of the regime, and so forth. The political arenas would therefore be discourse coalitions and political formations that debate and mobilise around societal changes like sustainability, and who are lobbying for institutional reforms already, and can see the appeal in material and practical (niche) expressions of their vision. The conditions attached to increased resource flows to the niche would be that it can make more manifest and credible the reforms being called for.

Of course, as the preceding sections emphasise, niche actors will develop different political narratives and debate which strategy to pursue. Different coalitions may pursue one or the other, or both, and the innovation will fragment along conforming and transforming pathways (Smith, 2007). Given that niche actors are dependent upon resources and opportunities for institutionalisation beyond their unilateral control, there will be limits to niche-based approaches. The discursive strategies depend upon broader narratives that arise through processes beyond the collective agency of niche actors. Clearly, the climate change narrative is not a product of advocacy for solar photovoltaic niches, for instance, but the continuing innovation of the former is an exemplifying resource for the discourse coalitions of the latter. Broad developments in socio-economic landscapes, and emerging contradictions within socio-technical regimes, inform the development of narratives that are carried by much wider webs of actors and institutions.

6. Conclusions and outlook

The aim of this paper was, first, to understand and analyse the dynamics of protection in sustainability transitions in a more systematic way, and, second, to propose how agency and politics might be captured in this framework.

In our framework, protective space dynamics exhibit three functional properties in relation to wider transition processes: shielding, nurturing and empowerment. Shielding is about holding off selection pressures in the context of multi-dimensional selection environments (industry structures, technologies and infrastructures, knowledge base, markets and dominant user practices, public policies and political power, cultural significance). Nurturing is about supporting the development of path-breaking innovation within passive and active shielded spaces through the development of shared, positive expectations, social learning and actor network building (SNM) or the development of system structures and functions (TIS). Empowering is about change in mainstream selection environments favourable to the path-breaking innovation and involves 'fit and conform' and 'stretch and transform' processes. Relationships between shielding, nurturing and empowerment can be understood as an iterative process: initial, passive protection enables early nurturing of the innovation, whose promise (if successful) empowers niche advocates to obtain more active protective measures, that assist in further nurturing, greater empowering, and eventually the institutionalisation of the innovation within a transformed selection environment.

Taking an 'outsider ontology', that views the niche as an object to be developed, a managerial perspective would seek to govern protective space through 'improving' the above kind of processes. Adopting an insider ontology, by contrast, the analyst considers these processes as *potentially* emerging through the agency of advocates of a 'niche' socio-technical configuration. The politics of trying to construct shielding, nurturing and empowering through multi-actor relationships indicates the task will be far from an orderly, singularly rational management task. Diverse claims on the

forms, focus and application of protections are likely. We identified narratives as key to the politics of protective space. We proposed that narratives for empowerment will show a number of characteristics: a) positive expectations about the future that justify the niche to wider audiences; b) explicit claims for present-day niche friendly institutional reforms; and c) statements that re-frame the past to criticise the prevailing regime in ways that emphasise future opportunities for the innovation. Depending on whether niche actors are seeking a fit-and-conform pattern or a stretch-and-transform pattern this might entail different political narratives for different audiences.

Our systematic conceptualisation of protective space plus our propositions concerning the roles played by narratives in actually constructing these spaces opens up new avenues for empirical and theoretical research. First, while previous research on niche development has paid much attention to the nurturing of path-breaking innovations, little systematic attention has been given to understanding how niche advocates mobilise existing or create new shields against mainstream selection pressures. In the context of dynamic and multi-dimensional selection environments, future research could explore patterns in niche development pathways by analysing advocates of path-breaking innovations and the strategies they deploy for mobilising passive spaces and creating active protective spaces through time. A 'linear' view would be one where advocates are first able to nurture path-breaking innovations in a shielded space in R&D environments, then move to mobilise or generate industrial protective space, followed by more regular market niche spaces and finally are able to mobilise or create spaces in relation to infrastructural requirements, public policies and political power and the cultural significance and associations of the regime. However, we think more diverse and non-linear pathways should be expected, depending on the ability of niche advocates to mobilise whatever spaces are at hand and on success and failure rates of nurturing the innovation within those spaces (cf. Geels & Raven, 2006). Such research would move beyond narrowly defined diffusion processes (through market niches) as well as broaden the scope of the niche development literature.

Second, new research might study in detail the process of empowerment in different cases, including cases in which actors seek to fit-and-conform as well as cases where actors seek to stretch-and-transform prevailing selection environment. While earlier niche literature identified a fit-and-stretch pattern as an important dynamic of regime shifts (Hoogma et al., 2002), a more detailed analysis of the underlying actor networks and their political and discursive strategies is needed. Moreover, while the two broad patterns are analytically attractive, we expect in empirical work to find a more messy and dynamic reality, in which different actor networks debate different adaptations to niche innovation under different regime circumstances (cf. Smith, 2007). It is here where a more sophisticated analysis of political narratives becomes helpful by providing an agency-based and politics-informed framework for understanding shifts in the resource interdependencies that drive niche development.

Finally, dynamic relationships between variation, selection environments and the emergence of new technological regimes are relevant to evolutionary perspectives in innovation studies generally. A recent review of research concluded little progress in understanding the emergence of new technological regimes (von Tunzelman *et al.*, 2008). Whilst innovation studies is generally more interested in markets than sustainability, it nevertheless involves debates about marketing strategies, patterns for accumulating capabilities (and profits), negotiating collaborative and competitive networks, and so on. Perhaps in forms less obvious than for sustainability, and often on narrower techno-economic grounds, these are normative debates about which kinds of innovation are desirable and the direction of future selection environments. The arguments in this paper might consequently stimulate debate about protective spaces in the transformation of selection environments more generally.

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References

Avelino, F. and J. Rotmans, 2009. Power in Transition: An Interdisciplinary Framework to Study Power in Relation to Structural Change. European Journal of Social Theory, 12, 4, 543-569.

Basalla, G. (1988) The Evolution of Technology, Cambridge, Cambridge University Press.

Bastos, M.I., Cooper C., 1995. Politics of Technology in Latin America Routledge, New York

Battilana, J., Leca, B., Boxenbaum, E., 2009. How actors change institutions: towards a theory of institutional entrepreneurship. The Academy of Management Annals 3:1, 65-107

Bell, M., 2006. Time and technological learning in industrialising countries: how long does it take? How fast is it moving (if at all)? International Journal of Technology Management 36, 1-3, 25-39

Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S. & Rickne, A. 2008. Analyzing the functional dynamics of technological innovation systems: A scheme of analysis. *Research Policy,* 37**,** 407-429.

Berkhout, F., Verbong, G.P.J., Wieczorek, A., Raven, R.P.J.M., Lebel, L., Bai, X., 2010. Sustainability experiments in Asia: innovations shaping alternative development pathways?. Environmental Science and Policy 13, 261-271

Brown, N., Rapert, B. and Webster, A. 2000. *Contested Futures: a sociology of prospective techno-science,* Aldershot, Ashgate.

Caniëls,M.C.J., Romijn, H.A., 2008. Strategic niche management: towards a policy tool for sustainable development. *Technology Analysis & Strategic Management* 20 (2), 245-266

Carlsson, B., Stankiewicz, R., 1991. On the Nature, Function, and Composition of Technological systems. Journal of Evolutionary Economics 1, 93-118

Chang, H.J., 2002. Kicking Away the Ladder: development strategy in historical perspective Anthem, London.

Cimoli, M., Dosi, G., Stiglitz, J.E., 2009. The political economy of capabilities accumulation: the past and future of policies for industrial development. In Cimoli, M., G. Dosi and J. Stiglitz (eds.) *Industrial Policy and Development: The Political Economy of Capabilities Accumulation*, Oxford University Press, New York NY, USA

Dewald, U. & Truffer, B. 2011 - in press. The local sources of market formation: regional growth differentials in Germand photolovtaic markets. European Planning Studies.

Dosi, G., 1982. Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change. Research Policy 11, 147-162

Fagerberg, J., 2006. Innovation. A guide to the literature. In: Fagerberg, J., Mowery, D.C., Nelson, R.R. (Eds.), The Oford Handbook Of Innovation, Oxford: Oxford University Press, 1-26

Fischer, F. 2003. *Reframing Public Policy,* Oxford, Oxford University Press.

Hommels, A., Peters, P., Bijker, W.E., 2007. Techno therapy or nurtured niches? Technology studies and the evaluation of radical innovations. Research Policy 36, 1088-1099

Gallagher, K. S., 2006. Limits to leapfrogging in energy technologies? Evidence from the Chinese automobile industry. Energy Policy 34**,** 383-394

Garud, R., Hardy, C., Maguire, S., 2007. Institutional entrepreneurship as embedded agency: an introduction to the special issue. Organization Studies 28, 957-969.

Garud, R., Kumaraswamy, A., Karnoe, P., 2010. Path dependence or path creation. Journal of Management Studies 47:4, 760-774

Geels, F.W., 2002. Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. Research Policy 31, 1257-1274

Geels, F. W. and Smit, W. A. 2000. Failed technology futures: pitfalls and lessons from a historical survey. *Futures,* 32**,** 867-885.

Geels, F. & Raven, R. 2006. Non-linearity and expectations in niche-development trajectories: ups and downs in Dutch biogas development (1973-2003). *Technology Analysis & Strategic Management,* 18**,** 375 - 392.

Geels, F.W., Schot, J.W., 2007. Typology of sociotechnical transition pathways. Research Policy 36, 399-417

Geels, F.W. and J. Schot, 2007b. Comment on `Techno therapy or nurtured niches?' by Hommels et al. [Res. Policy 36 (7) (2007)] *Research Policy* 36, 1100-1101.

Glynn, S., 2002. Constructing a selection environment: competing expectations for CFC alternatives. Research Policy 31**,** 935-946

Grin, J., Part 3: Understanding transitions from a governance perspective. In: Grin, J., Rotmans, J., Schot, J.W. , Transitions to sustainable development. New directions in the study of long term transformative change. Routledge

Hajer, M. & Wagenaar, H. (eds.) 2003. *Deliberative Policy Analysis,* Cambridge: Cambridge University Press.

Hardy, C., Maguire, S., 2010. Discourse, field-configuring events, and change in organizations and institutional fields: narrative of DDT and the Stockholm convention. Academy of Management Journal 53:6, 1365-1392

Hargrave, T. J. & Van de Ven, A. H. 2006. A collective action model of institutional innovation. Academy of Management Review*,* 31**,** 864-888.

Hellsmark, H.R.A. (2010) *Unfolding the formative phase of gasified biomass in the European Union* PhD thesis, Chalmers University of Technology, Gothenburg.

Hommels, A., Peters, P. & Bijker, W. E. 2007. Techno therapy or nurtured niches? Technology studies and the evaluation of radical innovations. *Research Policy,* 36**,** 1088-1099.

Hoogma, R., Kemp, R., Schot, J. Truffer, B., 2002. Experimenting for Sustainable Transport: The Approach of Strategic Niche Management Spon Press, London

Hughes, T.P. 1983. Networks of Power: Electrification in Western Society 1800–1930. Johns Hopkins University Press, Baltimore.

IEA, 2011. Clean Energy Progress Report. International Energy Agency, Paris

Jacobsson, S. 2008. The emergence and troubled growth of a [`]biopower' innovation system in Sweden. Energy Policy*,* 36**,** 1491-1508.

Jacobsson, S., Alam, G., 1994. Liberalisation and Industrial Development in the Third World: A comparison of the Indian and South Korean engineering industries Sage, New Delhi

Jacobsson, S. & Bergek, A. 2004. Transforming the energy sector: the evolution of technological systems in renewable energy technology. *Industrial and Corporate Change,* 13**,** 815-849.

Jacobsson, S. & Lauber, V. 2006. The politics and policy of energy system transformation--explaining the German diffusion of renewable energy technology. *Energy Policy,* 34**,** 256-276.

Jackson, T., 2009. Prosperity without growth: economics for a finite planet. Earthscan Publications.

Jessop, B. 1998. The rise of governance and the risks of failure: the case of economic development. *International Social Science Journal,* 155**,** 29-45.

Jessop, B. 2003. Governance and metagovernance: on reflexivity, requisite variety, and requisite irony. *In:* H.P.Bang (ed.) *Governance as social and political communication.* Manchester: Manchester University Press.

Johnson, A., 1998. Functions in Innovation System Approaches. Sweden, Chalmers University of Technology.

Kemp, R., 1994. Technology and the transition to environmentally sustainability: the problem of technological regime shifts, *Futures*, 26, 10: 1023-46.

Kemp, R., Schot, J.W., Hoogma, R., 1998. Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management. Technology Analysis & Strategic Management 10, 175-195

Konrad, K. 2006. The social dynamics of expectations: The interaction of collective and actor-specific expectations on electronic commerce and interactive television. *Technology Analysis & Strategic Management,* 18**,** 429 - 444.

Kooiman, J. 2003. *Governing as Governance,* London, Sage.

Lampel, J., Meyer, A.D., Field-configuring events as structuring mechanisms: how conferences, Ceremonies, and trade shows constitute new technologies, industries and markets. Journal of Management Studies 45:6, 1025-1035

Lang, T., Hines, C., 1994. The new protectionism London, New Press

Law, J., Callon, M. (1994) The life and death of an aircraft: a network analysis of technical change. In Bijker, W.E. and Law, J. (eds) Shaping technology/building society: studies in sociotechnical change, MIT Press, Cambridge, MA.

Lawrence, T.B., Suddaby, R., Leca, B. (Eds.), 2009. Institutional Work. Actors and Agency in Institutional Studies of Organizations. Cambridge University Press.

Leach, M., Bloom, G., Ely, A., Nightingale, P., Scoones, I., Shah, E. & Smith, A. 2007. Understanding governance: pathways to sustainability. *STEPS Centre working paper 2.* Brighton: STEPS Centre.

Leca, B., Battilana, J., Boxenbaum, E., 2008. Agency and institutions: a review of institutional entrepreneurship. Working paper, Copenhagen Business School, 08-096

Leventhal, D.A. (1998), The slow pace of rapid technological change: gradualism and punctuation in technological change, in: Industrial and Corporate Change (7): 217-47

Lovell, H., 2007. The governance of innovation in socio-technical systems: the difficulties of strategic niche management in practice. Science and Public Policy 34(1), 35-44

Lundvall, B.A. (Ed.), 1992. National systems of innovation: towards a theory of innovation and interactive learning. London: Pinter

Markard, J., Truffer, B., 2008. Technological innovation systems and the multi-level perspective: towards an integrated framework. Research Policy 37, 596-615

Meadowcroft, J. 1998. Co-operative environmental regimes: a way forward? *In:* Glasbergen, P. (ed.) *Co-operative environmental governance.* Dordrecht: Kluwer.

Metcalfe, J.S. 1998. Evolutionary economics and creative destruction. London: Routledge.

Mokyr, J. (1990). The Lever of Riches: Technological Creativity and Economic Progress. Oxford: Oxford University Press

Mouffe, C. 1996. Democracy, power and the 'political'. *In:* Benhabib, S. (ed.) *Democracy and difference.* Princeton, New Jersey: Princeton University Press.

Nelson, R.R., Winter, S.G., 1977. In search of a useful theory of innovation. Research Policy 6, 36-67

Nelson, R. R., 2008. What enables rapid economic progress: What are the needed institutions? Research Policy 37**,** 1-11

Nill, J. & R.Kemp 2009. Evolutionary approaches for sustainable innovation policies: from niche to paradigm? Research Policy 38, 668-680.

Phillips, N., Lawrence, T.B., Hardy, C., 2004. Discourse and institutions. Academy of Management Review 29:4, 635-652

Raskin, P., Banuri, T., Gakkopin, G., Gutman, P., Hammond, A., Kates, R. & Swart, R. 2002. *Great Transition - the promise and lure of the times ahead,* Boston, Tellus Institute and Stockholm Environment Institute.

Raven, R.P.J.M., 2006. Towards alternative trajectories? Reconfigurations in the Dutch electricity regime. Research Policy 35, 4, 581-595

Raven, R.P.J.M., Heiskanen, E., Lovio, R., Hodson, M., Brohmann, B., 2008. The contribution of local experiments and negotiation processes to field-level learning in emerging (niche) technologies: meta-analysis of 27 new energy projects in Europe. Bulletin of Science Technology and Society 28, 464-477.

Raven, R.P.J.M., forthcoming. Analysing emerging sustainable energy niches in Europe. A strategic niche management perspective. In: Verbong, G.P.J. and Loorbach, D., (Eds). Governing the energy transition. Chapter 6. Routledge.

Raven, R.P.J.M., Verbong, G.P.J., Schilpzand, W.F., Witkamp, M. J., forthcoming. Translation mechanisms in socio-technical niches. A case study of Dutch river management. Technology Analysis & Strategic Management.

Rhodes, R. A. W. 1997. *Understanding governance,* Buckingham, Open University Press.

Rhodes, R. A. W. & Marsh, D. 1992. New directions in the study of policy networks. *European Journal of Political Research,* 21**,** 181-205.

Rip, A., 1995. Introduction of new technology: making use of recent insights from sociology and economics of technology. Technology Analysis & Strategic Management 7, 417–431.

Rip, A., Kemp, R., 1998. Technological change. In: Rayner, S., Malone, E.L. (Eds.), Human choice and climate change, Vol. 2. Batelle Press, Columbus, OH, 327-399

Roe, E., 1994. Narrative policy analysis: theory and practice*,* Durham, NC, Duke University Press

Romijn, H., Raven, R. & de Visser, I. 2010. Biomass energy experiments in rural India: Insights from learning-based development approaches and lessons for Strategic Niche Management. *Environmental Science & Policy,* 13**,** 326-338.

Schot, J.W., 1992. The policy relevance of the quasi-evolutionary model: the case of stimulating clean technologies. In: Coombs, R., Saviotti, P., Walsh, V. (Eds.), Technological change and company strategies: economic and sociological perspectives. Academic Press, London, 185-200

Schot, J.W., Hoogma, R., Elzen, B., 1994. Strategies for shifting technological systems. The case of the automobile system. Futures 26 (10), 1060-1076

Schot, J.W., Geels, F.W., 2008. Strategic niche management and sustainable innovation journeys: theory, findings, research agenda, and policy. Technology Analysis & Strategic Management 20:5, 537-554.

Schrank, A. 1997. Asian industrialization in Latin American perspective: the limits to institutional analysis. *Latin American Politics and Society,* 49**,** 183-200.

Scott, J., 2006. Sociology – The Key Concepts. London and New York: Routledge

Shove, E., Walker, G., 2007. CAUTION! Transitions ahead: politics, practice and sustainable transition management. Environment, Policy and Planning A (39), 763-770

Smith, A., Stirling, A., Berkhout, F. 2005. The governance of sustainable socio-technical transitions. Research Policy 34, 1491-1510

Smith, A., 2007. Translating sustainabilities between green niches and socio-technical regimes. Technology analysis & strategic management 19, 4, 427-450

Smith, A. & Stirling, A. 2007. Moving outside or inside? Objectification and reflexivity in the governance of socio-technical systems. *Journal of Environmental Policy & Planning,* 9**,** 351-373.

Smith, A. & Stirling, A. 2010. The politics of socio-ecological resilience and socio-technical transitions. *Ecology & Society,* 15**,** 1-13.

Smith, A., Voss, J., Grin, J., 2010. Innovation studies and sustainability transitions: the allure of the multi-level perspective and its challenges. Research Policy 39, 435-448

Suurs, R.A.A, 2009. Motors of sustainable innovation: Towards a theory on the dynamics of technological innovation systems. Utrecht: Utrecht University

Steenblik, R.P., 1995. A note on the concept of 'subsidy'. Energy Policy 23, 6, 483-484

Stoker, G. 1998. Governance as theory: five propositions. *International Social Science Journal,* 155**,** 17–28.

STRN, 2010. A mission statement and research agenda for the Sustainability Transitions Research Network. Developed by the steering group of the STRN, 20 August 2010. Accessed online at Aug 2, 2011, at: http://www.transitionsnetwork.org/files/STRN_research_agenda_20_August_2010(2).pdf

Truffer, B., 2003. User-led Innovation Processes: The Development of Professional Car Sharing by Environmentally Concerned Citizens. Innovation: The European Journal of Social Science Research, 16, 2, 139-154

UNEP, United Nations Environment Programme. 2011. Towards a green economy: pathways to sustainable development and pverty eradication. *www.unep.org/greeneconomy.* Nairobi.

van Beers, C., van den Bergh, C.J.M., 2009. Environmental harm of hidden subsidies: global warming and acidification. Ambio 38, 6, 349-341

van den Belt, H. & Rip, A. 1987. The Nelson-Winter-Dosi model and synthetic dye chemistry. *In:* Bijker, W. E., Hughes, T. P. & Pinch, T. (eds.) *The social construction of technological systems.* Cambridge, Mass.: MIT Press.

Van den Bergh, J.C.J.M., 2011. Energy conservation more effective with rebound policy. Environmental Resource Economics 48, 43-58

Von Tunzelmann, N., Malerba, F., Nightingale, P., Metcalfe, S., 2008. Technological paradigms: past, present and future. Industrial and Corporate Change 17, 3, 467–484.

Voss, J., Smith, A., Grin, J., 2009. Designing long-term policies: rethinking transition management. Policy Science 42, 275-302

Wade, R., 1990. Governing the Market: theory and the role of government in East Asian industrialization. Princeton University Press, Princeton.

Wilks, S. & Wright, M. (eds.) 1987. *Comparative Government-Industry Relations,* Oxford: Clarenden Press.

Zietsma, C. & Lawrence, T. B. 2010. Institutional Work in the Transformation of an Organizational Field: The Interplay of Boundary Work and Practice Work. *Administrative Science Quarterly,* 55**,** 189-221.