



Transition pathways revisited: Established firms as multi-level actors in the heavy vehicle industry



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ABSTRACT

The multi-level perspective on sustainability transitions positions established firms (incumbents) as defenders of existing technologies at the “regime level.” By contrast, it positions new entrants at the niche level, as promoters of new technologies. This paper challenges the positioning of firms as actors on either regime or niche levels. Based on a comparative analysis of technology strategies in the heavy vehicle industry, the paper shows that established firms are active at both levels, developing several technology alternatives simultaneously. This means that incumbents’ technology strategies determine important parts of the required niche–regime interactions. The paper also shows how incumbents may pursue contrasting technology strategies. While some adopt a dualistic approach, keeping regime and niche level activities technologically and commercially separate, others develop integrated strategies where niche activities are leveraged to impact upon the regime level. The cases studied illustrate how the success of such integrated strategies depends on the emergence of bridging policies. Bridging policies are relevant both for linking early niche markets to broader regime-level markets, and for supporting further technological advancements of niche markets.

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1. Introduction

In recent years, the multi-level perspective has emerged as one of the most influential contemporary theoretical frameworks for assessing and understanding sustainability transitions (Markard et al., 2012). The multi-level perspective identifies critical tensions between stabilising and destabilising forces involved in transition processes (Geels, 2002; Smith et al., 2010) and highlights the importance of creating linkages between different levels, especially between the so-called regime and niche levels (Geels and Schot, 2007; Smith, 2007; Jørgensen, 2012). Scholars adopting the multi-level perspective describe the regime as an institutionalised, persistent, path-dependent, and rigid structure that favours stability and allows only incremental advancement (Fuenfschilling and Truffer, 2014). In contrast, they describe niches as local and dynamic ‘protective spaces’ (Smith and Raven, 2012) that facilitate the development and introduction of alternative technologies, making it possible for them to gain acceptance in the society (Schot et al., 1994; Kemp et al., 1998; Hoogma et al., 2002; Schot and Geels, 2008).

In a short time, this framework has inspired a rich literature, with a particular interest in transitions towards more sustainable patterns of production and consumption. In most cases, research attention has been directed at sectors such as energy and transport, which are associated with significant environmental impacts and involve complex capital goods. With a few exceptions, the framework has been built on geographically demarcated studies, and a majority of these studies have a national focus. There has been much less emphasis on organisational actors. As noted by Markard et al. (2012), the multi-level perspective suffers from a lack of analysis of the strategies of firms and their importance in transitions.

Merging the multi-level perspective with the literature on technology strategy, this paper will focus on the role of established firms in sustainability transitions. The paper examines an extended innovation process in a complex capital goods industry, the heavy vehicle sector, and presents detailed comparative case studies of the development and commercialisation of heavy hybrid-electric powertrains. The case analysis shows that established firms may pursue markedly different technology strategies with crucial consequences for transition prospects; further, these strategies can be much more ambitious than previously hypothesised in descriptions of transition pathways (Geels and Schot, 2007). The analysis highlights the innovative capacity of incumbent firms (cf. Schumpeter, 1942/2010), underlining that while niches

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are important for transitions, they are simultaneously problematic since they have a tendency to fragmentation and present difficulties in expanding beyond narrow boundaries. This implies that transitions in complex capital goods industries require bridging policies that interact with the relevant firm strategies to achieve diffusion of sustainable technologies to broader segments and volume markets.

The remainder of the paper is organised as follows. A brief review of the extant literature on transition pathways and technology strategy precedes a section on the industry context, and another on the research design. The subsequent section presents the hybrid-electric development efforts at two leading heavy vehicle manufacturers during the period 2005–2010, and discusses why one of them cancelled this effort. A comparison of the leading industry competitors in the early commercialisation phase in 2010–2012 follows. The final sections analyse the industrial and theoretical implications, and highlight critical factors for challenging an entrenched regime.

2. Theoretical framework

2.1. Transition pathways and regime–niche interaction

Multi-level theorists define transitions as ‘major, long-term technological changes in the way societal functions are fulfilled’ (Geels, 2002: 1257). The multi-level perspective offers a framework that makes it possible to map such change processes. The distinction between regimes and niches is central in this framework. The regime is depicted as a highly structured entity that associates technologies with societal practices. In addition to technologies, the regime incorporates related scientific knowledge bases, markets, user preferences, industry structures, policies, and cultural habits (Geels, 2004). Hence, the concept of the regime emphasises that technology is deeply embedded in social and institutional structures. The regime is ‘dynamically stable’ (Geels and Kemp, 2007), implying that it can accommodate incremental innovations along established trajectories; however, it has problems in driving radical technological innovation.

Radical innovations emerge in niches (Geels, 2002). According to the multi-level perspective, regimes and niches ‘are similar kinds of structures, although different in size and stability’ (Geels and Schot, 2007: 402). Whereas regimes are large, stable, and highly structured entities, niches are small, dynamic, and characterised by a low level of structuration. The literature on strategic niche management elaborates the concept of niches further, making distinctions between technological niches and market niches (Schot and Geels, 2008). Technological niches refer to local field tests and demonstrations involving a number of relevant stakeholders, including manufacturing firms, users, and policy makers. The construction of such niches, which align technological artefacts with societal expectations and institutional frameworks, makes it possible to build social acceptance for new technology in a controlled manner before a broader market introduction. In this context, market niches refer to limited geographical areas or narrow domains of application in which the particular merits of the new technology are of great value, while the deficiencies are less problematic. Hence, they provide favourable selection environments and favour further development and refinement. When the new technology is eventually launched on mainstream markets, these niches would have played a significant role in the preceding progress (Rip, 1995). Summarising the importance of technological and market niches for transition processes, Smith and Raven (2012) argue that these niches jointly provide protective spaces that nurture interactive learning processes and shield new technologies from premature competitive pressures. Moreover, by attracting support for new

technology, they provide critical empowerment by either making the innovations competitive within the unchanged selection environments or contributing to changes in the mainstream selection environments.

Responding to criticism that the original multi-level perspective presented very weak conceptualisations of agency and that transition theories need to pay more attention to regime–niche translations and interactions (Smith et al., 2005; Smith, 2007), Geels and Schot (2007) suggest a typology of four transition pathways based on the main actors involved:

1. *Transformation*: The regime actors adjust established technologies and practices in response to external pressure.
2. *Technological substitution*: The incumbent firms promoting regime technologies compete with the new firms promoting alternative technologies.
3. *Reconfiguration*: The regime actors adopt component innovations developed by the new suppliers. The new suppliers compete with the established suppliers.
4. *De-alignment and re-alignment*: The regime completely loses its legitimacy, and competition ensues among the new niche actors promoting various alternative technologies.

Of these four pathways, *technological substitution* and *reconfiguration* describe different kinds of regime–niche interactions. In the case of *technological substitution*, the existing technology is eventually replaced by new technology through a process of ‘niche accumulation’ (Geels and Schot, 2007: 410), in which the new technology promoted by the niche actors captures larger segments of the market. This pathway describes the tensions, power struggles, and fierce competition between niches and regimes. The competition constitutes a forceful process that eventually leads to the demise of established firms.

Reconfiguration, on the other hand, describes a pathway in which the incumbent (regime-level) actors adopt multiple new component technologies introduced by the new suppliers (the niche-level actors). This pathway is particularly relevant for complex systems that are based on several interacting technologies. It suggests a symbiotic relationship between the niche- and regime-level actors. While the industry incumbents continue to prosper, competition ensues between the new and the established component suppliers.

Although the typology suggested by Geels and Schot (2007) covers a spectrum of different trajectories, the incumbents (‘regime actors’) are essentially depicted as either defending and adjusting their entrenched technologies or picking up innovations developed by the new supplier firms. Their perception of industrial firms seems to be inspired by ‘Schumpeter I’, in which new firms are the agents of new ideas and innovations (Schumpeter, 1911/2008), and established firms resist change (cf. Wells and Nieuwenhuis, 2012). However, this perception offers a limited understanding of the technological activities and strategies that incumbent firms may pursue in eras of ferment (Anderson and Tushman, 1990), when incremental improvements along an established trajectory are replaced by experimentation and competition involving different technologies. In such periods, several interrelated strategic dimensions are open to established firms—from the *selection* of appropriate new technologies, to the *scope* of their development and application, and the *sourcing* of the requisite knowledge and resources. These core dimensions of a firm’s technology strategy will be investigated further in this paper.

2.2. Technology strategy

The first strategic dimension involves the selection of promising technologies and the development of these technologies into new competitive products (Helfat and Raubitschek, 2000). A key aspect

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