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Transition towards sustainable material innovation: evidence and evaluation of the Flemish case

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ABSTRACT

In this article, we focus on testimonies on recent sustainable material innovations in 15 Flemish production firms. We look at evidence of transition towards sustainable material innovation, considering: (1) how material innovation can improve the sustainability of products and processes with respect to people, planet and profit and (2) what are stimulating and hindering factors met when adopting sustainable material innovation. Trends observed from assessing the sustainability features of the individual material innovation cases are presented in *3P evaluation grids*. A meta-analysis of the testimonies considers drivers and barriers for sustainable material innovation on the level of technological niches, socio-technical regimes and socio-technical landscapes, referring to the multi-level perspective used in transition literature. It was found that the interplay between these levels has been key in all the assessed cases. Stimulated by the increasing scarcity and rising prices of raw materials, a growing eco-sensitivity among their customers, and the downright need for economic survival, production companies turn to look for more innovative ways of using materials in order to arrive at more sustainable products and production processes.

1. Introduction

The great challenge faced by economies today is to integrate environmental sustainability with economic growth and welfare. Therefore, in 2008, the European Commission (EC) adopted the action plan on Sustainable Industrial Policy and Sustainable Consumption and Production (European Commission, 2008). This action plan focuses on the industrial production process, the product itself and consumer behaviour. By undertaking simultaneous actions in these three fields, the EC aims at initiating an iterative cyclic process in which sustainable production units will lead to products with a lower environmental impact over their entire life cycle. At the same time the growing awareness of consumers must lead to shifts on the demand side, stimulating companies to develop new sustainable products with more sustainable production methods.

Rethinking materials and their use are key to more sustainable products and production processes: materials technology impacts a manufactured product by its choice of materials and its processing steps (Ashby et al., 2004). Therefore the International Panel for Sustainable Resource Management insists that resource and materials use should be an important factor of consideration in decisions at the company level (Hertwich et al., 2010).

The material life cycle illustrates this clearly: ore and feedstock are mined and processed to give a material. This is manufactured into a product that is used and, at the end of its life discarded or recycled. Energy and materials are consumed at each stage, generating waste heat and solid, liquid and gaseous emissions. Process related issues (relating to aspects of the in-plant manufacturing process) together with product related issues (concerning the use and end-of-life phase of the manufactured products) thus cover the entire material life cycle, indicating all possible options to implement sustainable material innovations. Sustainable material innovation comprises efforts on the technological level (material substitution, minimisation of material use, …) as well as non-technological innovations, such as new business models based on life-cycle thinking (dematerialisation, closing loops, …) (Rossy et al., 2010).

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This article follows a bottom-up approach and is based primarily on the testimonies of business representatives from Flemish production firms implementing material innovations leading to more sustainable products and production processes. Additionally, the sustainability features of the individual material innovation cases were assessed in 3P evaluation grids.

Looking at evidence for transition towards sustainable material innovation in the Flemish production industry, we focus on two particular questions: (1) What can we learn from our cases in terms of how the sustainability of products and processes can be improved by material innovation?; (2) What are the stimulating and hindering factors that Flemish firms meet when adopting sustainable material innovation?

We present the trends observed from the assessed cases, and bring a meta-analysis of the testimonies, considering drivers and barriers for sustainable material innovation on the level of technological niches, socio-technical regimes and socio-technical landscapes, referring explicitly to the multi-level perspective (MLP) used in transition literature.

The article is organized as follows. Section 2 elaborates on our understanding of niches, regimes and landscape. In Section 3 we describe our research design and methodology. Section 4 reports and discusses the results from the meta-analysis. In Section 5, we present our conclusions.

2. A multi-level perspective on transition

The work on transitions and system changes has expanded during the last decade (see e.g. Geels and Schot (2007) for an overview) and is still expanding (see e.g. the research agenda of the Sustainability Transition Research Network (STRN, 2010)). Here, we focus on the multi-level perspective that is at the heart of the transition literature. The MLP distinguishes three levels of heuristic, analytical concepts (Rip and Kemp, 1998; Geels, 2002): niche-innovations, socio-technical regimes and socio-technical landscape.

As Geels and Schot (2007), we define niche and regime as *organisational fields*, following the corresponding definition by DiMaggio and Powell (1983): "those organizations that, in the aggregate, constitute a recognized area of institutional life". Niches and regimes for us are communities of interacting groups.

Technological niches form the micro-level where radical novelties emerge. We understand networks in this context as composed of a small number of individuals from the company itself (a few employees, some managers…) and some individuals from external organizations such as supplier companies and knowledge centres (universities, centres of expertise…) supporting the company in its innovation process. Niches act as 'incubation rooms' protecting novelties against mainstream market selection (Schot, 1998; Kemp et al., 1998). This protection is needed as the novelties are initially often unstable socio-technical configurations with low performance.

The socio-technical regime forms the meso-level which is dynamically stable (Geels, 2002). This concept accommodates a relatively broad community of social groups and their alignment of activities (Geels and Schot, 2007). We distinguish between four groups of regime actors having an important influence on the chances of niche-innovations to become standard: competitors, customers, government authorities and pressure groups (such as NGOs). These regime players often have a rather constraining influence on niche players that aim for change.

The socio-technical landscape forms an exogenous environment at the macro-level, beyond the direct influence of niche and regime actors. It concerns factors such as macro-economics, deep cultural patterns and macro-political developments. Changes at the landscape level usually evolve slowly. A socio-technical landscape thus has system characteristics: relatively static, providing deep-structural 'gradients of force' (Geels and Schot, 2007).

The MLP literature argues that transitions come about through interactions between and within processes at these three analytical levels: (a) niche-innovations build up internal momentum, through learning processes, price/performance improvements, and support from powerful groups, (b) changes at the landscape level create pressure on the regime and (c) destabilisation of the regime creates windows of opportunity for niche-innovations (Geels and Schot, 2007). The alignment of these processes enables the breakthrough of novelties in mainstream markets where they compete with the existing regime.

3. Methodology

3.1. Data collection

The material analysed in this article was originally gathered within the context of a collaborative project, which aimed at promoting sustainable material innovation on a scientifically sound basis, and to help enterprises with expert input to trace and implement new opportunities. In that respect, testimonies were collected from Flemish enterprises on how material innovations enabled them to make their products and production processes more sustainable.

Enterprises with potentially interesting cases were selected from the project partners' contact databases.

In a first step, face-to-face interviews were conducted with company representatives, best-informed on the company's R&D strategy. These open, semi-structured interviews focussed on what sustainability means for the company, the extent to which material innovation is actively pursued and which are recent achievements in terms of more sustainable products or production. All interviews were recorded and transcribed.

In a second step, we elaborated on 15 specific cases that looked promising as 'good practices'. Documentation (offered by the company or extracted from external sources) was gathered to fill out the 3P evaluation grids designed for this purpose. In most cases this information was complemented by additional input and feedback from company representatives. Extra interviews with one or more company contacts were conducted to better understand the particularities of each case, sometimes leading to additional visits to production or R&D departments.

The cases represent companies from various industrial sectors: building industry (2), chemical industry (2), furniture manufacturing (4), medical equipment (1), metal processing (4) and plastic processing industry (2). This classification was based on financial company information from BEL-FIRST and other databases. Within our 15 cases we have four small enterprises, two medium and nine large companies.[1] Three cases originate from business-to-consumer oriented activities (B2C); whereas the other companies have their main activities in business-to-business transactions (B2B) (Fig. 1).

Additional information on drivers and barriers for sustainable material innovation was collected during two workshops. In a first workshop participants (#16: both companies and other actors) were asked to consider most important drivers and barriers and to group the collective results in thematic priority lists. The material gathered here and through the interviews was subsequently used as a basis to prepare a second workshop, to which all people

[1] Enterprises qualify as small, medium or large-sized enterprises respectively if the average number of employees is less than 50, less than 250 or over 250, as laid down in the Commission Recommendation 2003/361/EC.