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Drivers for and barriers to low-energy buildings in Sweden

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ABSTRACT

From the perspective of construction companies, this paper investigates the existence and significance of barriers and driving forces for the implementation of energy-efficient houses in Sweden. Here, eleven construction companies that build low-energy buildings comparable in performance with passive houses have been interviewed. One conclusion is that there is not one specific barrier that keeps energy-efficient housing from taking off. Instead, the barriers include a whole range of issues that have to be considered. Internal pressure has been a strong contributor to the onset of passive house constructions within the companies and the results indicate that personal commitment is central and perhaps the strongest driver. A general reflection from the interviews is that there is a need to show both construction companies and potential customers that it is possible to build passive houses and that they exist. Unlike the national building regulations, which are not considered to be relevant when it comes to energy consumption, the future building regulations from the European Union are identified as a regulatory driver. Moreover, life-cycle thinking is reported to increase among actors, but that it would be beneficial if banks as well as real estate agents could develop a comprehensive view and become better at considering energy and LCC in their capital budgeting templates. Even if the interest for passive houses is considered low among the public, the market is identified as promising among the construction companies - recently actually large enough to become a driver in itself.

1. Introduction

According to the Intergovernmental Panel for Climate Change (IPCC), the building sector is one of the most important and cost-effective sectors for reducing energy use and greenhouse gas emissions (IPCC, 2007). The technologies for increasing the energy-efficiency of buildings have existed many years. In the early nineties, a house with a drastically reduced need for space heating was built in Darmstadt, Germany. This house was the world's first passive house, a concept that since then has grown and today there are more than 20 000 passive houses in the world. A passive house has a highly insulated building envelope and reuses the heat in the exhaust air with a heat exchanger. This makes a conventional heating system redundant since heat gains from solar radiation, dwellers, indoor apparatus, etc., for large parts of the year is enough to keep a comfortable indoor climate. The criteria for zero-energy, passive, and mini-energy houses are maintained by the Swedish Centre for zero-energy houses (2013). In terms of primary energy consumption, buildings represent around 40% in most IEA countries (IEA, 2013). Consequently, in a cold country like Sweden where space heating accounts for a large share of the country's total energy consumption, large energy savings are possible. However, according to earlier research about technology change in the building sector, there is a “lack of transformation pressure, change aversion, territorial thinking, inability to use available knowledge, quality deficiencies, and prices that are higher than they should be” (Ministry of Health and Social affairs, 2002). Further, the Swedish building sector does not use innovations to build more energy-efficiently (Larsson, 2005).

When cost-effective measures, such as a passive house, are not utilized, an 'energy-efficiency gap' between optimal and actual levels of energy consumption is created. This gap is explained by the existence of structural and market barriers to energy-efficiency (Hirst and Brown, 1990) and can exist at various levels in society, from households, small businesses, corporations, and governments (Dietz, 2010). The existence of market barriers hinders countries from reaching optimal levels of energy use and examples of such are reported in literature (IEA, 2007). Passive houses offer a major opportunity for reducing the energy-efficiency gap in Sweden, but still no clear market change has happened.

The aim of this paper is to investigate the existence and significance of barriers and driving forces for the construction of passive

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houses in Sweden. First, a walk-through of the theory of the 'energy-efficiency gap' and diffusion of innovation theory is carried out in Sections 3 And 4. Thereafter, the results from an interview study are presented and discussed in Sections 5 & 6.

2. Methodology

From the perspective of construction companies, this paper describes barriers to and drivers for the implementation of energy-efficient buildings. The first part of the paper includes a literature survey that presents theory and background of diffusion of innovation and the energy-efficiency gap, both generally and for buildings, specifically. The findings of part 1 were used to create the interview questions for the second part of the paper, which presents and discusses the empirical findings from the interviews. Eleven Swedish construction companies that build low-energy buildings comparable in performance with passive houses were interviewed. Some of the companies build houses with a lower energy use than passive houses, but the energy performance of passive houses is here used as a benchmark. The companies were selected to catch a spread in size, geographical location and profile. To the extent it was possible, the interviewees were selected based on their position so that they have an overview of the strategies and decision-making in the company. Before the interviews, which were made over telephone, the prepared questions were sent out to the interviewees (see Appendix). This gave them time to think about their answers. During the interviews, the interviewees had the freedom to build a conversation around matters they wished to address, even if it was outside the areas of the prepared questions. In this way, the interviewee could use her or his own words and expressions to articulate her or his opinions. This more free conversation was encouraged and thus the questions were formulated thereafter. The authors have translated the quotes in the result chapter from Swedish to English, with some degrees of freedom.

The research was carried out as a case study in that it is an "empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 2003). It should be noted that this study does not provide results with statistical significance, but rather qualitatively describes the situations within the investigated companies. Further, a limitation with the study is that the opinions of customers are presented by the interviewed employees in the construction firms.

3. Diffusion of innovation in the building sector

Any factor that slows the diffusion or in any way accounts for the fact that a cost-effective technology only enjoys a limited market success is referred to as a market barrier (Jaffe and Stavins, 1994). Research has found numerous legislative, cultural, financial and technical market barriers (Osmani and O'Reilly, 2009) and in order to understand the adoption mechanisms of energy-efficient technologies, knowledge about the specific barriers and drivers related to the market penetration is needed. The diffusion process is described in the literature by several authors that reveal the complexity of it. The diffusion of an innovation is a process related to the change in society, which in turn is affected by actors, institutions, and the economic structures (Edquist and Lundvall, 1993; Nelson and Nelson, 2002). Moreover, social norms, opinion leaders, and governments are also involved in the diffusion process according to Rogers (2003). The adoption of a new technology is a process that a sector has to go through, and in order to succeed, Sahal (1981) argues that technology must be transferred together with knowledge of its use and application and not as a "self-contained artefact". On a large scale, changes first occur when the adoption rate of a technology together with the feedback from the evolving dynamics of the network has picked up a certain momentum. As described by Hughes' "seamless web", it is the whole network itself that ultimately will decide the energy use (Hughes, 1986).

From this perspective, the building sector needs to be analyzed. Relevant questions concerning the structure and dynamics of the sector are: which are the needed characteristics, organizations, and companies and how can energy consumption best be managed and arranged in order to improve the adoption rate (Pinkse and Dommisse, 2009). In order for innovation systems to develop, resources need to be mobilized and legitimacy needs to be created (Alkemade and Hekkert, 2009). Consequently, as put by Shove (1998), "there is real work to be done in articulating the features and characteristics of social worlds presupposed by proposed energy-saving scenarios", referring to (De Laat, 1996).

The implementation of buildings with a drastically reduced need for heat will interfere with the dynamics of the sector. Actors that loose from this change caused by passive houses could belong to industries that have a strong influence both economically and politically and they may therefore become market barriers. So far, the Swedish market for passive houses has been characterised by a fairly weak market pull, and with its absence, the market has largely been forced to rely on driving spirits who passionately have worked for the societal importance of improving the energy efficiency in the housing stock.

4. Drivers and barriers

This chapter presents theory of market barriers and drivers as presented in the literature, both generally and for buildings.

4.1. Information

Knowledge society is built on information and the existence of independent and impartial information about the benefits of energy-efficient technology is crucial for adoption (Rogers, 2003; Toole, 1998; Tushman and Nadler, 1978; Bond, 2011; Stern and Aronson, 1984; Halme et al., 2005; Attari et al., 2010). Accordingly, Rogers (2003) stresses the importance of good communication channels through which trustworthy information can flow. Referring to the building sector, information further serves as a knowledge injection to production, supply chains, delivery modes of buildings, and in-use services (Halme et al., 2005). Information also creates awareness and acceptance, where the former usually is obtained through mass media, and the latter from face to face communication (Rogers, 2003). In order to increase the possibility of becoming accepted, information should be specific, vivid, simple and personal (Stern and Aronson, 1984). In an English study, 78% of the survey participants submitted that the lack of data on the cost of zero carbon homes was a significant or major barrier (Osmani and O'Reilly, 2009). The information on energy-efficient technologies is often lacking, causing consumers not to change their behavior (Rogers, 2003).

4.2. Adoption costs & hidden costs

The adoption of a technology is preceded by a knowledge build-up through information gathering, learning, establishing contacts with suppliers, etc. These activities include costs that might not be visible in simple cost-effectiveness calculations and are therefore referred to as hidden costs (Jaffe and Stavins, 1994). If high enough, these costs will inhibit green investments.