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Technical skills, disinterest and non-functional regulation: Barriers to building energy efficiency in Finland viewed by energy service companies

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ABSTRACT

Energy inefficiency in the building stock is a substantial contributor to climate change. Integrated energy service companies (IESCs) have a potentially important role in improving energy efficiency. This paper presents a qualitative analysis of the energy efficiency barriers in the Finnish building sector based on data from interviews with twelve IESCs. Taking a novel supply side perspective, we place IESCs at the centre of the emerging energy services business ecosystem to identify the barriers and hindering factors (real world illustrations of barriers). From this perspective, we also examine cause-effect relationships between the hindering factors and the actors. Hindering factors, reported by IESCs, were categorised under a revised barrier taxonomy consisting of economic market failures and economic market, behavioural, organisational and institutional barriers. The most salient hindering factors—lack of technical skills, disinterest in energy efficiency improvements and non-functional regulation—were analysed with respect to ecosystem actors causing and affected by these factors. Public actors have a key role in overcoming these barriers, for instance, by creating new possibilities for entrants to take part in decision-making, increasing the functionality and practicality of policies and by providing up-to date energy efficiency information.

1. Introduction

Energy inefficiency in a large part of the current building stock is a substantial contributor to climate change (Ástmarsson et al., 2013); and, also, in many countries to fuel poverty (Sorrell, 2015). In the European Union (EU), buildings account for approximately 40 percent of total energy consumption and 36 percent of greenhouse gas emissions; and have a high energy saving potential compared to other economic sectors (EU, 2016; Forsström et al., 2011). Therefore, building-level energy efficiency improvements and on-site renewable energy installations have significant climate change mitigation potential. Although reduction in energy consumption is commonly associated with technological change (e.g. insulation or ventilation) it can also stem from improved management or maintenance (Robinson et al., 2015). Yet, the current rate of energy performance improvements in buildings is still low in Europe (Sweatman, 2012; Meeus et al., 2012).

Many opportunities exist for cost-efficient measures to improve energy efficiency, which are not realised currently (Sorrell, 2015). The gap between the optimal energy efficiency improvements and the realised improvements is called the 'efficiency gap' or the 'energy paradox' (Jaffe and Stavins, 1994; Gillingham and Palmer, 2013). The underlying causes for the energy efficiency gap are known as *barriers* (Sorrell et al., 2000). Weber (1997, p. 834) was one of the first to address the structure of energy efficiency barriers, proposing a barrier model according to the methodological questions: "*What* is an obstacle to *whom* reaching *what* in energy conservation?" (emphasis in original). Sorrell et al. (2000) suggest that any fruitful empirical research must provide a clear understanding of the nature of the barriers, identify the relevant actor, and identify the relevant energy efficiency investment.

So far, seminal contributions (e.g. Sorrell et al., 2000; Gillingham et al., 2009; Nagesha and Balachandra, 2006) have focused on the identification and classification of energy efficiency barriers, with recent work (e.g. Chai and Yeo, 2012 and Cagno et al., 2013) taking a more actor centric approach. The studies analysing barriers have focused on the failure of customers (e.g. households, public entities or companies) to make cost-efficient energy efficiency investments, which is evident in the numerous efficiency barrier models and taxonomies that have been developed. Some have identified supply side actors, especially energy service companies (ESCOs), as important for the transition towards low-carbon buildings (Robinson et al., 2015; Nolden

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and Sorrell, 2016), while only few studies have explored energy efficiency barriers from an energy service perspective. Duplessis et al. (2012) have, for example, explored the ways in which how markets for energy services can be supported. We address this gap in research regarding the analysis of barriers from the energy service company perspective, by empirically examining the views of integrated energy service companies (IESCs) in Finland due to their promising role in closing the energy efficiency gap. Moreover, we employ the concept of an "ecosystem" to have a brief look at how the barriers are caused by or affect other actors besides energy service companies.

Energy services have been suggested as a way to improve energy efficiency (Kindström and Ottosson, 2016). Several definitions of energy services exist (see Kindström et al., 2017). Bertoldi et al. (2006, 1820) define them as "a variety of activities, such as energy analysis and audits, energy management, project design and implementation, maintenance and operation, monitoring and evaluation of savings, property management, and energy and equipment supply." As integrated building-level approaches provide greater opportunities for improving energy efficiency (Levine et al., 2007), integrated energy services play an important role in achieving efficiency from a systemic perspective in contrast to individual incremental improvements. Such services through their nature have the potential to disrupt the existing system of planning and realising building energy use.

The potentially disruptive (Hannon, 2012) and increasingly popular (Duplessis et al., 2012) Energy Service Company (ESCo) business model typically offers "comprehensive contracts that include energy information and control systems, energy audits, installation, operation and maintenance of equipment, competitive finance, and fuel and electricity purchasing" (Sorrell, 2007, p. 507). Normally, such long-term service contracts (Hannon and Bolton, 2015) are defined to contain both finance and guarantee of energy and cost savings (Mahapatra et al., 2013) to allow clients to reduce energy costs, transfer risk and concentrate attention on core activities (Sorrell, 2007). The literature on integrated energy services does not yet provide a full account of the kinds of business models and their differences beyond the ESCo model (cf. Hannon and Bolton, 2015). Whilst the ESCo model is the most commonly mentioned *integrated energy service*, a variety of other 'one stop shop' energy service models also exist that do not include the guarantee and/or finance for the installed energy improvement measures (Mahapatra et al., 2013). Our study takes a broad scope on energy service companies and includes companies offering both ESCo and other integrated energy service models, enabling the inclusion of a greater number of companies involved in energy services.

We define IESCs as actors that provide holistic energy services which integrate a range of technical, financial and maintenance solutions to improve building energy efficiency and reduce energy demand in a cost-efficient way. Thus, we exclude companies providing single technology oriented services, such as heat pump installation or maintenance, from the study. Integrated energy services can comprise advice, consultancy, design, finance, metering, monitoring, management and optimisation, as well as the retail of diverse sets of technologies that through energy efficiency improvements and on-site renewable energy can result in reduced amount of purchased energy, cost of energy and reduced greenhouse gas emissions alongside improved living conditions. IESCs do not have to offer all the above-mentioned services; each typically has its own business model based on different services and customers. Fig. 1 illustrates how integrated energy services can address different stages of a building's life-cycle, including design, construction, maintenance and renovation.

IESCs operate in an interdependent network of actors who are highly heterogeneous and specialised, and whose complementarity adds to value creation in the sector. Drawing from the literature on business ecosystems (e.g. Moore, 1996), we place IESCs at the centre of an emerging energy services business ecosystem, since value creation related to integrated energy services is beyond the capacity of any single actor. Whilst previous studies often stop at the identification of energy efficiency barriers, we identify the actors that cause and are affected by energy efficiency barriers based on the views of IESCs. Applying such an approach to the case of building energy efficiency can help to reconcile the relationships between barriers and actors throughout the emerging energy services ecosystem. With this in mind, we pose two questions:

1. What are the barriers and hindering factors that IESCs experience when they deal with the energy efficiency gap in the Finnish building sector?
2. Who are the actors in the emerging energy services ecosystem in Finland, and how is the direction of the barriers formed between the actors?

Finland is interesting country setting to study barriers for IESCs in building energy efficiency for several reasons. In Finland, energy consumption per capita is the second highest in the EU and is double the EU average for energy consumption; largely due to Finland's energy intensive industry and cold climate. Yet, Finland was ranked among the top three countries in terms of progress in energy efficiency policy in the EU (Energy Efficiency Watch, 2013). Buildings account for 38 percent of the total energy consumption (space heating covering 25%) and 32 percent of greenhouse gas emissions (NEEAP-2 Finland, 2011; Vehviläinen et al., 2010; Statistics Finland, 2016). It has been estimated that the emissions of the Finnish building stock could be decreased by approximately 50 percent by increasing the energy efficiency of the current building stock, but this would require a substantial increase to the refurbishment rate, which is currently 1–1.5 percent annually (Airaksinen et al., 2013). In Finland, the ESCO sector emerged approximately 15 years ago and, in 2014, there were three to five companies active in the Finnish market (Bertoldi et al., 2014). The penetration of the ESCO business model has been slow in Finland, due to customers being unaware of ESCOs, high transaction costs related to savings, and the general financial situation in Finland (Pätäri et al., 2016).

We aim at providing new insights into the analysis of building energy efficiency barriers in the Finnish building sector by taking a novel supply centric approach that accounts for the directional relationships of the actors causing and being affected by the barriers. Taking an IESC perspective, we are able to reveal the often neglected perspective of barriers that energy efficiency supply companies face. Analysis of interview data from twelve IESCs and two intermediaries allows us to identify the actors that are affected by, and cause, the barriers, going beyond current literature which focuses on the identification of barriers.

The paper is structured as follows. Section 2 provides an overview of the concept of business ecosystems and energy efficiency barrier models, taxonomies, categories and barriers. Section 3 describes the research design and methods and outlines the case of the emerging Finnish energy services ecosystem. Based on our typology of energy efficiency barriers, Section 4 identifies the factors hindering energy service companies in Finland. Section 5 provides a more detailed analysis of the salient hindering factors; lack of technical skill, disinterest in energy efficiency improvement and non-functional regulation. Section 6 discusses the benefits and limitation of a supply oriented approach to energy efficiency barriers and Section 7 provides policy recommendations.

2. Business ecosystems and energy efficiency barriers

2.1. Business ecosystems

To understand the cause-effect relationship between the barriers and the actors at the boundary of energy and construction sectors, the business ecosystem concept is employed. The concept is relevant for the study of integrated energy services in the building sector, as the nature