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**Barriers to Green Innovation: Evidence from SMEs in the
Residential Construction Sector**

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Preface

Writing this master thesis has been the accumulation of my five years of studying at the University of Groningen. By combining my interest in SMEs with the strong belief that society's impact on the environment should be reduced, I was able to write a thesis that matched my interests. The results from this research will allow policy makers to implement regulations and structures that will reduce the barriers to green innovation in the residential construction sector. By reducing the barriers in this critical area, the build environment will be made more sustainable, resulting in a durable reduced impact on the environment.

For helping me to make this thesis a success, I would like to thank the following people: First of all, my supervisor Maryse Brand for supporting me during the writing of my thesis and especially for providing me with constructive feedback during the different writing stages. Secondly, Wytze van der Gaast and Erwin Hofman from the Joint Implementation Network in Groningen. Through their participation in the GreenEcoNet program, they have offered me several opportunities to attend very useful conferences and workshops. Furthermore, I would also like to thank them both for the personal advice and guidance they have given me during the writing of the thesis. Thirdly, all companies that have participated in the research for investing their time and effort in making the interviews a success. Fourthly, Charlotte Wellmer for helping me with difficult German translations and for supporting me during the stressful months of writing the thesis. Lastly, my parents for both their mental and financial support, which has allowed me to complete my studies successfully.

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Barriers to Green Innovation: Evidence from SMEs in the Residential Construction Sector

Abstract: This study investigates the barriers to green innovation that small and medium sized enterprises (SMEs) in the residential construction sector face. Despite the importance of understanding these barriers in effectively reducing them, the academic literature on this topic is scarce. This study, therefore, has tried to partly fill this gap by conducting fifteen semi-structured interviews with contractor SMEs in the Netherlands, Germany and the United Kingdom. The analysis of the results on a country level and a cross country level show that the barriers differ across countries, but that predominantly six similar barriers emerge across countries. These six barriers can be seen as important barriers to green innovation in the residential construction sector. The barrier lack of demand from the market is identified as the most important barrier, because most barriers influence or are influenced by this barrier. Reducing the lack of demand from the market is, therefore, key in the proposed policy actions of tightening environmental regulations in combination with the introduction of a favourable lending scheme for green innovations.

Keywords: Green innovation, Barriers, SMEs, Residential construction sector

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1. Introduction

“The global economic crisis, soaring commodity prices and growing awareness of humanity’s impact on the environment, have pushed the ‘green economy’ concept into the mainstream policy debate” (European Environmental Agency, 2013, p.5). The European Union is emphasising the role of green growth and green innovation in the transition to the green economy in their Europe 2020 targets. The role for small and medium-sized enterprises (SMEs) in this transition is essential, because they form the backbone of the European economy. The European Union has recognised the important role of SMEs and has launched several initiatives to stimulate green innovations in SMEs. Traditionally the focus of greening the economy and green innovation has been on energy-intensive industries such as the oil & gas and automotive industry (Pinske & Dommissie, 2009). McKinsey Global Institute (2007), however, found that the global residential sector, which is responsible for 25 percent of global energy demand, has the largest potential to reduce CO₂ emissions. Similarly, the Intergovernmental Panel on Climate Change (IPCC, 2007) found that the construction sector has the greatest and cheapest potential to reduce CO₂ emissions. According to Pinske & Dommissie (2009), this potential can be largely utilised by adopting already existing, so called ‘off the shelf’ technologies. These off the shelf technologies don’t require the companies to invest in R&D, which allows them to implement these green technologies at a low cost. This is especially important for SMEs who typically don’t have R&D departments and are resource constraint.

The European Union has recognised the important role of the construction sector in meeting the 2020 environmental goals and has revised the Energy Performance of Buildings Directive (EPBD) in 2010. The EPBD 2010 requires all new buildings to be nearly zero-energy buildings by 2020 (Ecofys, 2014). Building nearly zero-energy buildings entails that energy demand is minimised and that the remaining energy demand is supplied with renewable energy. This type of building, according to Albino & Berardi (2012), requires a radical change in current practice in the construction sector, which has been slow in adopting green innovations (Jaffe & Stavins, 1994; Pinske & Dommissie, 2009). According to Hadjimanolis (1999), understanding the barriers that cause the slow adoption of green innovations is essential in stimulating green innovations and thus facilitating the change that is needed. Although much research on green innovation has focussed on the drivers of green innovation, not much research has focussed on the barriers to green innovation (Marin et al., 2014). Especially the literature on barriers to green innovation in SMEs is scarce (Pinget, 2014). To the current knowledge of the author, there is even no academic literature that has created insight into the barriers to green innovations that SMEs in the construction sector face. However, with SMEs comprising 97% of all construction sector companies (Kildiene, 2013), knowledge on the barriers in SMEs is essential in understanding the low adoption of green innovation in the construction sector.

The scarce literature on barriers to green innovation in SMEs and the lack of literature on barriers to green innovation in the construction sector can be seen as a gap in the academic literature. This research will partly try to fill this gap by doing research on the barriers to green innovation in SMEs in the residential construction sector in three European countries (the

Netherlands, Germany and the United Kingdom¹). The residential construction sector was chosen as the setting for the research, because both the reports by McKinsey (2007) and IPCC (2007) indicated that the potential for green innovations in this subsector is the highest. By conducting the research in three countries the differences and commonalities between countries can be analysed. These differences will shed light on why certain barriers exist and the factors that influence these barriers, such as national legislation. The barriers identified and the differences between the countries, could have important policy implications for national governments. The research will, therefore, answer the following research questions:

- (i) Which barriers to green innovation do SMEs in the residential construction sector face?
- (ii) How do the barriers to green innovation differ across countries and how can these differences be explained?
- (iii) What policy lessons can be drawn from the identified barriers and differences across countries?

These research questions will be answered by conducting semi-structured interviews with five contractor SMEs in each of the three European countries. The results of the interviews will be analysed by making company case reports and by combining them into national reports with a cross case analysis. Based on the national reports, the similar procedure will create a cross national report.

This research aims to contribute to the academic literature by identifying the barriers to green innovation for SMEs in the residential construction sector in three European countries. By comparing the barriers across countries, country specific or overarching barriers can be identified. This will partly fill the previous identified gap in the academic literature, namely that the literature on barriers to green innovation in SMEs is scarce and that no literature exist on barriers to green innovation in SMEs in the construction sector.

The remainder of this paper is structured as follows. In section 2 the existing literature will be reviewed, elaborating on the concepts of innovation, green innovation, green innovation in SMEs and barriers to green innovation for SMEs. In section 3 the research method of this paper will be discussed, while section 4 includes the results of the barriers for each country and a cross country analysis. Section 5 includes the discussion, conclusion, policy implications and limitations and future research.

¹ Elaboration on why these specific countries have been selected can be found in section 3.1

2. Literature review

In this section, a review of literature on innovation, green innovation, green innovation in SMEs and the barriers to (green) innovation in SMEs is given.

2.1 Innovation

Research on innovation started when Schumpeter introduced innovation to the economic theory (Godin, 2008). He stated that economic development is driven by the discontinuous emergence of new combinations (innovations) that are economically more viable than the old way of doing things (Schumpeter, 1934). Schumpeter classified innovation in five different types; product innovation, process innovation, market innovation, input innovation and organisational innovation. From these types of innovation, product- and process innovation have received the most attention (Fagerberg, 2009). Ever since Schumpeter introduced innovation in the economic theory, the economic relevance has been beyond doubt, with innovation strengthening the competitiveness of individual companies, sectors and countries (Porter, 1985). However, there are also non-economic arguments for innovation, such as reducing the negative impact on the environment, which will be discussed in the next section.

2.2 Green innovation

Innovation that leads to a reduced impact on the environment can be classified as ‘green’, ‘eco’, ‘environmental’ or ‘sustainable’ innovation. The multitude of classifications shows that there is not yet a clear consensus on how to describe this type of innovation. As this paper aims to investigate barriers to green innovation, the concept of green innovation needs to be defined clearly. In an attempt to clarify the concept of green innovation, Schiederig et al. (2012) found that all four classifications in the literature are used interchangeably and that they only show minor conceptual differences. They identified five important aspects that were observed in nearly all definitions;

- (1) Innovation object: Product, process, service, method;
- (2) Market orientation: Satisfy needs/be competitive on the market
- (3) Environmental aspect: Reduce negative impact
- (4) Impulse: Intention of reduction may be economical or ecological
- (5) Level: Setting a new innovation/green standard to the firm

The first two aspects can also be related to non-green innovation, the third aspect however, clearly sets apart green from non-green innovation. The fourth aspect poses a problem in clearly separating green from non-green innovation, because the impulse to innovate might be economical, it can still have ecological benefits. By choosing the definition of green innovation by the Organisation for Economic Co-operation and Development (OECD), which includes both impulses, the problem is resolved. The OECD (2008) defines green innovations as:

“Green innovations encompass all innovations that have a beneficial effect on the environment regardless of whether this effect was the main objective of the innovation, and that are also novel to the firm that introduces them. They include process, product and organizational innovations.”

By looking at green innovation at the micro level, which defines innovation as new to the firm, the OECD definition is in line with the fifth aspect by Schiederig et al. (2012). In the remainder of this paper the notions of 'green', 'eco', 'environmental' and 'sustainable' innovations will be grouped under green innovations, because they only show minor conceptual differences (Schiederig et al., 2012). By grouping the notions together, potential confusion about definitions being used interchangeably is prevented.

2.3 Green innovation in SMEs

As mentioned in the introduction, SMEs are vital in the transition to a green economy. In this transition green innovation and green growth are essential. But how do SMEs and large companies differ in respect to innovation and green innovation? It was again Schumpeter who inspired this discussion by his opposing views on how firm size relates to innovation (Tether, 1998). Where in Mark 1 he argues that the entrepreneur (SME) is more important to innovation, in Mark 2 he states that large businesses are more important (Storey & Green, 2010). According to Tether (1998) there has been extensive research on the differences in innovation between SMEs and large companies, but the results are inconclusive and highly dependent on the measurement and interpretation of innovation. Bos-Brouwers (2010) states that it is not important to question whether SMEs are more or less innovative than large companies, but that it is important to acknowledge that SMEs innovate differently from large companies. Similarly, Nootboom (1994) argues that large companies and SMEs will be good at different types of innovation. Large companies will be better at generating fundamentally new technologies, while SMEs are better at applying and modifying innovations to the customers need. These differences are caused by respective strengths of the large companies and SMEs. According to Nootboom (1994), the strength of large companies lies in the level of specialisation of people and equipment, economies of scale and scope, larger financial resources and the spreading of risks. The strength of SMEs lies in their flexibility and adaptability caused by greater proximity to the market, less bureaucracy, informal communication along shorter lines and greater motivation (Nootboom, 1994). The large companies and the SMEs complement each other with these strengths, as the strengths of the one, are often the weakness of the other. What can be clearly seen in the five stages of innovation according to Schumpeter (1934). These stages are invention, development, tooling/production, introduction to practice/market and diffusion. Large firms tend to be better at the first two stages, while SMEs tend to be better at the implementations of these inventions and bringing them to the market. Large firms then take over, because they are more effective in the diffusion of the invention (Nootboom, 1994).

2.4 Barriers to green innovations in SMEs

Most research on green innovations has focussed on the drivers of green innovation and not on the barriers hindering these green innovations (Marin et al., 2014). However, the importance of understanding the barriers to green innovation is high, because a better understanding of what hinders green innovation, can make their drivers more effective (Hadjimanolis, 1999). Whether SMEs implementing green innovation face different barriers than SMEs implementing other types of innovation is part of a larger debate in the literature. This debate focusses on whether green innovation is a type of innovation that needs its own theories and approaches (De Marchi, 2012; Rennings, 2000). The general conclusion in this debate is that there are large similarities,

but that innovation theory does not fully cover the complex nature of green innovations (Jakobsen & Clausen, 2014). This is most evident in the externalities and drivers concerning the introduction of green innovation (De Marchi, 2012). The drivers for innovation have traditionally been classified into two categories; demand pull and technology push. These two drivers are comparatively weak in green innovations (Bernauer et al., 2007). The government is therefore trying to drive green innovation through regulation, this is known as the regulatory push/pull effect. Despite the government's intervention, the drivers in this regulation imposed innovation are still weaker than the drivers for innovation driven by the market (Rennings, 2000). When trying to introduce green innovations, firms will therefore be confronted with stronger barriers (Horbach, 2008). This was confirmed by Jakobsen and Clausen (2014), who found that innovation and green innovation share the same barriers to innovation, but that they are stronger in firms introducing green innovations.

When SMEs innovate differently from large companies, as was discussed in section 2.3, they will probably also face different barriers to innovations than large companies. According to Madrid-Guijarro et al. (2009), SMEs are particularly restricted by innovation barriers because of their limited resources in terms of capital, knowledge and skilled labour. The barriers that SMEs face are classified in various ways, but most researchers classify them as internal and external to the firm (Hadjimanolis, 1999). Madrid-Guijarro et al. (2009) subdivide the internal and external barriers into four subcategories. Internal barriers consist of financial resources, human resources, weak financial position and high costs and risks. The external barriers consist of turbulence, lack of external partner opportunities, lack of information and lack of government support. An overview of these barriers is presented in table 1. Although most research on innovation classifies barriers into internal and external, this research will classify the barriers into market-, regulatory and firm internal barriers. This classification is based on the framework for studying green innovations by Bernauer et al. (2007). The classification is similar to the standard classification, besides that it adds a third category. The regulatory barrier is added, because of the importance of regulatory forces in green innovations.

As mentioned in the introduction, the specific knowledge on barriers to green innovation in SMEs is scarce. After an extensive literature study on this topic, only one report on the topic was found. This is an analytical report on attitudes of European entrepreneurs towards eco-innovation and was commissioned by the European Commission (Eurobarometer, 2011). This report lists fourteen barriers to green innovation that SMEs face, but it is not a scientific paper. In order to validate the scientific relevance of these barriers, the fourteen barriers are compared with barriers to innovation in SMEs found by Madrid-Guijarro et al. (2009) and Hadjimanolis (1999), see table 1. This comparison can be made due to the earlier discussed findings of Jakobsen and Clausen (2014), that innovation and green innovation share the same barriers to innovation. The comparison shows that all eight barriers to innovation found by Madrid-Guijarro (2009) were also found in the Eurobarometer (2011) report. From the thirteen barriers that Hadjimanolis (1999) identified, eight corresponded with the Eurobarometer (2011) report. The five not corresponding barriers by Hadjimanolis (1999) are listed at the bottom of their corresponding classifications in table 1. The comparison identified that the barriers found in the Eurobarometer (2011) report show large similarities with the literature on barriers to

innovation. The fourteen barriers from the Eurobarometer (2011) report will therefore be used as main input for the next section, where the possible barriers for green innovation in the construction sector will be developed. Together with the five not corresponding barriers found by Hadjimanolis, this will make the list of possible barriers to green innovation in the construction sector.

Table 1: Comparison of barriers to (green) innovation

	Eurobarometer, 2011	Madrid-Guijarro, 2009	Hadjimanolis, 1999
Market barriers	Lack of funds within the enterprise	Lack of financial resources	Lack of internal funds
	Uncertain return on investment/ too long payback period	Weak financial position High cost and risk	
	Lack of qualified personnel and technological capabilities within the enterprise	Poor human resources	Lack of technical expertise
	Reducing energy use is not an innovation priority		
	Reducing material use is not an innovation priority		
	Market dominated by established firms		
			Culture and systems related Resistance to change in the firm Lack of management time
Regulatory barriers	Existing regulations and structures not providing incentives to eco-innovate	Lack of governmental support*	Governmental regulations
	Insufficient access to existing subsidies and fiscal incentives	Lack of governmental support*	Policy
Firm internal barriers	Uncertain demand from the market	Turbulence	Lack of customer need
	Lack of external financing		Difficulty in obtaining finance
	Limited access to external information and knowledge	Lack of information	Difficulty in obtaining technological information
	Lack of suitable partners	Lack of external partners opportunities*	
	Lack of collaboration with research institutes and universities	Lack of external partners opportunities*	
Technical and technological lock ins		Market limitations Antitrust measures Difficulty in obtaining raw materials	

* Barrier is only listed once by Madrid-Guijarro but corresponds multiple times with Eurobarometer barrier

2.5 Barriers to green innovation in the construction sector

The previous paragraph identified the fourteen barriers from the Eurobarometer (2011) report as possible barriers to green innovations in SMEs, but how do these barriers apply to the construction sector? An extensive literature search did not yield an article discussing barriers to green innovation in the construction sector. This paragraph will, therefore, convert the identified barriers, into construction sector specific barriers. The relevance of the fourteen barriers in the construction sector was first analysed by using the Eurobarometer (2011) report. The relevance of the fourteen barriers for the European construction sector is presented in table 2. The fourteen barriers will be further analysed in the next section by discussing them in the context of the construction sector based on the available literature.

Table 2: Relevance of barriers to green innovation in the EU27 construction (Eurobarometer, 2011)

	<i>Ranking of relevance</i>	Barrier to green innovation	% Serious²
Market barriers	1.	Lack of demand from the market	69%
	6.	Lack of external financing	59,5%
	9.	Market dominated by established firms	52%
	10.	Technical and technological lock ins	50,1%
	12.	Limited access to external information and knowledge	43,7%
	13.	Lack of suitable partners	41,7%
Regulatory barriers	4.	Insufficient access to existing subsidies and fiscal incentives	61,9%
	5.	Existing regulations and structures not providing incentives for green innovations	60%
Firm internal barriers	2.	Uncertain return on investment/ too long payback period	64,3%
	3.	Lack of funds within the enterprise	63,5%
	7.	Reducing energy use is not an innovation priority	53,4%
	8.	Lack of technical expertise in personnel	52,1%
	11.	Reducing material use is not an innovation priority	45,1%
	14.	Lack of collaboration with research institutes and universities	32,3%

2.5.1 Market barriers

The construction sector is known for its complex nature, which is characterised by inter-organisational collaborations, a project based structure and collaborating partners sharing power (Beerepoot & Beerepoot, 2007). An example of this complex nature is that green innovations in the construction sector are not implemented in the companies themselves, but are implemented as part of their building projects (Miozzo & Dewick, 2002). Consequently, the benefit of implementing green innovations are not for the building companies, but for their customers. This makes the demand for green innovations from their customers, essential in the uptake of green innovations in the construction sector. Corresponding with the Eurobarometer (2011) report, the barrier uncertain demand from the market, or more applicable, *lack of demand from the market* can be seen as a major barrier to green innovation.

² This percentage is compiled from the answers somewhat serious and very serious of respondents in the construction sector in the Eurobarometer (2011) report

The economic recession followed by the financial crisis had a big impact on the construction sector, with construction output in 2014 still being 25% lower than in the pre-crisis high (Eurostat, 2015). This has led to a large number of bankruptcies and has many companies experiencing difficulties in obtaining external finance. Implementing green innovations require higher upfront investments, which are hard for the companies to finance. The barrier *lack of external financing* can, therefore, be seen as a barrier to green innovation.

The contractor deals with all the stakeholders in a building process, such as architects, sub-contractors, materials- and service suppliers and customers (Winch, 2010). Therefore, the contractor plays a key role in introducing green innovations (Beerepoot & Beerepoot, 2007). In order to introduce green innovations in a project, the contractor will have to negotiate with all these stakeholders and rely on their capabilities in introducing green innovations in a project. This dependence on suitable partners coincides with the barrier found in the Eurobarometer (2011) report 'lack of suitable partners'. A *lack of suitable business partners* could therefore be an important barrier to green innovation in the construction sector.

For the barriers *market dominated by established firms, technical and technological lock ins* and *limited access to external information and knowledge* no construction sector specific literature was found. This can be explained by the earlier discussed absence of literature on barriers to green innovation in the construction sector.

2.5.2 Regulatory barriers

National and international governments play an important role in stimulating demand for green innovation in the construction sector. The demand is stimulated through legislation, monitoring and subsidy programmes (Beerepoot & Beerepoot, 2007). Recent legislation by the European Union requires the construction sector to radically change towards going green, because it requires all new buildings to be nearly zero energy buildings after 2020 (Ecofys, 2014). The important role of governments in creating demand for green innovation also gives them an important role in the barriers to innovation. The barriers *existing regulations and structures not providing incentives to eco-innovate* and *insufficient access to existing subsidies and fiscal incentives* can, therefore, be seen as important barriers to green innovation in the construction sector.

2.5.3 Firm internal factors

The return on investment and payback period for green innovations in the construction sector, differs strongly from other industries. Where in most industries the green innovations are implemented in the firm, green innovations in the construction sector are implemented in their building projects (Miozzo & Dewick, 2002). This difference has important consequences for the return on investment and payback period of green innovation in the construction sector. Where traditionally the decision on whether to implement green innovations depends on the return on investment and payback period over a number of years, construction companies have to recoup their investment in green innovation at the moment they sell their building projects. The resulting dependence on their customers increases the uncertainty of investing in green

innovations. This uncertainty, however, only applies to the designing and/or construction of buildings where the customer is not yet known, the so called building for the market. Contrary to building for specific customers, this entails that construction companies have to anticipate the demand for green innovations from future customers. Not knowing the customers before the buildings are designed or built, increases the risk of investing in green innovations. The barrier *uncertain return on investment* can, therefore, be seen as a barrier to green innovation in the construction sector.

During the economic recession many SMEs in the construction sector have struggled to keep their business profitable, which forced them to use their financial reserves. The consequent lower financial reserves, combined with the fact that most capital of SMEs in the construction sector is invested in building stock (Beerepoot & Beerepoot, 2007), results in the liquidity of many SMEs being under pressure. The low liquidity will prevent SMEs from investing in green innovations, because these require higher upfront costs. The barrier *lack of funds within the enterprise* can therefore be seen as a barrier to green innovation in the construction sector.

Green innovations in the construction sector mostly lead to a reduction in energy usage. The benefit of the reduction in energy usage, however, does not lie with the construction company, but with the customer (Du et al., 2014; Albina & Berardi, 2012). Consequently, the construction company does not have an incentive to reduce the energy usage. The barrier *reducing energy use is not an innovation priority* can, therefore, be seen as a barrier in the construction sector.

The barriers ‘culture and systems related’, ‘resistance to change in the firm’ and ‘lack of management time’ were identified by Hadjimanolis (1999) as barriers to innovation, but did not correspond with the barriers to green innovation found in the Eurobarometer (2011) report. These three barriers, grouped together under ‘resistance to change in the firm’, could form an important barrier in the construction sector, where a radical change in current practice is needed (Albino & Berardi, 2012). In a sector where a radical change is needed, resistance to change can be an important barrier in hampering the change. The barrier *resistance to change* can, therefore, be seen as a barrier to green innovation in the construction sector.

Similar to three market barriers, no construction sector specific literature was found for the barriers *lack of technical expertise in personnel*, *reducing material use is not an innovation priority* and *lack of collaboration with research institutes and universities*.

2.5.4 Conclusion on barriers

From the fourteen barriers identified in the Eurobarometer (2011) report, eight were also identified in the literature as barriers to green innovation. Seven of these eight barriers found in the literature correspond with the seven barriers with the highest relevance found in the Eurobarometer (2011) report, see table 2. In order to prevent a premature dismissal of possible barriers to green innovation, six of the seven remaining barriers from the Eurobarometer (2011) report, will also be incorporated in the remainder of the research. The barrier lack of collaboration with research institutes and universities is not included in the research, because it showed large similarities with the barriers ‘lack of suitable business partners’ and ‘limited access to external information’ and because it was clearly seen as the barrier with the lowest

relevance in the construction sector, see table 2. The barrier lack of collaboration with research institutes will, therefore, be combined with the barriers ‘lack of suitable business partners’ and ‘limited access to external information’. The thirteen barriers from the Eurobarometer (2011) report supplemented with the barrier resistance to change by Hadjimanolis (1999), results in fourteen possible barriers to green innovation in the construction sector, which are presented in table 3. How these fourteen barriers will be used in the remainder of the research, will be discussed in the next chapter.

Table 3: Possible barriers to green innovation in the construction sector

Barrier to green innovation	
Market barriers	Lack of demand from the market
	Lack of external financing
	Market dominated by established firms
	Technical and technological lock ins
	Limited access to external information and knowledge
	Lack of suitable partners
Regulatory barriers	Insufficient access to existing subsidies and fiscal incentives
	Existing regulations and structures not providing incentives for green innovations
Firm internal barriers	Uncertain return on investment
	Lack of funds within the enterprise
	Reducing energy use is not an innovation priority
	Lack of technical expertise in personnel
	Reducing material use is not an innovation priority
	Resistance to change in the firm

3. Methodology

This study uses semi-structured interviews to determine the barriers to green innovation for SMEs in the residential construction sector in three European countries, how these barriers differ across countries and what policy lessons can be drawn. The chapter will begin with discussing the selection of the countries in the research, after which the data collection, sample selection, data analysis and reliability and validity will be discussed.

3.1 Countries in the research

By requiring all new buildings to be nearly zero efficient in 2020, the EPBD 2010 has forced an increased uptake of green innovations in the construction sector (Albino & Berardi, 2012). This can be seen in the sharp increase of SMEs in the construction sector offering green products. Where the construction sector only made up 18% of the total of SMEs offering green products in 2012, these figures rose to 26% in 2013 (Eurostat, 2013). An examination of the figures on the country level, showed large differences between countries. These differences on country level have been used to make a selection of the countries in this research. In order to increase the scope of the research, three countries with differing trends have been selected. Together with the practical consideration of wanting to conduct the interviews in the native language of the interviewees, the research has taken place in the Netherlands, Germany and the United Kingdom. The figures from the Eurostat (2013) report for the selected countries are presented in table 4.

Table 4: Construction sectors share of total SMEs offering green products (Eurostat, 2013)

Country	% SMEs 2012	% SMEs 2013	$\Delta\%$
EU 28	18	26	8
Germany	11	35	24
The Netherlands	17	23	6
The United Kingdom	36	33	-3

Table 4 shows that the Netherlands approximately followed the EU28 trend, with a growth of 6%. The United Kingdom and Germany clearly deviate from the average trend, where the former saw a decrease and the latter a sharp increase. The three differing trends make an interesting comparison between the countries.

3.2 Data collection

Most research on SMEs and green innovation has used quantitative research methods to gather data (Revell & Blackburn, 2007). Although quantitative methods allow the comparison of large number of companies, they do not provide a deeper understanding of the reasons behind green innovation. Therefore, in order to create a deeper understanding of the barriers to green innovation, a qualitative research method, namely semi-structured interviews has been used. Semi-structured interviews have been selected, because they allow the researcher to investigate complex topics, while also allowing the researcher to investigate other topics that might arise during the interviews (Galletta, 2013; Bernard, 1988). This makes semi-structured interviews

appropriate for research into the complex nature of barriers to green innovation and possible diverse reasons behind them.

The interviews were conducted using an interview guide, which was drafted by using the interview guidelines suggested by Emans (2004). The interview guide, see appendix 1, consisted off introductory questions about the company, background questions about green innovations in the company, and main questions about barriers to green innovations. In order to keep the duration of the interview within acceptable limits for the interviewees, the fourteen possible barriers identified in the literature part, were divided into six aided and eight unaided barriers. The six aided barriers were discussed in all interviews, while the unaided barriers were only discussed if they were mentioned by the interviewees. The distinction between aided and unaided questions was based on their relevance in the construction sector, earlier presented in table 2.

The first interviews were conducted in the Netherlands, where all interviews were conducted face to face and lasted between 45-60 minutes. The interviews in Germany and the United Kingdom were conducted over the phone and lasted between 15-30 minutes. The difference in the length of the interviews can be attributed to the method of conducting the interviews, because companies will most likely not agree to an interview over the phone of 45-60 minutes. The knowledge and experience from the researcher, gained in the interviews in the Netherlands, has allowed the interviews to be conducted more time effectively in Germany and the United Kingdom. However, the interviews in Germany and the United Kingdom still had to be shortened by leaving out some of the background and introductory questions. This gap of knowledge, in comparison with the Netherlands, has been partly solved by a meticulous investigation of the company websites.

3.3 Sample selection

The time intensive character of interviews has limited the number of respondents that can be used in the research. This has important consequences for the reliability of the research, because with five interviews in each county, these groups might not form an accurate representation of the total population in each country. In order to increase the reliability of the research, the selection of companies in each country was limited to a specific geographical region. This has eliminated potential geographical differences between regions in their perception of barriers to green innovation. In the Netherlands the geographical region was limited to the city of Groningen and surroundings. The city of Groningen was selected, because it is the city of the university where this research is written and because it allowed the researcher to conduct all interviews face to face. To eliminate any region size related differences, similar regions have been selected in Germany and the United Kingdom. In Germany the city of Oldenburg and surroundings and in the United Kingdom the city of York and surroundings have been selected. Both cities are of similar size to Groningen and, similar to Groningen, also harbour an important university in the region.

In the Netherlands the contractor companies were approached on the basis of their membership of the industry association ‘Bouwend Nederland’. From the fifteen companies that were

approached, five agreed to cooperate with an interview, yielding a 33,3% response rate. In the United Kingdom a similar approach was used by approaching companies from the industry association ‘federation of master builders’. Due to the low response rate in the United Kingdom, the list of members from the federation of master builders did not prove sufficient for five interviews. Therefore, the number of companies was increased by also contacting companies that are registered at the National House Building Council, which is a quality mark for builders in the United Kingdom. After contacting 150 companies from both registers, five companies had agreed with an interview, yielding a response rate of 3,3%. In Germany, a similar trade association to those in the Netherlands and the United Kingdom exists, but it does not provide information about their members to third parties. The selection of companies in Germany, therefore, differed from those in the two other countries. The companies in Germany were approached by searching for ‘Bauunternehmen Oldenburg’ (building company Oldenburg) and ‘Wohnbauunternehmen Oldenburg’ (residential building company Oldenburg). In Germany thirteen companies were approached, after which five agreed to cooperate in an interview, yielding a response rate of 38,5%. An overview of the fifteen companies and their main characteristics can be found in appendix 3.

The response rate in the United Kingdom clearly stands out from the response rate in the two other countries. This difference cannot be attributed to the interviews being conducted over the phone, because the same applied to Germany. Based on the experiences of the researcher in approaching the companies, the difference could be explained by cultural differences. Where companies in Germany in the Netherlands were willing to cooperate, although it did not directly benefit the companies, the absence of direct benefit for companies in the United Kingdom proved vital in not cooperating in the research. The strong Anglo-Saxon focus on profit making could prove an explanation for the difference.

3.4 Data analysis

Based on Eisenhardt (1989) and Yin (2009), the data collected from the interviews has first been analysed by making individual case studies for each company. By doing a cross-case analysis of the case studies in each country, national case studies have been generated. The same procedure has been applied to create a cross country case study, based on the national case studies. Miles & Huberman (1984) state that a visual representation of qualitative data will help interpret the results. Therefore, a visual representation of the data was made, see appendix 4. This was done by reducing the data on the barriers to simple yes or no answers and by compiling these answers into a table. The visual representation of the data together with the national and cross national case studies have served as basis for the results section.

3.5 Reliability and validity

The use of semi-structured interviews limits the reliability of the research, because semi-structured interviews are hard to replicate exactly. In order to enhance the reliability the interview guide has been added as appendix 1 and the data gathering and analysis process have been described. The use of semi-structured interviews, however, increased the validity by allowing the researcher to probe for possible underlying causes. This was especially important, because the interview questions could only be based on a limited amount of available literature.

4. Results

This chapter will first briefly discuss two major developments in the residential building sector. This will help to interpret the results, which consist of country and a cross country analysis on the barriers to green innovation. The chapter concludes with an overview of the feasibility of the national legislation towards achieving the EPBD 2010 goals.

4.1 Residential construction sector

The residential construction sector across the European Union and the three countries in this research is currently subject to two major developments. These are the consequences from the crisis that are still being felt and the increasing environmental demands for new buildings. The recent financial crisis and economic downturn have had a disastrous effect on the construction sector, with the output in 2014 still being 25% under the pre-crisis high (Eurostat, 2015). Although the crisis hit all three countries in this research, they were affected and have recovered differently. This can be seen in figure 1, which shows that Germany has experienced continuous growth from 2011 on. The same applies to the United Kingdom, with the exception of 2012. The growth in both countries is however expected to slow down in the coming years. Contrary to the United Kingdom and Germany the residential sector in the Netherlands is expected to grow strongly from 2015 on, but this growth has been preceded by three years of negative growth.

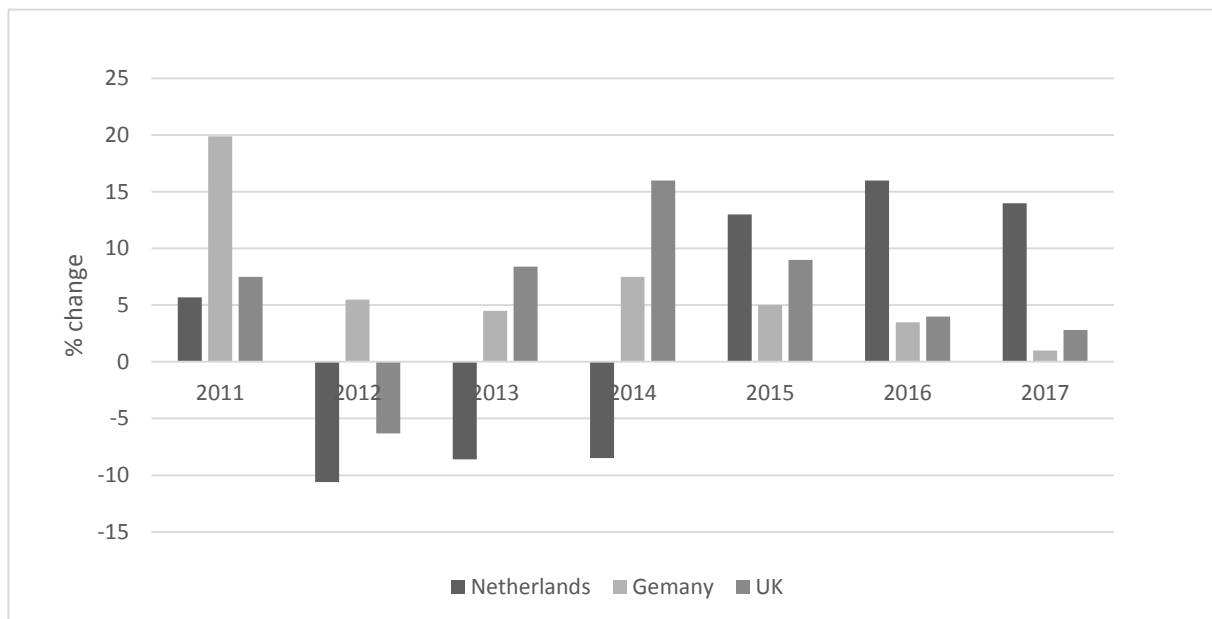


Figure 1: Historic and expected growth of residential construction (Euroconstruct, 2014^{abc})

The residential building sector has always been subject to regulations concerning the environmental aspects of building. The passing of the EPBD by the European Union in 2010 has strongly increased the stringency in this regulation, by demanding that all new builds must be nearly zero energy buildings in 2020. A nearly zero energy house requires the need for energy in a house to be minimised, especially for heating and cooling. The remaining energy use in a building should be covered with renewable energy and other technologies (Li et al.,

2013). The building of nearly zero energy buildings therefore requires a radical transformation from the current practice in the building sector (Albino & Berardi, 2012). The exact implementation of the EPBD per country has been left to the national governments. This has allowed national governments to design regulations according to their national requirements (Atanasiu et al., 2011). In order to better comprehend the environmental regulations that the residential sector in the Netherlands, Germany and the United Kingdom face, the respective national policies will be briefly discussed.

In the **Netherlands**, the EPBD 2010 requirements have been included in the already existing energy performance coefficient (EPC) system. The EPC system sets the minimum requirement for the energy performance of buildings and is incorporated in the building regulations. When the EPBD 2010 was introduced, the EPC norm was 0,8, while a zero energy building equates to an EPC of 0. Leading up to 2020, the EPC norm was gradually reduced in 2011 to 0,6 and was further reduced to 0,4 in 2015. The final step to an EPC of 0 will be incorporated in the building regulations in 2020.

Germany has included the EPBD 2010 requirements in the energy saving ordinance (Energieeinsparverordnung – ENEC). This sets, similar to the EPC in the Netherlands, the minimum requirements for the energy performance of buildings. At the introduction of the EPBD 2010 the energy saving ordinance required all new buildings to have a maximum primary energy use of 50 kWh/(m² ·a). The German government intended to gradually lower the maximum kWh/(m² ·a) with 12,5% in 2014 and again with 12,5% in 2016. Due to delays in passing the bill through parliament, the first reduction in 2014 was not achieved. Therefore, the reduction of the maximum primary energy use will now take place in 2016 and will be done in a single step of 25%. Similarly, the thermal insulation of buildings in 2016 must be 20% higher than current standards. Whether the German government will further lower the maximum primary energy use and thermal efficiency in meeting the requirement of nearly zero energy buildings in 2020 is still uncertain. The German government has stated that this will depend on the economic developments by 2020 and in particular on the energy prices and the construction costs at that time.

The government in the **United Kingdom** has not drafted specific regulations in meeting the EPBD 2010 requirements. The UK government is convinced that their policy regarding zero carbon homes in 2016 will ensure that they meet the requirements. When the zero carbon policy was introduced in 2007, the goal was that all new homes should be zero carbon from 2016 on. This was to be achieved by decreasing the emission standard of 2006 by 25% in 2010 and by 6% in 2013. This results in a remaining final step of decreasing the emission standard by 69% in 2016. After pressure from the building industry, the UK government however has decided to change the zero carbon goal. The zero carbon goal now only applies to the regulated energy use such as space heating and lightning, but excludes emissions from household appliances. This has resulted in a required reduction of carbon emissions compared to 2006 by 44-60% (depending on the type of building), instead of 100% as was previously envisioned. The lower required reduction in carbon emission still requires the residential construction industry to cut carbon emissions by 14-29% in 2016.

4.2 The Netherlands

The residential building sector in the Netherlands is characterised by a relatively low number of private commissioning of houses, namely only 11% in 2011 (Centraal Bureau voor de Statistiek, 2011). This makes the Dutch residential building sector mostly a suppliers market, where the remaining 89% of houses is being built on a project development basis by contractors, investors, real estate developers and social housing associations. Especially the financial problems of the social housing associations have hampered the residential building sector in the recent years (Euroconstruct, 2014^b). With the revival of the housing market, new residential construction is expected to grow 13-16% in the 2015-2017 period. (Euroconstruct, 2014^b).

4.2.1 Market barriers

The literature part has identified six potential market barriers for the uptake of green innovations in the construction sector. Similar to the literature, the lack of demand from the market proved to be the most important barrier identified in the interviews. This lack of demand was categorised in two major groups, namely the lack of demand from real estate developers and investors and the lack of demand from consumers. In most interviews, the lack of demand of the former was explained by their focus on the short term and their focus on minimising the investment to attain the highest return. Consequently, the real estate developers and investors are demanding the cheapest ways to adhere to governmental environmental regulation and are not demanding green innovations beyond the standards set by regulation. The respondents also linked the lack of demand from consumers to financial motivations, because the financial crisis has made it more difficult for consumers to obtain mortgages. The difficulties in obtaining mortgages and the higher costs typically associated with green innovations, make that the consumer is often not able to pay for the extra investment in green innovation and is thus not demanding green innovations. Besides consumers not able to pay for green innovations, the companies also identified a group of consumers that is just not willing to pay for green innovations. The payback period of green innovations for these consumers is often the prohibiting factor. These consumers only look at the first ten year of exploitation of a house, but many green innovations do not yet payoff in this period.

In contrast with the literature, four out of five interviewees did not see a lack of external finance as a barrier hindering green innovation. The barrier market dominated by established firms was mentioned by two companies, namely NL4³ and NL3. The first company could not compete with the established companies due to their large experience and economies of scale in project development. The second company is introducing zero energy buildings for a highly competitive price, but is experiencing resistance from the large established companies in the industry. The answers in the interviews on the barrier lack of suitable business partners were ambiguous. With three companies stating that there are plenty suitable business partners and two companies stating that there is a lack of suitable business partners. The two companies, namely NL2 and NL3, that stated that there was a lack of suitable business partners indicated that specific business partners are conservative and that they are now performing these services

³ These company codes correspond with the company codes in appendix 3 and 4, which provide more information about the companies

in-house. The barriers ‘lack of access to external information and knowledge’ and ‘technical lock ins’ were not mentioned in the interviews.

4.2.2. Regulatory barriers

The barrier insufficient access to existing subsidies and fiscal incentives proved an important barrier. With four out of the five companies stating that subsidies and fiscal incentives would help them in offering more green innovations, but that such subsidies and fiscal incentives do not exist. The interviews showed an ambiguous result on whether the barrier ‘existing regulations and structures not providing incentives for green innovations’ is important. All the companies agreed that the existing and tightening EPC regulation has stimulated green innovation in the recent years. The structure and norm in the industry of awarding contracts on the basis of the lowest tender, however, is an important barrier for green innovation. Although the tenders have to comply with the EPC regulation, the process of awarding the tender to the lowest bidder, forces companies to choose the cheapest options in complying with the EPC norm. This has led to building roofs being covered with solar panels, while the walls are poorly insulated. This example directly goes against the objective of the nearly zero efficient buildings, where minimising the energy demand is key, after which the remaining energy need is supplied with renewable energy. The tender system in its current form is therefore an important barrier to green innovation.

4.2.3 Firm internal barriers

The uncertain return on investment in green innovation proved an important barrier in all five companies. In building for the market, where the customers are not known at the moment of designing and/or constructing of the building, the companies were hesitant in implementing green innovations, because of the uncertainty of recouping these investments. The earlier identified lack of demand for green innovation by consumers, was seen as a major driver for the uncertain return on investment.

The barrier ‘reducing energy use is not an innovation priority’ was identified as a barrier in the literature, but this was not reflected in the interviews. Most companies saw reducing energy use as part of their corporate social responsibility and were actively reducing their own energy needs. The barrier ‘reducing material use is not an innovation priority’ was however perceived as an important barrier by NL4. The company stated that the costs of materials are so low in comparison to the costs of labour, that saving on material costs is too expensive. This was illustrated by the following example: ‘*if you drop a nail, it is too expensive to pick it up, where previously crooked nails were beaten straight.*’ Similar to the lack of external financing, four out of five companies did not see ‘lack of funds within the company’ as an important barrier to green innovation. The same applies to the barriers ‘resistance to change in the firm’ and ‘lack of technical expertise’ as they were not mentioned in the interviews.

4.2.4 Barriers in the Netherlands

The barriers ‘lack of demand from the market’ and ‘uncertain return on investment’ were identified as the most important barriers in the Netherlands. Especially the lack of demand from real estate developers and investors can be seen as a major barrier in the supplier focussed market, because these parties comprise a large part of the market. The demand from real estate

developers and investors could be stimulated with tighter regulations. Tighter regulations could, however, have a negative effect on the demand from consumers, because this group is already facing financing difficulties and tightening regulations will increase these difficulties due to the increased costs of building. The uncertain return on investment is a barrier for companies, because the lack of demand from consumers is increasing the uncertainty of recouping the investments in green innovations. Subsidies or fiscal incentives could decrease this uncertainty, therefore, the absence of these subsidies and financial incentives is seen as an important barrier.

4.3 Germany

The residential construction sector in Germany has grown strongly in the recent years. This growth was primarily caused by the countries growing housing shortage, low interest rates and the favourable income and employment situation (Euroconstruct, 2014^a). The growing sector has attracted an increasing number of investors, which is changing the German market. Traditionally the focus in the German market has been on privately commissioned houses, the large interest of investors, however, is increasingly shifting the focus to multi-family buildings (Eurostat, 2014^a). However, with 71% of houses being privately commissioned (Landesbetrieb für Statistik und Kommunikationstechnologie Niedersachsen, 2013), the German residential construction sector can still be characterised as a demand focused market.

4.3.1 Market barriers

The barrier 'lack of demand from the market' was identified as the most important market barrier. Similarly to the Netherlands, the lack of demand can be categorised in two major groups, namely the lack of demand from real estate developers and investors and the lack of demand from consumers. The interviews identified that most consumers in Germany are interested in green innovations and are willing to invest in them. Combined with the high percentage of private commissioning, a high demand for green innovations would be expected. This is however only partly the case, because increased cost of building and building plots is causing consumers to experience difficulties in financing their 'standard' new build. The difficulties in obtaining finance is lowering the demand for green innovations. In order to minimise the loss in demand for green innovations, the German government is allowing consumers to finance their green innovations under favourable conditions. This KfW program, which will be discussed in more detail in the next section, is helping German consumers to invest in green innovations. Despite the governmental financing scheme, the companies in the research still identified a lack of demand by consumers, especially due to difficulties in obtaining finance. The lack of demand from real estate developers and investors for green innovations is purely economically motivated. These organisations are profit oriented and are looking to maximise their investment. Investing in green innovation beyond environmental regulation, does not result in higher returns on investment. The real estate developers and investors will therefore not invest in green innovations, which causes a lack of demand. The barrier 'lack of external financing' was only perceived as a barrier by one company. The other four companies stated that obtaining external financing was no problem or that they did not require any external financing. The remaining four market barriers were not mentioned in the interviews.

4.3.2. Regulatory barriers

The barrier ‘insufficient access to existing subsidies and fiscal incentives’ was not perceived as a barrier for green innovation. The companies did not make use or were aware of any subsidies or incentives and stated that they were not required for companies, because the government is already targeting the consumers with subsidies and fiscal incentives. By creating the demand in consumers, the government is more effectively creating demand for green innovation, than it would with targeting companies.

The structures by which the German government is trying to increase the demand for green innovations are part of the barrier ‘existing regulations and structures not providing incentives for green innovations’. An example of the German government increasing demand are the KfW loans introduced in 2006. These loans are available to consumers when they build or buy homes that have a lower energy requirement than is demanded by current regulation. The loans go up to €50.000 and have a very low interest rate. Depending on the energy efficiency of a house, a maximum of €5.000 of this loan is not required to be paid back. This favourable loan scheme has resulted in an increased demand for green innovations by consumers and thus at the building companies. The companies stated that besides the governmental structures, the governmental regulations are also stimulating green innovations, but that stricter regulations are currently not economically viable. Stricter regulations are not economically viable, because they will further increase the costs of building, making them unaffordable for a large group of consumers. Contrary to what was found in the literature, the existing regulations and structures in Germany are providing an incentive for green innovations. The barrier ‘existing regulations and structures not providing incentives for green innovations’ is therefore not applicable to Germany.

4.3.3. Firm internal barriers

The barrier uncertain return on investment was identified by two companies as a barrier to green innovation. According to these companies, the uncertain return on investment is caused by the high costs of building and the resulting inability of customers to finance their new build. The companies state that the high costs of building are primarily caused by the increased prices of land and the extra costs of building according to environmental regulations.

The difficulties of consumers financing their new build increases the chance of construction companies not fully recouping their investments in green innovation in building for the market. However, with only two out of five companies stating that the uncertain return on investment is a barrier to green innovation, the barrier can only be classified as a moderate barrier to green innovation in Germany.

GE5 illustrated the barrier ‘reducing material use is not an innovation priority’ with the exact same example of the nail, that was already given in the Netherlands. This exemplifies the fact that the cost of labour is much higher than the cost of material, which acts as a barrier to green innovation. The remaining firm internal barriers were not mentioned in the interviews.

4.3.4. Barriers in Germany

The lack of demand from the market proved to be the most important barrier to green innovation in Germany. The demand focussed market, caused by the high percentage of private commissioning, makes the lack of demand from consumers essential. Although most consumers

in Germany are interested in green innovation, difficulties in financing is strongly lowering the demand for green innovations and is increasing the uncertain return on investment for companies building for the market. On the other hand, the regulations and structures, in particular the KfW loans, have proved an incentive instead of a barrier to green innovation. Despite the incentives from regulations and structures, the companies still perceive a lack of demand from consumers.

4.4 The United Kingdom

Similarly to the Netherlands the residential construction sector in the United Kingdom can be characterised as a suppliers market, with only 7,6% of the houses being privately commissioned in 2012 (Wallace et al., 2013). Consequently, the remaining 92,4% of the houses are being built on a project development base by contractors, investors, real estate developers and social housing associations. The residential construction sector in the United Kingdom has grown rapidly in the past years. The sector is, however, under pressure in the coming years due to increased costs of debt servicing for public housing providers and stricter lending criteria imposed in 2014 (Euroconstruct, 2014^c).

4.4.1. Market barriers

Four out of five companies identified the barrier ‘lack of demand from the market’ as a major barrier hindering green innovation. These companies distinguished two types of lack of demand from consumers, firstly the consumers with a genuine lack of demand and secondly the lack of demand from consumers due to financial limitations. The first group encompasses consumers who feel that the current regulations are already (to) strict and are not demanding extra green innovations. The second group encompasses consumers that would like to implement more green innovations, but are held back by financial limitations.

Financial limitations also posed an important barrier for companies in introducing green innovations, as the barrier ‘lack of external finance’ was identified by four out of five companies as important. This was illustrated by company UK4, which intended to build houses with stricter environmental features according to CSH4 (see next section), but did not receive the required additional funding from the bank to build beyond environmental regulations. As a result the project was discarded, clearly making the lack of external financing a barrier to green innovation. The remaining market barriers were not mentioned in the interviews.

4.4.2. Regulatory barriers

The barrier ‘existing regulations and structures not providing incentives for green innovations’ can be seen as an important barrier in the United Kingdom. All the companies in the research stated that the existing regulations and structures are not providing an incentive for green innovation. Three companies even state that the regulations are inconvenient, difficult to adhere to and that they ignore the extra financial burden for companies and consumers. The two other companies state that no incentive exist to invest in green innovation beyond the regulation imposed standards. The government in the United Kingdom has tried to create this incentive by implementing the Code for Sustainable Homes (CSH), which is a voluntary program aimed at reducing carbon emissions beyond environmental regulations. The companies in the research however state that the program is not working or that they have even never heard of it. Although

none of the companies were aware of and thus were not making use of subsidies or fiscal incentives, the barrier ‘insufficient access to existing subsidies and fiscal incentives’ was not perceived as a barrier to green innovation. The companies stated that subsidies and fiscal incentives should target the consumer, increasing the demand for green innovations, instead of targeting companies.

4.4.3. Firm internal barriers

In the interviews, the barrier ‘uncertain return on investment’ was identified as the biggest barrier to green innovation. The companies stated that investments needed to comply with environmental regulations cannot be fully recouped, because most consumers are not interested in the environmental performance of a building. This was illustrated by UK2, which stated: *“it’s not the environmental performance of a building that matters for customers, it is the pound per square meter they get”*. This lack of interest from most customers, is not allowing the extra costs needed to comply with environmental regulations to be passed on to the customers. The companies that build for the market will, therefore, not invest in green innovations that will further increase the environmental performance of a building. The uncertain return on investment can be seen as a major barrier to green innovation in the United Kingdom.

The barrier ‘lack of funds within the enterprise’ was identified by three companies as a barrier to green innovation. The lack of funds has resulted in companies putting projects on hold and is seen as a clear barrier hindering green innovation. The remaining internal barriers were not mentioned in the interviews.

4.4.4. Barriers in the United Kingdom

The lack of demand from consumers was identified as a big barrier to green innovation in the United Kingdom. The consumers are either not willing or able to pay for the green innovations. This has resulted in large problems for the building companies, which cannot recoup their investments in green innovations. The uncertainty of recouping their investment in green innovations, has caused building companies to identify the barrier ‘uncertain return on investment’ as major barrier hindering green innovation. The unwillingness of banks to provide external financing and difficulties in internal financing, has proven to delay and cancel investments in green innovation.

4.5 Cross country analysis

In this section the results from the three countries will be incorporated in a cross country analysis, which will distinguish country specific and generic barriers to green innovation.

4.5.1. Structure of the market

The structure of the residential construction sector in Germany differs strongly from those in the Netherlands and the United Kingdom. This is caused by the high percentage of private commissioning, which results in a demand focussed market in Germany. The low percentage of private commissioning in the Netherlands and the United Kingdom make that these markets are supplier focussed. In a supplier focussed market, most houses are built on a project development basis, after which they are sold to consumers. This poses large problems with investing in green innovations in comparison with a demand focussed market, where investing

in green innovations happens according to the customers demand. Not knowing the customers before the buildings are designed or built, makes the risk of investing in green innovations considerably higher in a suppliers market.

4.5.2 Market barriers

The barrier 'lack of demand' was identified as a major barrier in all three countries in the research. The Netherlands and Germany showed the biggest resemblance, by both dividing the lack of demand in the same groups, namely the lack of demand from real estate developers and investors and the lack of demand from consumers. The problems with the former group were identical in both countries, namely demanding the cheapest solutions to comply with environmental regulation. Although the problems are identical in both countries, the lack of demand from real estate developers and investors, can be seen as a bigger barrier to green innovation in the Netherlands than in Germany. This is caused by the supplier focussed market in the Netherland, which results in a much higher percentage of real estate developers and investors, than in the demand focussed market in Germany.

The lack of demand from consumers in Germany is primarily caused by consumers not able to pay for the green innovations. In the Netherlands and the United Kingdom however, the lack of demand from consumers is also caused by consumers that are not willing to pay for green innovations. The difference between Germany and the two other countries can be partly explained by the number of properties households buy on average. Where in the Netherlands and the United Kingdom, households buy multiple houses during their lifetime, households in Germany typically only buy one house (Voigtlander, 2012). These differences are culturally driven, but are also caused by different mortgage markets and fiscal stimuli for buying houses. The fact that German households typically only buy one house and live there for a long period of time, makes the payoff period for most green innovations worth while, explaining the absence of the group of consumers that is not willing to pay for green innovations. The contrary applies for households in the Netherlands and the United Kingdom, which explains the group of consumers that are not willing to pay for green innovations.

The Netherlands and Germany show large similarities concerning the barrier 'lack of external finance', because in both countries the lack of external finance is not seen as a barrier to green innovation. In the United Kingdom, however, the lack of external financing was identified as an important barrier to green innovation. The difficulties in passing on the increased costs of green innovation to consumers and the resulting increased costs for companies, could be seen as possible explanations for the lack of external financing in the United Kingdom

4.5.3 Regulatory barriers

The companies in Germany perceived none of the possible regulatory barriers as a barrier to green innovation. This clearly sets Germany apart from the Netherlands and the United Kingdom. The regulations and KfW loan structure are seen as a clear incentive for green innovation, while subsidies and fiscal incentives for companies are seen as unnecessary, because the consumers are already being targeted. The companies in the United Kingdom supported the view that subsidies and fiscal incentives are not necessary for companies, but the

companies in the Netherlands perceived the insufficient access to existing subsidies and fiscal incentives as a clear barrier to green innovation.

The interviews in the Netherlands further identified that the barrier ‘existing regulations and structures not providing incentives for green innovations’ needs to be split in a regulations and a structures part, because the regulations were seen as stimulating green innovation, while the structures were seen as a barrier to green innovation. The companies in the United Kingdom made the same distinction, but with regulations and structures both seen as a barrier to green innovation. Section 4.1 showed that the regulations towards stimulating green innovation are quite similar in all three countries, namely gradually lowering maximum energy use. The perceptions of how these regulations are perceived, however, differs across countries. In the Netherlands and Germany the regulations are perceived as stimulating green innovation, but similar regulations in the United Kingdom was perceived as a barrier to green innovation.

4.5.4 Firm internal barriers

The uncertain return on investment was identified as an important barrier in the Netherlands and the United Kingdom, while only proving a moderate barrier in Germany. This difference can be largely explained by the supplier focussed market in both the Netherlands and the United Kingdom. In a supplier focussed market the number of buildings constructed for the market, where the company does not know the customer, is higher than in a demand focussed market. The larger group of buildings constructed for the market increases the uncertainty of investing in green innovations in the Netherlands and the United Kingdom.

Similarly to the lack of external finance, the barrier ‘lack of funds within the enterprise’ was not perceived as a barrier in the Netherlands and Germany, but was in the United Kingdom. The barrier ‘reducing material use is not an innovation priority’ were only mentioned by one company in the Netherlands and Germany as a barrier hindering green innovation.

4.5.5 Barriers across countries

The cross country analysis showed that the barriers differ across countries, but that predominantly similar barriers have emerged in each country. The most important barriers identified and their country specific relevance have been summarised in table 5.

Table 5: Important barriers in the research and the country relevance

	#	Barrier	NL	GE	UK
Market barriers	1a	Lack of demand from real estate developers and investors	Yes	Yes	-
	1b	Lack of demand from consumers	Yes	Yes	Yes
	2	Lack of external financing	No	No	Yes
Regulatory barriers	3	Insufficient access to existing subsidies and fiscal incentives	Yes	No	No
	4a	Existing regulations not providing incentives for green innovations	No	No	Yes
	4b	Existing structures not providing incentives for green innovations	Yes	No	Yes
Firm internal barriers	5	Uncertain return on investment	Yes	Mode-rate	Yes
	6	Lack of funds within the enterprise	No	No	Yes

4.6 Feasibility of environmental goals

The different national policies in achieving the European Union 2020 environmental goal of only building nearly zero efficient buildings, previously discussed in section 4.1. As part of the interview, the companies were asked whether they deemed their national policies for achieving these goals feasible. Table 6 presents an overview of how the companies deemed their national legislation towards environmental goals.

Table 6: Feasibility score of national legislation towards environmental goals

Score	NL	GE	UK
Feasible	1		
Feasible, but will drive up costs	2		1
Feasible, but still many years away	2		
Unfeasible, will drive costs up too much		4	1
Unfeasible		1	3

The figures from table 6 clearly show that the United Kingdom's goal of reaching zero carbon homes in 2016 is deemed unfeasible by most companies in the research. Furthermore, at the moment of writing this paper, only nine months remain until 2016 and no revision of the environmental regulations have been presented to parliament. This makes the likelihood of the United Kingdom attaining the, already downward adjusted 2016 goals, look highly unlikely.

Although 2020 is still five years away, all the companies in Germany deemed the attaining of the governmental policy goals unfeasible. The main reason being that the building of nearly zero energy buildings will drive up costs too much, making them unaffordable for the customers. Due to the resistance in the building industry, the recent delays in passing environmental regulations through parliament and the dependence on the economic situation in 2020, make the likelihood of Germany attaining the EU 2020 goals at least look questionable. Contrary to the two other countries, all companies in the Netherlands stated that the national policy towards the EU 2020 goals are feasible. Two companies however stated that it will drive up costs and that expensive houses are already a problem in the market. Based on the attitude in the industry and the clear ambition of the Dutch government to achieve the EU 2020 goals, the Netherlands appears to be on course in achieving the EU 2020 goals.

The observation that Germany and the United Kingdom are unlikely to attain their environmental goals, sheds a disturbing light on the feasibility of achieving the EU 2020 environmental goals across Europe. When rich and prosperous countries like Germany and the United Kingdom are already facing difficulties in attaining the environmental goals, these difficulties are likely to be much bigger in less rich and less prosperous countries across the European Union. This makes the attainment of the European 2020 environmental goals, set in the EPBD 2010, look highly problematic. How policy makers could potentially change this negative trend, can be read in the policy implications in the next chapter.

5. Discussion and conclusion

The construction sector comprises 10% of the European GDP and is vital in reaching the 2020 environmental goals of the European Union. Despite the obvious importance, the ‘greening’ of the construction sector, has received little scholarly attention. This is clearly shown in the fact that no academic literature exist on barriers to green innovation in SMEs in the construction sector. This research has aimed to contribute to the academic literature by identifying the barriers to green innovation for SMEs in the residential construction sector in three European countries. By comparing the barriers across countries, country specific and overarching barriers have been identified.

5.1 Discussion and conclusion

From the fourteen possible barriers identified in the literature review, six proved to be the most important barriers to green innovation. An overview of these barriers and their country relevance is shown in table 5. The barrier lack of demand from the market was identified as the most important barrier to green innovation in all three countries. An explanation for the importance of this barrier can be found in the complex nature of introducing green innovations in the construction sector. Green innovations in the construction sector are not implemented in the building company, but are implemented as part of their building projects (Miozzo & Dewick, 2002). The benefit of implementing green innovations, therefore, lies with the end user, instead of the building company. With no direct benefit for the building company, the introduction of green innovations in the construction sector is largely dependent on the demand from the market, explaining the importance of the barrier lack of demand from the market. The lack of demand from the market can also be linked to a major problem of green innovation identified in the academic literature, namely the relatively weak ‘demand pull effect’ in green innovations. This effect is seen as the main reason for the low demand for green innovations (Bernauer et al., 2007; de Marchi, 2012). Although national governments are trying to increase the demand for green innovation in various ways, it will always be weaker than innovation driven by the market (Rennings, 2000).

National policies in stimulating the demand for green innovation differ across countries, which results in different perceptions of regulatory barriers across countries. In this research, Germany was the best example of this difference, with none of the possible regulatory barriers being perceived as a barrier to green innovation. The most prominent difference between Germany and the two other countries is the KfW loan structure providing incentives for green innovation. The regulation in stimulating green innovation in all three countries is focussed on gradually lowering maximum energy use. Although the regulations are similar, the perception of whether these regulations stimulate green innovation differs across countries. Where in the Netherlands and Germany this type of regulation is seen as an incentive for green innovation, the similar regulation in the United Kingdom is seen as a barrier to green innovation. An explanation for this difference was not found in this research, but could be culturally related with Anglo-Saxon aversion of regulative interference.

The barriers ‘lack of funds within the enterprise’ and ‘lack of external financing’ were identified as major barriers to green innovation in the United Kingdom. Although the barriers were not identified in The Netherlands and Germany, this research has adopted them among the most important barriers, because of their importance in the United Kingdom. They were also adopted because the two barriers will likely form an important barrier to green innovation in other countries, in particular in less rich and prosperous countries than the countries in this research. The barrier ‘uncertain return on investment’ was identified as the most important firm internal barrier to green innovation. The uncertainty of investing in green innovations proved higher in supplier focussed markets, where construction companies often do not know their customers before the buildings are designed or built. Not knowing the customer in combination with a lack of demand in the market increases the uncertainty about the return on investment in green innovations.

With the European Union 2020 environmental goals quickly approaching and with both Germany and the United Kingdom unlikely to attain these goals, this research has identified the urgency for governments to further reduce the barriers to green innovation. The focus in reducing these barriers should be on the barrier ‘lack of demand from the market’, because an analysis of the interaction between the barriers, see appendix 2, shows that most barriers influence or are influenced by this barrier. The barrier lack of demand from the market can therefore be seen as the biggest barrier to green innovation. This research has contributed to the academic literature by identifying and analysing the six most important barriers to green innovation in the residential construction sector. A better understanding of these barriers and the reasons behind them is the first step in decreasing the barriers (Hadjimanolis, 1999). How policy makers could use this knowledge in reducing the barriers will be discussed in the next section.

5.2 Policy implications

The interviews identified that the lack of demand from real estate developer and investors is primarily caused by their focus on a short term return on investment. Which in practice results in these companies choosing the cheapest solutions in complying with environmental regulations and not demanding green innovations beyond regulation imposed standards. The same applies to the group of consumers that is not willing to pay for green innovations. From a policy perspective, increasing the demand from these two groups (2,3⁴) could be quite simple, namely tightening environmental regulations (1). This, however, poses problems with the affordability of buildings for consumers, because tightened environmental regulations will drive up building costs (6). The rise of building costs, associated with implementing green innovations, has proved vital in the lack of demand from consumers (5). Because the lack of demand from consumers, in primarily Germany and the Netherlands, is based on a large group of consumers that are not able to afford implementing green innovations (4). Tightening environmental regulations, therefore, also require policies that decrease the financial limitations for consumers. The KfW loan system in Germany has proven effective in reducing these

⁴ These numbers correspond with the numbers in figure 2, which is a visual representation of the proposed policy actions and their effects

financial limitations for consumers. Policy makers in the Netherlands and the United Kingdom should, therefore, implement a similar system (7). Besides governments, financial institutions also need to adapt their mortgage calculations to the new emerging standards of house building. These will result in higher initial investments for consumers, but will lead to lower operating costs for the consumer (8). The savings on operating costs will allow consumers to make higher monthly repayments than in traditional calculations, justifying the higher mortgages (9). However, the biggest challenges and responsibility in reaching the EU 2020 environmental goals lies with policy makers. Based on this research, policy makers should further tighten environmental regulations towards the EU 2020 goals, but only if they are in conjunction with implementing or expanding the use of KfW loans and similar systems. This will increase the demand for green innovations (10) without compromising the affordability for consumers. How the demand is increased by the proposed policy actions is presented in figure 2.

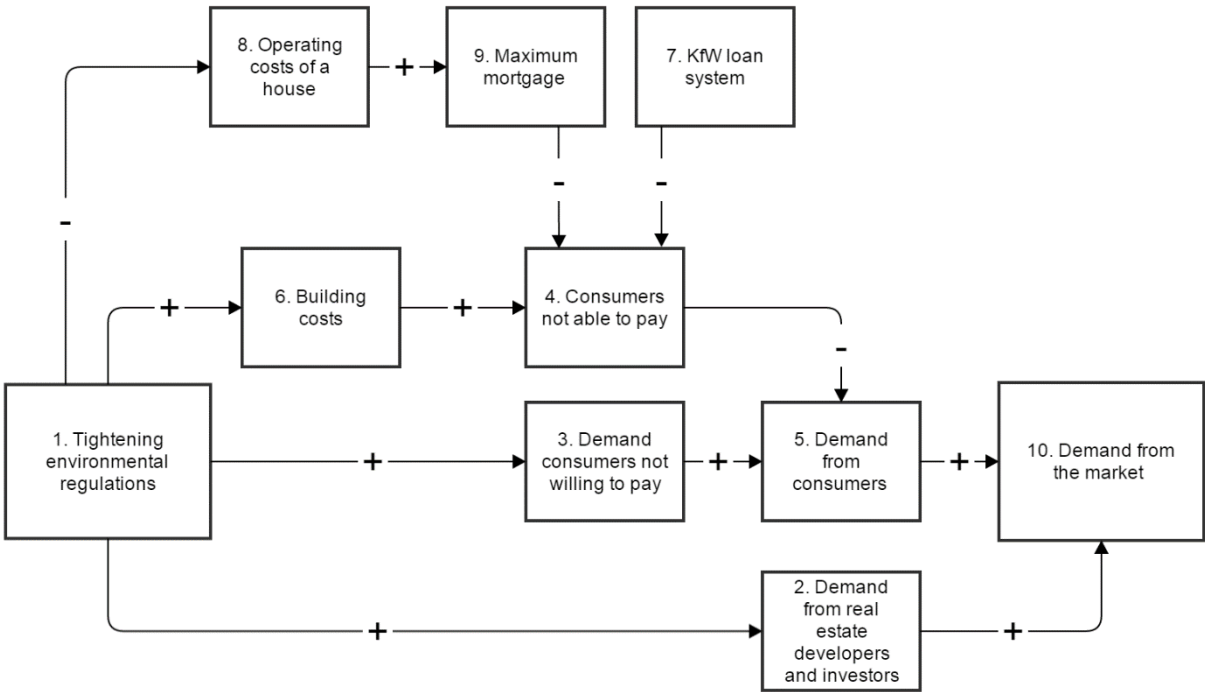


Figure 2: Proposed policy actions and their effects

5.3 Limitations & Future research

To the current knowledge of the author, this is the first academic research that has attempted to create an insight into the barriers to green innovation that SMEs in the construction sector face. This research can, therefore, be seen as a starting point in filling this gap in the academic literature. With a relative low number of five interviews in only one specific region in each country, the generalizability of this study on a country level is limited. Larger studies therefore need to test whether the results can be generalizable for the countries in the research. The three countries in this research, all belong to the highest developed countries in the European Union, further research in less developed countries in the European Union, could therefore yield very different results on the barriers to green innovation. Future research should also focus on the

barriers to green innovation in the refurbishment of the existing building stock, because the biggest savings in CO₂ reduction can be achieved in the existing building stock. Similar to new builds, the lack of demand from the market will also be the biggest barrier in the refurbishment of the existing building stock. However, this demand will most likely not be easily stimulated by regulations, but will require subsidies and strong fiscal incentives for both consumers and companies.

5.4 Concluding remarks

The importance of the construction sector in the general economy and in reaching environmental goals is beyond doubt, therefore, the researcher was surprised about the lack of available data on the construction sector. This was not only the case in the academic literature, but also on a European Union level, where no reports exist that in detail describe national and European Union wide construction sector characteristics. The data that is available is fragmented and difficult to compare due to the use of different terminologies. The lack of data raises questions about the effectivity of construction sector specific policies, because without a clear insight into the characteristics of the sector, it is difficult to design effective policies. The European Union and national governments should, therefore, focus their efforts on creating country and European Union wide detailed reports on the characteristics of the construction sector. This will help in creating more effective construction sector specific policies and will spur academic researches to do research in the sector.

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Appendix 1: Interview guide

1. Introduction

1. Do you mind if I make an audio recording of the interview. I will be the only one to have access to it and it will be deleted after the research is finished.
2. This interview is part of my research on barriers to green innovations in SMEs in the construction sector. This topic was chosen because of new EU legislation from 2010, which requires all new residential buildings to be nearly energy neutral in 2020 (EPC 0). This legislation requires the construction sector to undergo rapid changes and could therefore be an interesting sector to study.
The research is part of my master thesis at the University of Groningen in the Netherlands and will be used in a EU project on green innovation in SMEs. For this research I will conduct fifteen interviews in three European countries; the Netherlands, the United Kingdom and Germany.
3. As I already mentioned in our phone conversation on **(Fill in date appointment was made)** the interview will take about 30-45 minutes and will mostly contain open questions.
4. Before we start the interview do you have any questions?

Start the audio recording

Note current date and time:

2. Introductory questions

1. Could you give a short introduction of yourself and your role in the company?
2. Can you also give an introduction of the company and its main activities.
 - Minimum information required:
 - List of activities of the company
 - Number of employees
 - Annual turnover

3. Background questions

In the following questions, the notion of green innovation will be an important aspect. Therefore I will clarify the concept of green innovation used in this research. Green innovation in the construction sector is defined as:

All innovations (materials/procedures/techniques/technologies) that are new to the firm and that have a beneficial effect on the environment. This can be techniques that already have been used by other companies, but have recently been introduced in the company. For example the introduction of offering heat pumps for heating houses, where previously only gas heating was offered.

3. Has the company introduced green innovations in the past three years?
 - What were/are the motives behind these innovations? (e.g. market demand /regulation imposed/cost saving)
 - How many green innovations have been introduced in the past three years?
 - Are you expecting to introduce more/similar/less green innovations in the coming years?
4. Could you explain the process of building a new house (e.g. contact with customers, architects and **subcontractors**). In which part of these processes is sustainable is green innovation an important aspect.

4. Main questions

5. In the process of building new houses and introducing green innovations, what would you see as important barriers hindering the implementation of green innovations?
 - After the barriers that the interviewee presented are discussed, continue with the aided barriers that have not yet been discussed.

Follow up questions for possible barriers can be found on the next pages and are structured as follows:

1. Lack of demand from the market
2. Lack of external financing
3. Insufficient access to existing subsidies and fiscal incentives
4. Existing regulations and structures not providing incentives to green innovation
5. Uncertain return on investment
6. Lack of funds within the enterprise
7. Market dominated by established firms
8. Technical and technological lock ins
9. Limited access to external information and knowledge
10. Lack of suitable business partners
11. Reducing energy use is not an innovation priority
12. Lack of technical expertise in personnel
13. Reducing material use is not an innovation priority
14. Lack of collaboration with research institutes

Aided barriers to green innovation

Market barriers:

- 1. Lack of demand from the market:**
 - a. How do you evaluate the demand from the market for green innovation?
 - b. Can this be seen as a barrier to green innovation in the company?
 - c. How does it affect the implementation of green innovations by the company?
 - d. What reasons can you give for the lack of demand
 - e. Can you divide the lack of demand into specific groups (e.g. private customers, housing associations)?
 - f. Is there a difference between groups in the lack of demand?
 - g. How would you explain the lack of demand in the different groups

2. Lack of external financing

- a. What sources of external finance does the company use (e.g. bank loans, venture capital, public equity)?
- b. Is it difficult to obtain external finance?
- c. Can this be seen as a barrier to green innovation by the company?
- d. How does it affect the implementation of green innovations in the company?

Regulatory barriers:

3. Insufficient access to existing subsidies and fiscal incentives

- a. Does the company currently make use of subsidies and fiscal incentives concerning green innovation?
 - If yes, continue to 3b.
 - If no, continue to 3c.
- b. What kind of subsidies and fiscal incentives are this (e.g. regional/national/international)?
 - In what technology field ?
 - How do you evaluate them
 - Would you make use of them again in the future?
- c. Why does the company not make use of subsidies and fiscal incentives?
 - Possible answers:
 - Don't know about any subsidies/fiscal incentives
 - Takes too much time
 - Too much regulation concerned
 - The company is too small
- d. How does the (not) using of subsidies and fiscal incentives affect the implementation of green innovations by the company
- e. Can this be seen as a barrier to green innovation?

4. Existing regulations and structures not providing incentives to green innovation

- a. Are there, that you know of, regulations and structures in place that stimulate green innovation in the construction sector?
 - If Yes, continue to question 4b.
 - If no, continue to question 4c.
- b. What are these regulations and structures (e.g. monitoring and certification)?
 - Do you feel that they are effective
- c. **(only if 4a. is no)** Do you think that these regulations and structures exist?
 - Do you think that they should be necessary?
- d. How do the regulations and structures affect the implementation of green innovations by the company?
- e. Can the regulations and structures be seen as a barrier to green innovation?

Firm internal barriers:

5. Uncertain return on investment

- a. What is the general return on investment that the company is striving for?
- b. Do you think the return on investment is lower for green innovations?
- c. Why do you think this is?
- d. How does the uncertain return on investment influence the implementation of green innovation by the company?
- e. Can the uncertain return on investment be seen as a barrier to green innovation?

6. Lack of funds within the enterprise

- a. How would you characterize the financial position of the company?
- b. Can you explain why this position is as it is?
- c. How does this position influence the implementation of green innovation by the company?

Unaided barriers to green innovation

If unaided barriers are mentioned by the interviewee, try to find out as much as possible about the reasons behind the barrier

Market barriers:

7. Market dominated by established firms
8. Technical and technological lock ins
9. Limited access to external information and knowledge
10. Lack of suitable business partners

Firm internal barriers:

11. Reducing energy use is not an innovation priority
12. Lack of technical expertise in personnel
13. Reducing material use is not an innovation priority
14. Lack of collaboration with research institutes

5. Concluding questions

6. Would you deem the national policies in achieving the European Union 2020 environmental goals as feasible and can you explain why you do so?
7. Do you have any remarks or other comments that could be helpful in my research?
8. Thank the interviewee for their cooperation

Stop

audio

recording

Note current time:

Appendix 2: Model of the barriers to green innovation

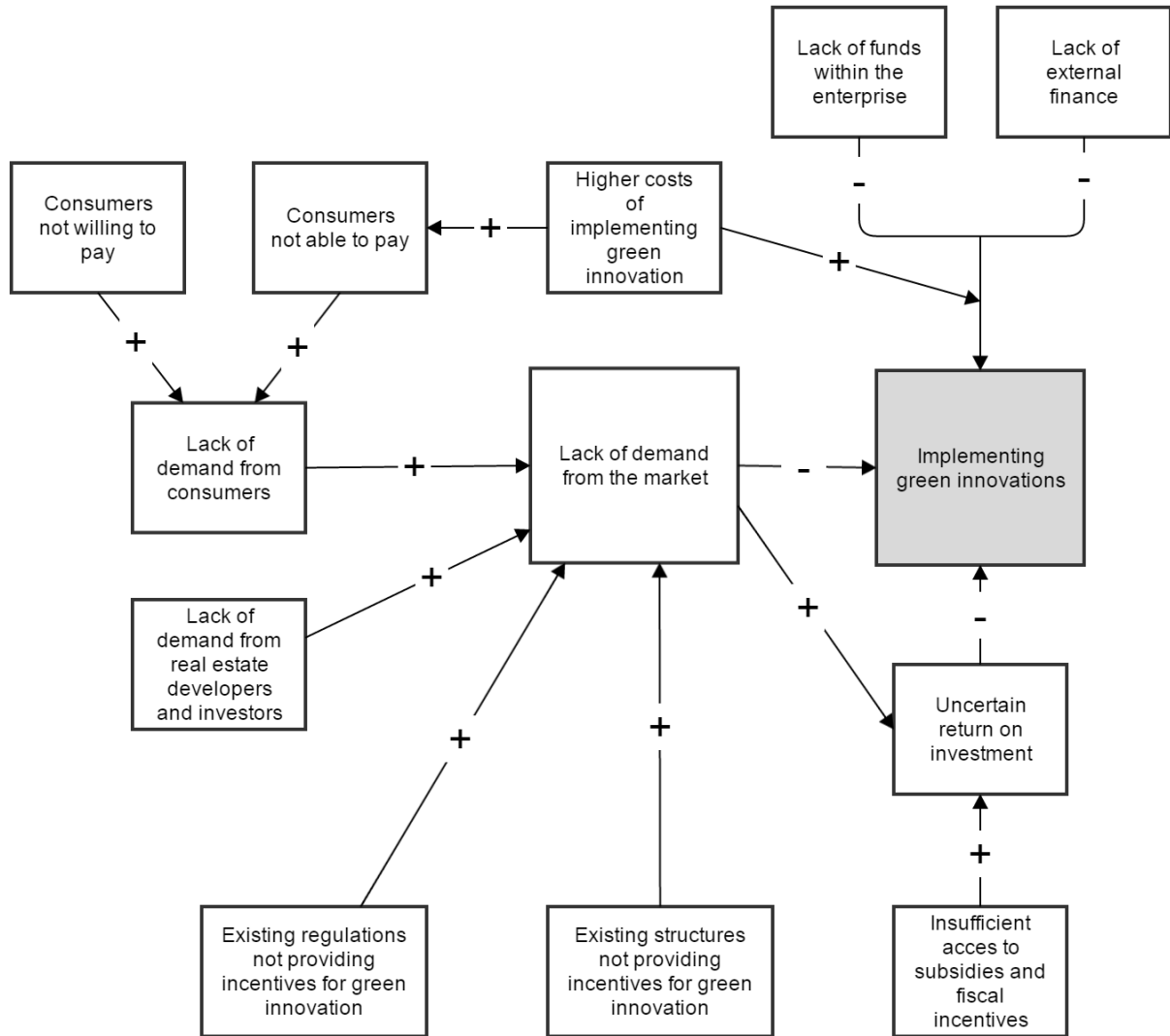


Figure 3: Model of the barriers to green innovation

Appendix 3: Characteristics of companies in the research

Company code	Employees	Turnover in million €	Description
NL1	160	40-45	All-round contractor, which in the recent years had to focus all their efforts on surviving as a company.
NL2	100	40	Project developing for mostly housing associations, investors and real estate developers. The company has a separate taskforce for dealing with the challenges of building nearly zero energy buildings in 2020.
NL3	120	45-50	All-round contractor, with a strong belief that building zero energy building is the future. The company has developed their own concept, which allows them to build zero energy buildings for a competitive price, but is experiencing resistance from the industry.
NL4	10	-	Small contractor, that is facing difficulties in competing with the large companies, due to the lack of economies of scale.
NL5	11	-	Small contractor and project developer is experiencing no demand for green innovations from consumers, stricter regulations have taken away all demand beyond regulations
GE1	5	5	Small contractor mainly focussed on new builds and refurbishing old buildings.
GE2	28	-	Building company that build houses for specific consumers, builds for the market and builds houses that they will rent out.
GE3	100	35	Building company that mostly does project development and privately commissioned houses
GE4	8	8	Small building company that mostly does project development and privately commissioned houses, but all houses that are 30% better than is demanded by regulations
GE5	50	7	Building company that mostly does private commissioned houses, other part is built for the market
UK1	40	4,5	Mostly a civil engineering company, but a small part of their activities is new builds
UK 2	12	-	Small building company, only works on construction of new detached houses
UK 3	6	4	Small building that does mostly does project development. Has introduced buildings with green innovations, but did not recover the investment.
UK 4	7	13,5	Building company that introduces buildings with high environmental performances. The building company is the only one in the research that did not perceive a lack of demand from the market
UK 5	15	13,5	Building company that solely does project development

Appendix 4: Visualisation of the data from the interviews

	Size class		Barrier 1			Barrier 2		Barrier 3		Barrier 4		Barrier 5		Barrier 6	
	Small	Medium	Yes, from real estate developers and investors	Yes, from consumers (1 = not willing to pay, 2 = not able to pay)	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
NL1	-	X	-	2	-	-	X	-	-	-	-	-	-	-	-
NL2	-	X	X	2	-	-	X	-	-	-	-	-	-	X	-
NL3	-	X	X	1,2	-	-	X	X	-	X	-	-	X	-	-
NL4	X	-	X	1,2	-	X	-	X	-	-	-	-	-	-	X
NL5	X	-	X	1,2	-	-	X	-	-	-	-	-	-	-	-
GE1	X	-	X	2	-	-	X	-	-	-	-	-	-	-	-
GE2	X	-	-	2	-	-	X	-	-	-	-	-	-	-	-
GE3	-	X	X	2	-	-	X	-	-	-	-	-	-	-	-
GE4	X	-	X	2	-	X	-	-	-	-	-	-	-	-	-
GE5	-	X	-	2	-	-	X	-	-	-	-	-	-	-	-
UK1	X	-	-	2	-	X	-	-	-	-	-	-	-	-	-
UK2	X	-	-	1	-	X	-	-	-	-	-	-	-	-	-
UK3	X	-	-	1,2	-	X	-	-	-	-	-	-	-	-	-
UK4	-	X	-	-	X	X	-	-	-	-	-	-	-	-	-
UK5	-	X	-	1,2	-	-	X	-	-	-	-	-	-	-	-

Small = 10-49 employees or turnover 2 – <10 million
 Medium = 50-249 employees or turnover 10 – <50 million
 Barrier 1 = Lack of demand from the market
 Barrier 2 = Lack of external financing

Barrier 3 = Market dominated by established firms
 Barrier 4 = Technical and technological lock ins
 Barrier 5 = Limited access to external information and knowledge
 Barrier 6 = Lack of suitable business partners

	Barrier 7		Barrier 8				Barrier 9		Barrier 10		Barrier 11		Barrier 12		Barrier 13		Barrier 14		Env. goals	
	Yes	No	Regulations		Structures		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
			Yes	No	Yes	No														
NL1	X	-	-	X	-	-	X	-	-	X	-	-	-	-	-	-	-	-	X	-
NL2	X	-	-	X	X	-	X	-	-	X	-	X	-	-	-	-	-	-	X	-
NL3	-	X	-	X	X	-	X	-	-	X	-	X	-	-	-	-	-	-	X	-
NL4	X	-	-	X	X	-	X	-	X	-	-	X	-	-	X		-	-	X	-
NL5	X	-	-	X	-	-	X	-	-	X	-	-	-	-	-	-	-	-	X	-
GE1	-	X	-	X	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	X
GE2	-	X	-	X	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	X
GE3	-	X	-	X	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-	X
GE4	-	X	-	X	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-	X
GE5	-	X	-	X	-	X	-	X	-	-	-	X	-	-	X	-	-	-	-	X
UK1	-	X	X	-	-	-	X	-	X	-	-	-	-	-	-	-	-	-	-	X
UK2	-	X	X	-	X	-	X	-	X	-	-	-	-	-	-	-	-	-	-	X
UK3	-	X	X	-	X	-	X	-	X	-	-	-	-	-	-	-	-	-	-	X
UK4	-	X	X	-	-	X	X	-	-	X	-	-	-	-	-	-	-	-	-	X
UK5	-	X	X	-	-	-	X	-	-	X	-	-	-	-	-	-	-	-	X	-

Barrier 7 = Insufficient access to existing subsidies and fiscal incentives

Barrier 8 = Existing regulations and structures not providing incentives for green innovations

Barrier 9 = Uncertain return on investment

Barrier 10 = Lack of funds within the enterprise

Barrier 11 = Reducing energy use is not an innovation priority

Barrier 12 = Lack of technical expertise in personnel

Barrier 13 = Reducing material use is not an innovation priority

Barrier 14 = Resistance to change in the firm

Yes = the national environmental policies are feasible

No = the national environmental policies are not feasible