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Energy efficiency in the food retail sector: Barriers, drivers, and acceptable policies

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Abstract

The objective of this research is to empirically examine the drivers and barriers to energy efficiency measures in an important energy-using sector, namely the food retail sector, and support more effective energy efficiency policies for this sector. Although food retailers consume a significant amount of energy due to the refrigeration, air conditioning and specialised lighting needs of stores, there has been little research in this sector on the barriers and drivers for implementing energy efficiency measures. A survey of small food retailers was carried out to understand the barriers and drivers to greater uptake of energy efficiency measures and to examine the acceptability of different energy efficiency policy options for food retailers. In addition, external stakeholders were consulted in order to validate and contextualise the results of the survey. We find there is a complementary relationship between energy efficiency barriers and drivers for food retailers that is remarkably coherent. We identify policies, such as subsidies and support for ESCOs, that both exploit the complementarities between barriers and drivers and are acceptable to food retailers also. This methodology should help identify and design more effective policies to deliver energy efficiency improvements in the food retail sector.

1. Introduction

Improving energy efficiency has become one of the most significant energy and climate change policy objectives for many businesses and governments globally. Energy efficiency measures can help governments achieve environmental objectives such as a reduction in greenhouse gas emissions while simultaneously meeting increasing energy demand and achieving security of energy supply. Improved energy efficiency can provide multiple benefits to energy consumers and its role is particularly relevant when applied to the services sector, where energy efficiency can improve profitability and productivity (Ryan & Campbell, 2012). Energy efficiency policy is a fundamental component of the Climate and Energy Package which consists of binding European Union (EU) legislation with the objective of a 20% increase in energy efficiency emissions by 2020 (European Commission, 2010).

To develop effective energy efficiency policies to achieve these objectives, it is essential to understand the factors that drive interest in energy efficiency among different types of consumers (Trianni et al., 2013). For businesses, these factors can include the characteristics of the business, the environment in which the business operates, the barriers and the drivers to energy efficiency and the attitudes and reactions towards energy efficiency policies of these businesses. Recent research has indicated that understanding these factors at the sector and sub-sector levels is essential to develop targeted policies and increase the likelihood of achieving the desired outcome (International Energy Agency, 2015; Trianni et al., 2013; Trianni et al., 2016).

Schleich and Gruber (2008) have shown that the retail sector warrants particular focus in terms of developing policy that addresses the barriers to energy efficiency. However, it has received limited

attention, despite the significance of the retail sector in terms of its economic, social and environmental consequences.

Economically, the services sector is one of the fastest growing sectors in Europe, and accounted for 13.3% of European energy consumption in 2014. The services sector was the only sector where energy consumption increased over the period 2005 to 2013, by 5.7% (European Environment Agency, 2015). The retail sector represents the largest share of electricity consumption in the services sector and is responsible for 30% of the total electricity consumed (Constantinos et al., 2010; Enerdata, 2014). This is accredited to the increase in demand for electrical appliances, in particular information and communication technologies and energy intensive processes such as air conditioning (Tassou et al., 2011). Among retailers, food retailers are responsible for both direct and more significantly indirect negative environmental impacts due to their proportionately large energy consumption in the services sector (Beshr et al., 2015). They have the highest specific energy consumption followed by textile retailers and DIY and furniture stores (Retail Forum for Sustainability, 2009). Socially, the retail sector and in particular food retailers, play a pivotal role in providing employment and as a space whereby community residents interact daily with each other. Environmentally, the food retail sector Improvements in energy efficiency have the potential to positively contribute to sustainably developing each of these features.

In an Irish context, the services sector is the largest provider of employment; it is also responsible for 12% of final energy use by sector in Ireland (CSO, 2014) and in 2015 electricity consumption in this sector increased by 4.8% (SEAI, 2016). The retail sub-sector is the largest component of the services sector with 40,000 stores nationally, employing 275,000 people and contributing tax revenues to the exchequer more than €5 billion, highlighting the social and economic significance of the retail sector (IBEC, 2013). Factors such as the challenging economic conditions, reduced consumer demand and rising business costs have culminated in job losses and reduced profitability in retail in recent years. To our knowledge there has been no research carried out on energy efficiency investment in this sector in Ireland.

The aim of this research is to deepen the understanding of not only the barriers and drivers to the adoption of energy efficiency measures in SMEs but also provide a deeper insight into the potential attitudes and reactions to energy efficiency policies in the retail sector. We do this through an empirical survey of small food retailers' attitudes to energy efficiency measures and energy efficiency policies. This research focuses on incorporating the circumstances of businesses at the sub-sector level to support targeted and informed energy efficiency policy development. By focusing on a regional sub-sector, the food retail sector of Mid-West Ireland, policy options can be developed that address the specific barriers and drivers, while factoring in the acceptance and attitudes towards energy efficiency policies.

The paper is structured as follows: Section 2 provides some background context with an overview of the most relevant literature on the study of barriers and drivers of energy efficiency, and in particular by small and medium enterprises (SMEs). Section 3 outlines the methodology. Section 4 presents and discusses the results. Finally, Section 5 highlights the implications for policy of the findings and proposes conclusions and recommendations for future research.

2. Context

Despite the associated economic, social and environmental benefits which exist not only at an organisational level, but also on a national and international level, there remains inadequate adoption of energy efficiency measures by businesses (Ryan and Campbell, 2012; IEA, 2015). Yet limited

research exists on the drivers and barriers associated with energy efficiency and particularly in the context of smaller businesses, such as food retailers (Cagno and Trianni, 2013).

Economic considerations are a key driver in the adoption of energy efficiency in general; these considerations range from potential cost savings, rising energy prices, the availability of public financing, and the reduction in the cost of energy-efficient technology (Sorrell, 2004; Thollander and Ottosson, 2008; Bunse et al., 2011; and Lee, 2015. Kissock and Eger (2012) and Cagno and Trianni (2013) have therefore suggested that there is a need to establish ways of communicating to firms the cost saving potential of energy efficiency.

The availability of public financing in the form of subsidies and grants has been identified as a significant driver for the adoption of energy efficiency and Cagno and Trianni (2013) found this to be the most important driver for small and medium enterprises. This highlights the role that policy can play in incentivising implementation and reaffirms the argument of de Groot et al. (2001) for the importance of subsidies in fostering energy efficiency adoption.

Sweeney (2009) and Hirigoyen et al. (2005) suggest that energy efficiency may have the potential to contribute towards the environmental aspect of a supermarkets corporate social responsibility. However, Ochieng et al. (2014) argue that while retailers can improve their image by showcasing environmental improvements resulting from energy efficiency measures, it is not a high priority for consumers and therefore may not be an important driver of energy efficiency adoption.

No sub-sectoral energy consumption data exists specifically for the Irish retail sector, however it can be expected to follow international trends with regard to the potential for energy efficiency improvements. The retail sector uses most energy in lighting, heating, ventilation, air conditioning and refrigeration. Food retailers have higher refrigeration energy costs (approximately 48% of energy costs and therefore consume a higher proportion of electricity over other energy sources), than other retailers while others have more significant air conditioning costs (Jamieson, 2014). Improving energy efficiency can make a big difference to energy consumption – highly efficient refrigeration systems, for example, can result in up to 44% less energy consumption and 78% reduction in CO_2 emissions compared with conventional refrigeration systems. The building fabric is also important in food retail store energy consumption with typically two-thirds of heat in-store lost through the building fabric. A 20% cut in energy costs is estimated to represent the same bottom line benefit as a 5% sales (The Carbon Trust, 2012).

Barriers to the adoption of energy efficiency, regardless of the sector, occur in the form of market failures and market barriers.[1] Although a widely-used concept, barriers to improvements in energy efficiency are classified in multiple and overlapping ways (Blumstein et al., 1980; Painuly and Reddy, 1996; Sorrell et al., 2000 and 2011; de Almeida et al., 2003; and Cagno et al., 2013). On a scale where a barrier is at one end a fact, and at the other, a construct of the actors in a sector, it is likely that these barriers will fall somewhere in between at varying levels. This makes the comparison of different studies potentially problematic, however four categories of barriers consistently appear in the literature, namely organisational, informational, behavioural and economic barriers.

[1]Mankiw (1998) defines market failures when the market fails to allocate resources efficiently. These include misplaced or split incentives, distortionary fiscal and regulatory policies, unpriced costs such as air pollution, unpriced goods such as education, training, technological advances, insufficient and incorrect information (Jaffe & Stavins, 1994) (Brown, 2001). Market barriers are those barriers which are not classified as market failures, but also impact on the adoption of EE procedures and technologies. They may include transaction costs, access to capital and behavioural barriers (Sorrell et al., 2004).

Informational barriers appear to be particularly problematic for smaller businesses (de Groot et al., 2001; Schleich, 2009; Kostka et al., 2013). While others suggest that the size of the business is not a critical factor in relation to informational issues (Cagno and Trianni, 2014), in smaller businesses energy is generally the responsibility of management who are likely to lack the necessary human capital, scientific expertise and knowledge regarding energy efficiency (Kountas et al., 2011) (Harris et al., 2000) and often will prefer larger strategic projects (Schleich, 2009).

Economic theory suggests that, provided with the necessary information, a decision maker will behave rationally with the decision being free of cognitive limits or bias (Sorrell, et al., 2011). However, a significant amount of empirical research has also identified 'other priorities' of business and management as the most significant barrier in the adoption of energy efficiency (de Groot et. al., 2001; Rohdin and Thollander, 2006; Cooremans, 2012).

While a business might have access to the appropriate information and have sufficient management commitment to implement energy efficiency measures, issues surrounding access to internal or external capital can ultimately prevent the adoption of these measures (Brunke et al., 2014). Yet, while these economic and financial considerations may represent a barrier, Schleich and Gruber (2008) argue that it may not imply a failure which warrants an intervention in capital markets. Even where financial incentive schemes do exist management may not avail of these due to their lack of confidence in the assignment approach (Catarino et al., 2015).

Despite substantial research of barriers, it is arguable that the energy efficiency 'gap' (Jaffe and Stavins, 1994) remains, resulting in DeCanio's (1998) 'paradox' regarding the inadequate adoption of energy efficiency being even more enigmatic more than two decades later. There has also been much less research on the drivers of energy efficiency in industry than the barriers (Cagno et al., 2016); an overview of the drivers and barriers to the adoption of energy efficiency measures is provided by Brunke et al. (2014). Trianni et al. (2016a) developed a classification and categorisation of drivers for industrial energy efficiency. The authors separate drivers into regulatory, economic, informative, and vocational training drivers, and in each category further classify them into external and internal drivers.

In addition, the relationship between barriers and drivers has received limited attention in the literature, with the exception of recent research by Trianni et al. (2016b) and Cagno et al. (2016) to investigate this 'relevant novelty'. This is despite the importance of identifying whether there are links between the most significant drivers and the most significant barriers to energy efficiency that can be exploited in the design of effective EE policy. Trianni et al. (2016b) assess how the drivers for efficiency can mitigate the barriers using an empirical study of SMEs from various sectors in the north Italian manufacturing industry. To our knowledge there has been no study of similar issues in businesses in the services sector. Therefore, a primary objective of this paper is to identify the drivers and barriers to energy efficiency in the retail sector and explore links between the two.

An additional objective of this study is to explore the attitude of businesses to energy efficiency policies in the retail sector. As expected, well-designed policies can result in substantial energy savings (Geller et al., 2006). The success of energy efficiency policy is dependent on the degree to which policy instruments trigger the right drivers and barriers, however these success factors have not been sufficiently addressed by policy makers and ultimately has resulted in ineffective energy efficiency policies (Cagno et al., 2015).

Goulder and Parry (2008) show that a reasonable degree of fairness is necessary to ensure acceptance of policies, even if this necessitates a sacrifice of cost effectiveness. As outlined by de Groot et al.,

(2001) acceptance of a policy is a pre-requisite for its success. By combining the information from retailers on policy acceptance with the knowledge gathered on barriers and drivers of energy efficiency in the retail sector, we can also develop recommendations on policies that are likely to be most effective.

The concept of placing the energy user as a central element in the policy development process has recently become mainstreamed in Irish energy policy with the publication of the Energy White Paper highlighting the important role of the 'energy citizen' (DCCAE, 2015). In light of the recent shift towards the democratisation of energy policy there is a need for research which incorporates the attitudes and perspectives of energy users, in this case retailers, such information could provide crucial information in the design of future energy efficiency policy.

This study adds value to the existing literature by addressing the gaps outlined above by carrying out an empirical study of the drivers and barriers to energy efficiency simultaneously in a sub-sector not previously studied, namely the food retail sector. An improved sector and sub-sector understanding of factors such as the motivations driving the adoption of energy efficiency and the barriers preventing this along with the opinions and acceptance of policy may facilitate the development of more effective and targeted energy efficiency policies.

3. Methodology

This study adopted a mixed methods approach to empirically identify the drivers and barriers to energy efficiency in addition to the attitudes towards energy efficiency policy. This involved combining quantitative questionnaires and qualitative semi structured interview research techniques, methods, approaches and concepts into a single study (Johnson and Onwuegbuzie, 2004). This design provided diverse yet complementary data on a broader perspective than a mono-method.

3.1 Questionnaire

A survey of food retailers was carried out in the mid-west, mainly rural, region of Ireland. This approach was chosen because much of the research on drivers and barriers to energy efficiency has been conducted on an analogous regional scale, such as Rohdin and Thollander (2006) in Oskarshamn, Sweden and Cagno et al. (2015) in Utrecht, Netherlands. By adopting a similar approach in this study, it enables more accurate comparisons with the existing literature. Also, this region was selected because of the importance of the commerce and trade sector in this region responsible for almost 24% of employment (CSO, 2011). The food retail sector also plays a pivotal social and economic role in rural areas, often being the principal source of local employment.

The survey population was comprised of 130 independently-owned and operated, franchise-based retail food outlets. Larger retailers such as Tesco, Dunnes Stores, Lidl and Aldi were not included in the survey, as these stores are not operated independently. The stores included in the survey are listed in Table 1, along with the parent company and number of stores nationally.

Table 1: Number of stores per franchise in Ireland (collated from franchise websites)

Franchise	No. of Stores in Ireland	Parent Company
SuperValu	222	Musgrave Group
Centra	450	Musgrave Group
EuroSpar	55	BWG
Spar	400	BWG
Londis	360	BWG
Mace	230	BWG

Costcutter	114	Barry Group

The survey questionnaire was initially trialled on two members of management in two different retail stores. It was found that the questionnaire was too long and that the style of questions on drivers and barriers, which focused on selecting the level of importance of each barrier and driver, a method used by de Groot et al. (2001), was too complex and a more straightforward method should be used. As a result of the pilot test the survey was adapted with an online questionnaire replacing the original proposed questionnaire booklet, reducing the time required to complete the questionnaire.

Considering the dispersed nature of the study area, the mid-west, a mainly rural, region of Ireland; an online approach provided access to respondents from a wider geographic area. This approach also acknowledged the time constraints of the survey population where managers or owners of independently-owned and operated stores are directly working on all store operations. The online survey allowed them to complete the survey in their own time and eliminate administrative burdens. A simple ranking method was introduced to identify the importance of the barriers and drivers in relation to energy efficiency.

The online questionnaire was designed using the online survey website www.sogosurvey.com. This website was selected as it offered many unique design features and received positive reviews. The survey was comprised of closed questions, to take into account the fact that managers may not be knowledgeable on energy management. A weakness of the closed question approach was that it could not reflect people's rationale for the answers they selected. Asking people to formulate their own responses is acceptable for those who can do so; however the risk is that when analysing the data the researcher will be overly influenced by these responses and ignores the opinions of the less articulate. However, the forced choice approach used for the questionnaire was unable to take into account respondent's rationale to the answers they selected, the importance of which should be considered for future research on this topic.

With a population of 130 applicable businesses in this region the authors received 42 completed questionnaires, representing a response rate of 32.5%. Response rates for comparable studies vary significantly, for example de Groot et al. (2001) received a response rate of 4.2% while Thollander & Ottossen (2008) achieved a response rate of 68% with a total of 40 responses. Since this response rate falls between the two, it was considered satisfactory. It is probable that the limited size of the businesses surveyed and the time constraints of the respondents prevented a higher response rate. No observable difference existed between the characteristics of the respondents and the non-repondents in terms of the franchise type, the location and the size of the business. It was therefore decided that the accuracy and validity of the research would not benefit from a non-response bias test. The quantitative data obtained from the questionnaires was analysed using IBM-SPSS and Microsoft Excel.

A summary of the stores' characteristics is provided in Table 2. The size of the store was determined by the number of employees; a similar approach is adopted in comparable studies by Cagno and Trianni (2014) and Liu (2014). Of the respondents, 50% had an employment level of 15 or less at the time of completing the survey; in addition, the largest proportion of respondents (38%) had been in operation for less than 15 years. The stores did not provide information on their energy expenditure.

Table 2: Characteristics of Respondents

Characteristic	Distribution of stores

Duration in Business	1-15 years: 38% 16-30 years: 24% 31-45 years: 14% 46+ years: 24%.
Size of Store	0-3 employees: 5% 4-8 employees: 21% 9-15 employees: 24% 16+ employees: 50%
Importance of Energy Consumption	Not important: 0% Moderately important: 5% Important: 36% Very important: 59%
Completed Energy Efficiency Measures	No measures: 14% Have taken measures with the primary purpose of reducing energy consumption in their store: 86%.
Anticipated Energy Efficiency Measures	Plan to implement EE measures: 71% Uncertain or did not plan on implementing energy efficiency measures: 29%

Retail managers and store owners themselves were considered to be the appropriate population to respond to the questionnaire, as it is considered unlikely that businesses of this small size would have internal or external energy consultants or environmental strategists employed and that decisions regarding energy efficiency would rest with the retailers themselves. They were requested to answer the questions on behalf of their store, similar to the method used by Schleich (2009). The questionnaire was divided into four parts, namely;

1. General characteristics / Energy characteristics
2. Barriers to the adoption of energy efficiency
3. Drivers for the adoption of energy efficiency
4. Attitudes towards energy efficiency policies

Part 1 focussed on identifying both the general and energy characteristics of the retail store. The most significant characteristics which affect energy consumption are size, based on the number of employees, and years the business is in operation, as applied in Cagno and Trianni (2014) and Liu (2014). Relevant energy characteristics include the importance of energy costs in the running of the business and whether energy efficiency measures had been already adopted.

In Parts 2 and 3, the respondents were asked to rank the barriers and drivers to energy efficiency in their store. The categorisation of the barriers and drivers used for the questionnaire were determined based on those which appeared prominently in the literature review. The literature review highlighted that barriers and drivers to energy efficiency are classified in multiple and overlapping ways.

Previous research on taxonomies of barriers from Blumstein et al.(1980), Painuly and Reddy (1996), Sorrell et al. (2000), de Almeida et al. (2003) and Cagno et al. (2013) provided a comprehensive review on the categorisation of barriers, which were analysed to determine which barriers would be investigated in this study. This analysis resulted in identification of the most significant categories

and types of barriers, namely; economic, organisational, behaviour, information and awareness as presented in Table 3.

Respondents ranked the top 4 barriers and drivers from a list and these were scored on a weighted basis, with a rank of '1' given to the barrier or driver of most significance and '2' to the next most significant. Of the barriers included in the questionnaire, five were economic, two related to lack of information and awareness, three related to behaviour and two to organisation (lack of ownership of the property) in accordance with Cagno et al. (2013) and other researchers cited previously (Table 3).

Table 3: Barriers to Energy efficiency in Questionnaire

Barriers	**Category**
Not enough time to investigate potential for energy efficiency (EE)	Organisational
Tenant	
Don't want to replace existing technology	Behaviour
Prefer to wait for cheaper technology	
Other investments prioritised	
Lack of information on EE	Information and awareness
Not aware of EE technology appropriate for the store	
Uncertainty on payback on EE investment	Economic
Energy costs not high enough to warrant investment in EE	
Difficulties obtaining external finance	
Not enough internal finance available	
EE equipment too expensive	

While there has been substantial research on taxonomies of barriers, there has been much less research on drivers and ultimately means there is no established taxonomy of drivers for energy efficiency, justifying Cagno and Trianni's (2013) view that these businesses have been completely overlooked in this regard. An analysis of the available literature on taxonomies of drivers from Reddy and Assenza (2007), Thollander and Ottossen (2008) and Cagno and Trianni (2013) highlighted that the most prominent categories and types of drivers were regulatory, informative and economic. The questionnaire therefore included two regulatory, three informational, and six economics drivers (Table 4).

Table 4: Drivers to Energy Efficiency in Questionnaire

Drivers	**Category**
Availability of free energy audit	Regulatory
Demand from head office to reduce energy consumption	
Examples of other stores installing energy efficient technology	Informative
Establish green image of business	
More information on energy efficiency available	
Energy supplier providing incentives for energy efficiency	Economic

Provides an advantage over competing stores	
Good deal provided by equipment suppliers for energy efficient technology	
Future expected increase in energy costs	
Grants or subsidies available for energy efficient equipment	
Cost reduction from lower energy usage	

Finally, in Part 4 respondents outlined their attitudes towards energy efficiency policy; this part was comprised of three distinct segments. Firstly, respondents selected the most acceptable payback time for energy efficiency technologies. Secondly, respondents ranked in order of acceptability eight energy efficiency policies with a rank of '1' given to the most acceptable policy right down to the least acceptable represented by the number '8'. Thirdly, respondents selected the probable reaction the business of an increase in the cost of energy due to a carbon tax. The options ranged from installing energy efficiency technology to shutting the business down, similar to de Groot et al. (2001).

3.2 Qualitative analysis - interviews with external stakeholders

Shove (1998) criticised the tendency in research to focus on individual decision makers as if they make decisions in a vacuum, regardless of social and institutional context. This criticism remains highly relevant in the current research of drivers and barriers to energy efficiency which has solely focused on the attitudes and behaviours of a key decision maker within an organisation, such as in the first part of this research. Yet, such an approach does not give adequate consideration to the wider social context in which decisions regarding energy are made; this gap in the literature has been acknowledged by Cagno et al. (2015) and Chai and Yeo (2012). In order to address this omission in the literature, qualitative semi structured interviews were conducted with external stakeholders on the national level who have a significant influence on the adoption of energy efficiency in the retail sector.

The process for selecting the interviewees was adapted from Chai and Yeo's (2012) framework which proposes a systems approach to overcome energy efficiency barriers and categorises energy efficiency barriers based on the stage at which the barriers exist. This allowed us to understand the roles and responsibilities of major stakeholders which then provided the basis for selecting interviewees from the following groups: retailers, retail franchises, policy makers, energy consultants and technology suppliers.

The objective of the interviews was to provide an external perspective on the factors examined in the questionnaire survey rather than representing a general view of the particular stakeholder groups. Using a purposive sampling approach, the interviews were conducted with one representative from each of the selected groups. These representatives were selected due to their expert knowledge on energy efficiency in the retail sector, their individual input is not intended to represent the wider body of their profession or industry. For example, the energy management consultancy interviewee's responses were from his perspective and do not represent all energy management consultants. Allowing for the different role each interviewee plays in the adoption of energy efficiency in the retail sector, no detailed interview guide was developed as each interview was intended to be exploratory. However the interviews were structured into three sections which shaped the discussions: drivers of energy efficiency in the retail sector, barriers to energy efficiency in the retail sector and the implications of policy in addressing these factors in the retail sector.

Table 5: Overview of interviewees for qualitative component

Interviewee	Category
Sustainable energy Authority of Ireland (SEAI)	Policy maker (national energy agency)
Musgrave Group	Franchise headquarters
Green Aware Environmental Consultants	Energy management consultants
Ballinlough Refrigeration Ltd.	Equipment company (customers: Spar, Mace, Costcutter and SuperValu)
Queally's SuperValu Kilrush	Retailer

The qualitative semi structured interviews were analysed using a conventional content analysis approach. Kumar (2014) describes this process as analysing the contents of interviews in order to identify the main themes that emerge from the responses given by respondents. Three stages of content analysis were adopted in order to analyse the qualitative interviews:

1. Identification of the main themes
2. Classification of responses into main themes
3. Integration of themes and responses into the text where relevant to the analysis

While the number of the semi-structured interviews was limited to five, the findings provide perspectives that complement the results of the questionnaire and identify new areas of significance which could be expanded upon in future research.

4. Results and Discussion

This section first presents the results obtained from the quantitative component through the questionnaires. Subsection 4.1 presents the results on barriers to energy efficiency, Subsection 4.2 presents the results on drivers to energy efficiency, and the attitudes towards energy efficiency policy are given in Subsection 4.3. The information obtained from the semi structured interviews in conjunction with the review of the literature is then used to inform the discussion of the results.

4.1 Barriers

We present the results of the questionnaire relating to barriers in two ways: firstly, in terms of the total aggregated score for each barrier (in Figure 1), and secondly as a frequency of the scoring for each barrier (Figure 2). Survey respondents were asked to limit their selection and ranking of barriers to the four most significant barriers in order of significance. This was done for three reasons:

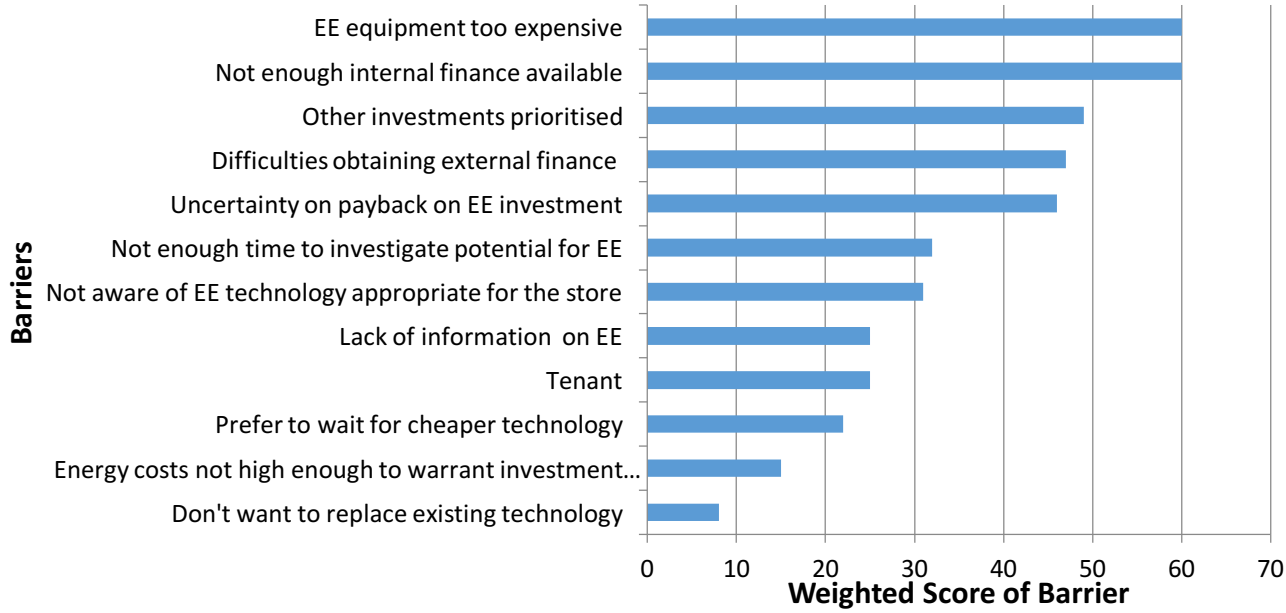
1. A requirement to select more than 4 barriers was anticipated to be more onerous for respondents and reduce the number of completed reponses.
2. It also may be difficult for respondents to distinguish between the significance of, for example, barrier 7 and barrier 8 (in comparison to distinguishing between barrier 1 and barrier 2) – this could have led to respondents simply ranking the less significant barriers outside the top four in a potentially inaccurate/non-reflective manner.
3. The significance of barriers outside the top 4 are likely to have a minimal impact on the decision to adopt energy efficiency

Since participants were only allowed to select four barriers to energy efficiency, the estimated average ranking is not a useful metric, as it does not reflect the number of times participants selected the barrier. A weighted score approach was adopted to aggregate the results, with the most

significant barrier receiving a score of 4, the second most significant received 3, the third most significant received 2, while the fourth received 1. This approach was adopted as it enables barriers of lower significance to be distinguished from those more significant. For example, no respondent selected the barrier 'prefer to wait for cheaper technology' as the most significant barrier, however 12 respondents considered it a barrier of some significance (i.e. ranked between second and fourth most significant 12 times).

We find that four out of the top five ranked barriers in Figure 1 were economic barriers. Only low energy costs were not highly ranked as a barrier to energy efficiency. Specifically, the initial cost of energy-efficient equipment and the lack of internal finance represented the highest ranked barriers for retailers, in line with previous research from Trianni and Cagno (2012) and Cagno et al. (2015). The importance of other investments ranked third and, while considerable, it is not the most significant barrier as was the case in other research (Rohdin & Thollander, 2006; de Groot & Verhoef, 2001; Cooremans, 2012). When interviewed, the external stakeholders confirmed that the biggest concern of smaller independent retailers when adopting energy efficiency measures is exclusively price. However, for larger non-independent retail stores quality and efficiency of equipment is a primary consideration. This suggests that smaller retailers are more vulnerable to economic barriers than their larger counterparts. The lack of time that retailers have to investigate the feasablity and costs of energy efficiency measures was further elaborated by the interviewee representing a franchise headquarters where he explained that retailers "are so busy with other tasks and the day to day running of the store".

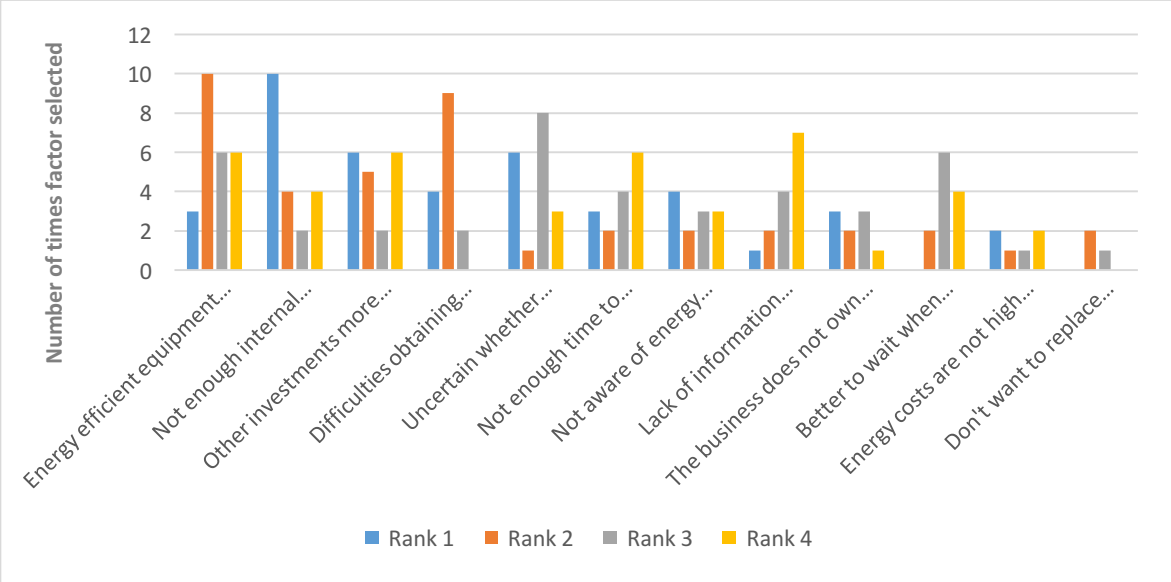
Figure 1: Barriers to investment in energy efficiency ranked in order of significance



A limitation of the methodology is that it is difficult to assess the level of knowledge of retailers on the technology and costs associated with improving energy efficiency and whether their answers represent real knowledge or assumptions. This quantitative questionnaire does not allow us to statistically report on whether retailers have actual experience of high costs of energy efficient equipment or they are simply assuming this to be the case.

Interestingly, the vast majority of respondents to the survey indicated that they had already implemented some energy efficiency measures and also plan to implement more energy efficiency measures in the future. Therefore it is likely that they have some idea of the costs of energy efficiency measures.

Figure 2: Frequency of ranking for barriers



Lack of internal finance represented the second most significant barrier overall to retailers with stakeholders also referring to the considerable time and difficulties to acquire capital from financial institutions for retailers. This is particularly relevant in the context of the recent economic downturn in Ireland, as lending conditions restricted with all banks. Interestingly, the lack of internal finance was more frequently ranked first and the initial cost of energy-efficient equipment was most frequently second by participants, which has not previously been highlighted.

However, despite the significance of economic barriers, non-economic barriers were perceived to have a substantial influence over the inadequate adoption of energy efficiency. 'Other investments prioritised' was found to be the third most significant barrier; this is despite the fact that 62% of the retailers considered energy efficiency a 'very important' issue. This is comparable to findings from Schleich (2009) who identified that energy efficiency adoption is perceived as merely a discretionary maintenance project by businesses. Although he identified this as an issue, the retail franchise interviewee also highlighted that energy-efficient equipment such as LED lighting and glass doors on refrigeration are now standard specification of their stores, rather than optional.

Retailers ranked "lack of time" to investigate the feasablity and costs of energy efficiency measures as a signiciant barrier. The interviewee representing a franchise headquarters further elaborated, as he explained that retailers "are so busy with other tasks and the day to day running of the store". The retailers outlined that a 'lack of awareness of energy efficiency technology appropriate for their store' was a significant barrier, yet scored only half the value of the most significant barrier. It is interesting to note that while economic barriers ranked the highest, these barriers are only relevant at the latter stages of the decision-making process of adopting energy efficiency. A lack of awareness of energy efficiency on the other hand could prevent adoption of efficiency measures at the very beginning of the process before the cost of the investment is even considered. A technology supplier

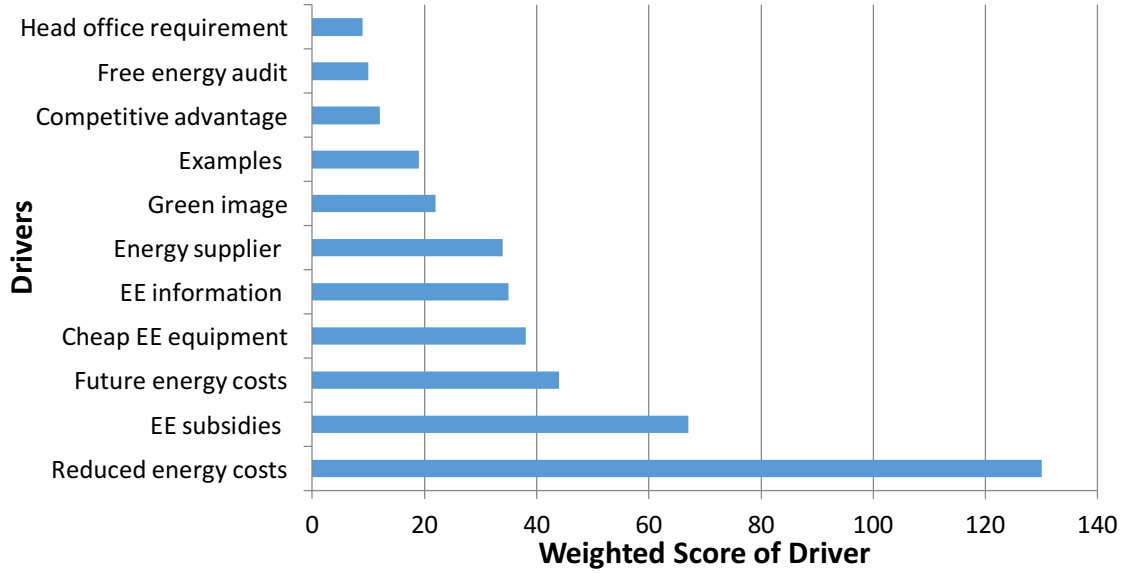
outlined that “the message isn’t getting out there enough about energy-efficient equipment”. The consequences of this are also noted by the policy maker interviewed who recognised that “industries were not aware themselves of what technology was appropriate for them”.

Using a Fisher’s Exact Test, selected principally as it is an accurate form of statistical analysis when sample sizes are small, we investigated the relationships between the size of the store and the type of barrier considered more significant (economic or non-economic). It was found that the size of the store did not determine whether a retailer perceived economic barriers or non-economic barriers to be more significant.

4.2 Drivers

Survey respondents were asked to rank the four most significant drivers in order of significance. Of the drivers proposed, participants chose economic drivers as the top four drivers, followed by a fifth that was the availability of information.

Figure 3: Overall scores of drivers



Notes: Weighting calculated as: 1st preference = 4 points, 2nd preference = 3 points, 3rd preference = 2 points, 4th preference = 1 point.

The cost reduction from lower energy use as a result of adopting energy efficiency measures had the highest total score of all the drivers. It was also most frequently ranked first by retailers - 66% of retailers selected it as the highest factor in motivating them to adopt energy efficiency measures, similar to findings by de Groot et al. (2001), Lee (2015) and Cagno and Trianni (2013) and Trianni et al. (2016). The importance of cost reduction of energy-efficient technology was also highlighted by all interviewees as the most significant driver, with the technology supplier highlighting that in his dealings with retailers the only consideration was the impact on “bottom line profit”. This highlights the necessity of promoting methods which clearly outline the cost saving measures of energy-efficient technology. It also complements findings from recent research by Trianni et al. (2016) which highlighted the importance for increased awareness of the non-energy benefits of energy efficiency.

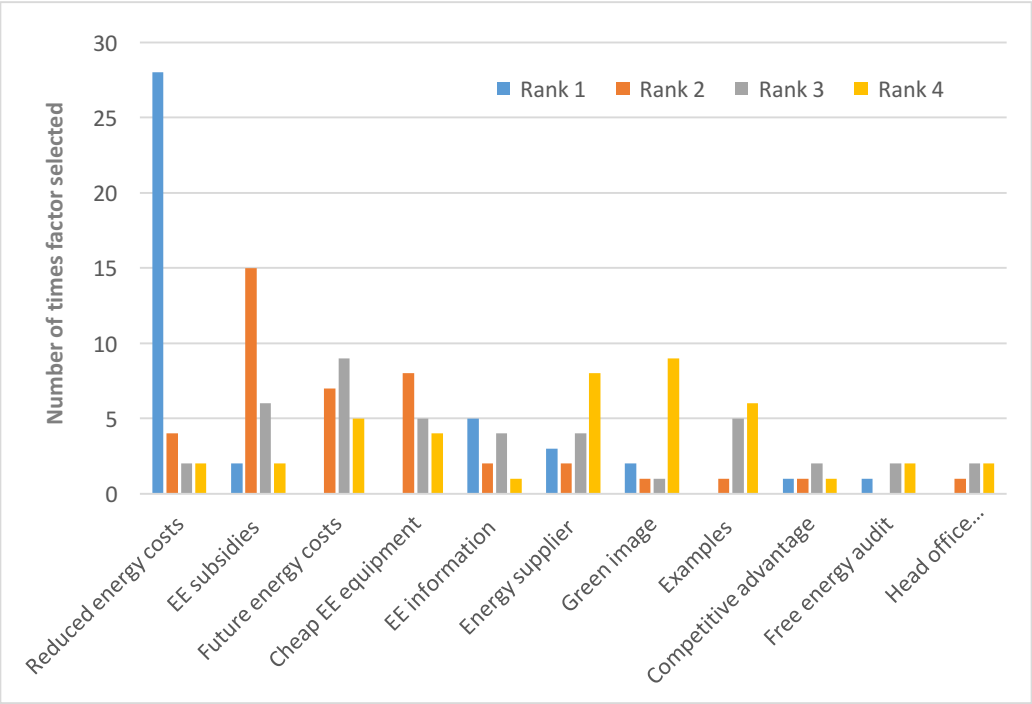


Figure 4: Frequency of rankings for drivers

The availability of grants and subsidies for energy-efficient technology was identified by retailers as the second most important driver; this result aligns with earlier findings highlighting the cost of energy-efficient equipment and the lack of capital as the most significant barriers. While Cagno (2015) outlined that technology suppliers are the most relevant external actor in the adoption of energy efficiency this finding illustrates the leading role that government has to play in incentivising energy efficiency adoption. However, stakeholders expressed concern in relation to public financing for energy efficiency and referred to the effect of the declining level of financing available in Ireland following the economic downturn. The interviewees also conveyed their frustration with the limits of subsidies - they felt that those who have the capabilities and experience with the process continuously apply and receive public finance while businesses without the resources or knowledge of the application process are perceived to be neglected.

One quarter of respondents ranked a green image as fourth most significant driver, although this result risks being dependent on the individual managers who responded to the questionnaire. This finding would appear to be corroborated between the questionnaire respondents and interviewees. The technology supplier outlined that a "CO_2 footprint means nothing to retailers". This may be because retailers believe their customers don't care about a green image, as outlined by interviewed retailer who said it "won't convince anyone to come in the door".

These findings are similar to those of Ochienget et al. (2014) who notes that despite this there is an opportunity to showcase environmental improvements. This is alluded to by the interviewed retailer who remarked that "it is nice to talk about when you are asked". The policy maker noted that establishing a green image was predominately something that concerned large international companies, yet added that more recently it is becoming something about which smaller businesses are approaching the energy authority. Cagno et al. (2015) supported this view, showing that businesses require something tangible, such as subsidies, to incentivise improvements in energy efficiency as opposed to intangible benefits such as developing a green image. Yet this area may be

of future relevance to policy makers wishing to highlight the potential of non-energy benefits beyond that of financial savings.

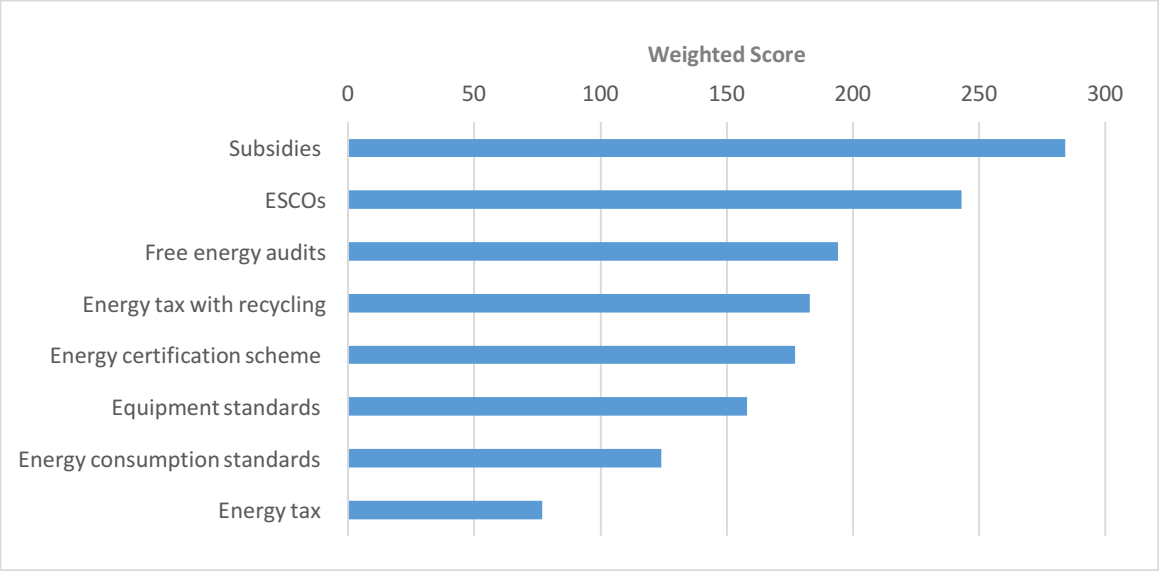
4.3 Attitudes towards policy

This study specifically addressed the acceptance of policy, acceptable payback times and awareness of current energy efficiency policy from the retailers and associated stakeholder's perspective. In addition, the relationship that exists between the barriers, drivers and acceptance of policy was analysed to provide a more comprehensive understanding of these dynamic factors.

4.3.1 Policy acceptance

The retailers were asked to rank a range of policies from 1 to 8 in terms of their acceptability. The policies included various economic instruments such as subsidies and energy taxes, with and without revenue recycling, in addition to regulatory measures, such as equipment performance standards and energy consumption target standards; and information measures such as energy audits and certification schemes. Support for Energy Service Contract providers (ESCOs) was also offered as a policy measure, which may be an economic or regulatory policy. The results were combined using a weighting such that first preferences received 8 points and eighth preferences received 1 point to calculate total weighted scores presented in **Error! Reference source not found.**. **Error! Reference source not found.** presents the incidence of the rankings for each measure.

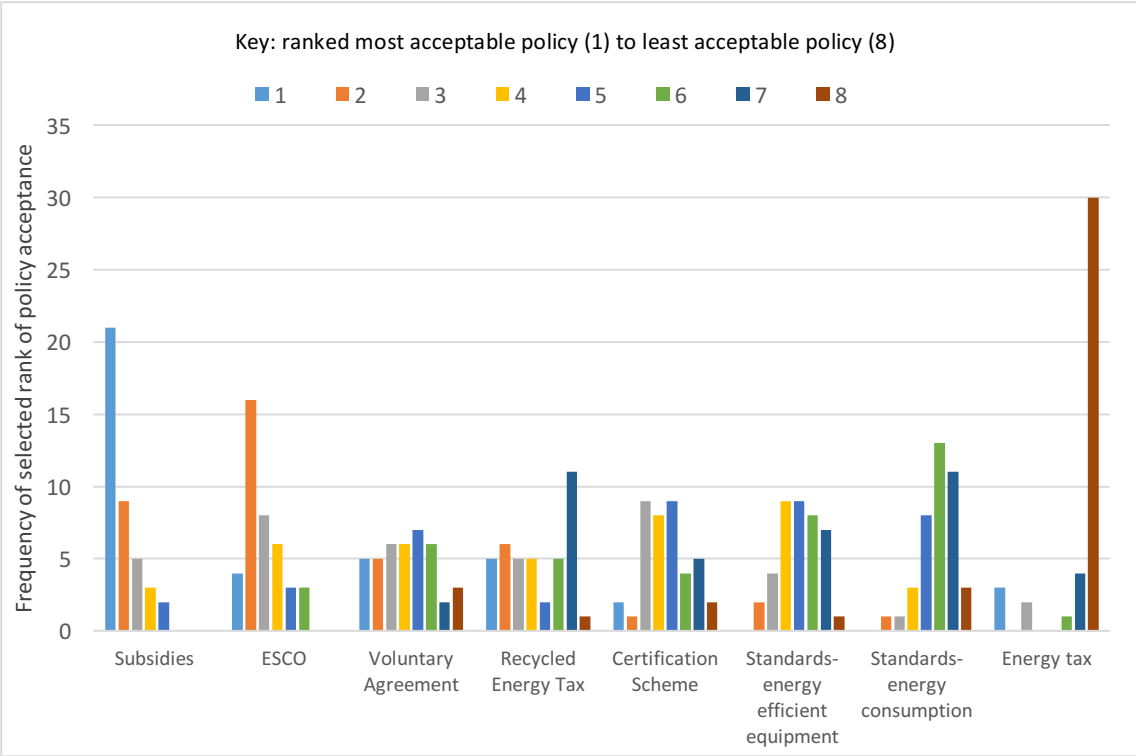
Figure 5: Total scores for policy acceptance.



Notes: Weighting calculated as: 1st preference = 8 points, 2nd preference = 7 points, 3rd preference = 6 points, 4th preference = 5 points, 5th preference = 4 points, 6th preference = 3 points, 7th preference = 2 points, 8th preference = 1 point.

As expected, subsidies ranked highest among retailers as the policy deemed most acceptable, while energy taxes were least acceptable. These results are unsurprising given that the first section of the survey of barriers showed that businesses regarded the cost of energy-efficient equipment and access to capital as the leading barriers to the adoption of energy efficiency for retailers. However, external stakeholders identified retailers' over-reliance on subsidies to engage in energy efficiency measures as a concern and recognised that it may not be the most sustainable method of promoting energy efficiency. While the seriousness of economic barriers cannot be understated, these findings suggest that future policy development should focus on creating mechanisms for sustainable financing of energy efficiency projects that include the private sector.

Figure 6: Frequency of rankings of policy acceptance

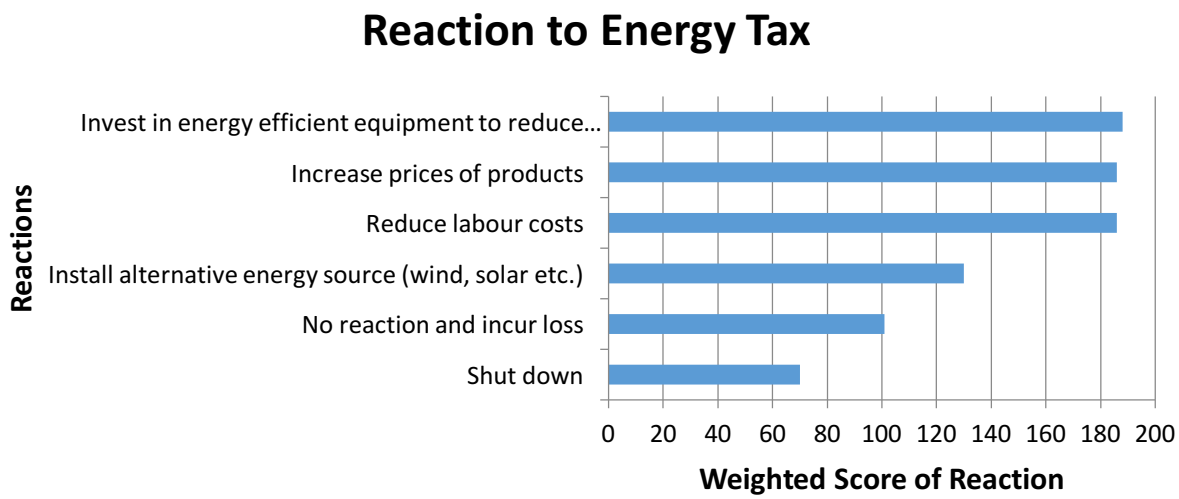


A potential solution to the unsustainable reliance on subsidies for the promotion of energy efficiency is through the utilisation of energy services companies (ESCO's) which ranked as the second most acceptable policy measure from the retailers' perspective. ESCO's can finance and install energy-efficient equipment in businesses and are repaid based on energy savings for a specified duration, outlined in a contract. Despite the findings that this approach is highly acceptable from the retailers' perspective, there was considerable uncertainty and mistrust regarding the ESCO market from the external stakeholders interviewed, similar to the issues outlined in Backland and Eidenskog (2013). Some mentioned previous experience of ESCO's in Ireland where businesses were tied into long term contracts, allegedly for longer than necessary. Consequently, mistrust developed in the ESCO market, which would have to be regained for success with this approach in the future.

There was a relatively high acceptance of the concept of an energy tax with recycled revenues used towards a reduced corporation tax. This modest level of acceptability of energy taxes with revenues recycled highlights that businesses are not averse to taxes per se, instead they are, as also suggested by de Groot et al. (2001), more worried about the loss of competitiveness associated with a tax. The adverse effects of taxes were perceived to be substantially reduced when the revenues generated by the tax are recycled back to businesses, and hence achieve a higher level of acceptability in comparison to a tax with no recycling of revenues, as was suggested by Geller et al., (2006).

The questionnaire asked a further question on the reaction of retailers to the introduction of an energy tax with no recycling of revenue effects and the results are presented in **Error! Reference source not found.**. Retailers were asked about (a) the acceptability of such a tax, and (b) their expected behaviours in response to this policy measure. While a non-recycled energy tax was deemed not acceptable, the most likely reaction in response to the tax was to invest in energy efficiency to reduce energy costs, highlighting the potential of this instrument to achieve its objectives. However, this response was only marginally higher than a reaction which would see retailers either increase the prices of their products or reduce labour costs, both negative reactions in terms of the wider social and economic consequences.

Figure 7: Reaction of retailers to energy tax.



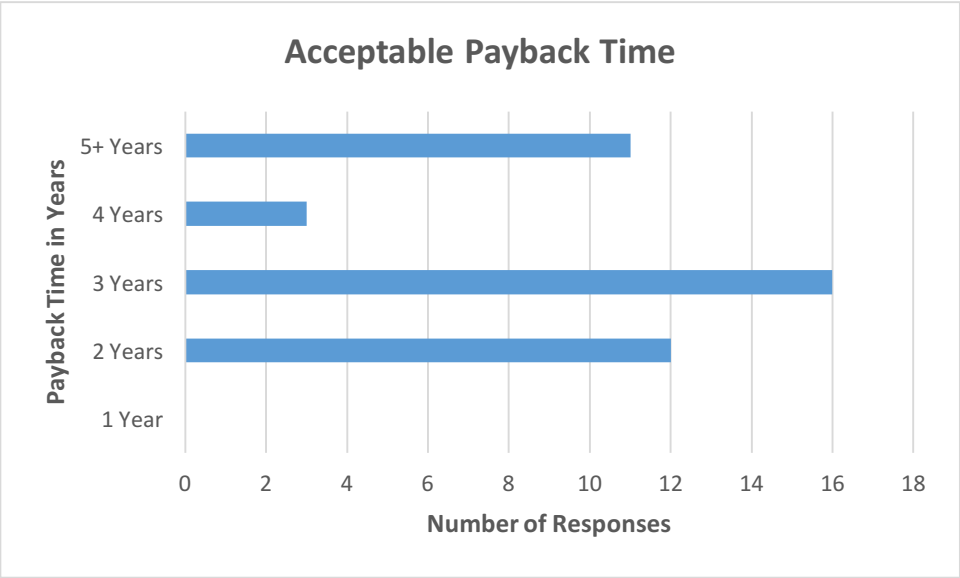
Notes: Weightings used to combine scores: 1st preference = 6 points, 2nd preference = 5 points, 3rd preference = 4 points, 4th preference = 3 points, 5th preference = 2 points, 6th preference = 1 point.

The policy option of regulatory standards on both the energy performance of equipment and level of energy consumption received a low level of acceptance from retailers. However, the external stakeholders were optimistic about the impact of equipment standards. This aligns with Groot et al. (2001) who found that equipment standards were more acceptable than standards on energy consumption. When interviewed, the policy maker found that energy performance standards for equipment would "ensure manufacturers that meet criteria get the recognition deserved" while an energy consultant outlined that such regulation would "force top management buy-in" (to energy efficiency). The interviewed stakeholders noted that retailers rely on independent testing in ensuring their equipment is energy efficient yet the stakeholders cautioned that unregulated testing and standards can be open to manipulation and therefore may not be reliable. Stakeholders also recommended that regulations and energy performance standards come with a requirement for enforcement and this challenge should not be underestimated by policy makers.

4.3.2 Payback time and awareness

The uncertainty regarding the payback period of energy-efficient equipment was identified previously as a moderate barrier to the adoption of energy efficiency. The reliance by retailers on subsidies to bring down the payback down to appropriate levels was highlighted by many of the external stakeholders, however less evident was what was the actual acceptable payback time for retailers when purchasing energy-efficient equipment.

Figure 8: Acceptable payback time for energy-efficient equipment from retailer's perspective



Retailers were asked what payback time would be the acceptable payback time for investment in energy efficiency measures.[2] The findings in Figure 8 highlight that a relatively short period, 2 to 3 years, is the most acceptable for the majority of this sample, with 66% of respondents selecting this payback time. However, there was also a significant minority willing to accept more than 5 years as a payback period. It was noted that 35% of smaller retailers (those with less than 15 employees) are willing to accept payback times of longer than 5 years while only 12.5% of larger stores are willing to accept payback times of longer than 5 years. However, the Fischer's exact test carried out to test the significance of the relationship between the size of the store and the payback time found that the length of the acceptable payback time was not related to the size of the store.

The technology supplier interviewed outlined that comparing the payback period associated with energy-efficient and inefficient equipment is a fundamental aspect of the business' selling strategy. Promoting information on the payback time associated with efficient equipment which falls in the acceptable payback time range could be an effective measure to promote energy efficiency adoption. Subsidies for an energy efficient also generally shorten the payback time and are thus a relevant policy here.

Table 6: Retailers level of awareness of current energy efficiency policy measures

Policy Measure	Percentage of Respondents Aware of Policy Measure
Unaware of Any of Outlined Policy Instruments	50%
SEAI's Small and Medium Enterprises Support Programme	40.48%
Accelerated Capital Allowance	21.43%
Better Energy Communities	16.67%
National Energy Efficiency Fund	16.67%

Earlier findings in this study found that a lack of awareness of energy-efficient technology was a moderate barrier to the adoption of efficiency measures. In the survey we also asked retailers about

[2] The type of energy efficiency measures was not specified and this might explain some of the variation in acceptable payback times.

their awareness of energy efficiency policy measures currently in place. The findings suggest that the lack of awareness of energy efficiency extends beyond a lack of knowledge of the technology appropriate for their business and includes a lack of awareness of policy and support measures appropriate for retailers; 50% of retailers surveyed were completely unaware of any of the energy efficiency policies which are applicable to their business.

4.3.3 Relationship between barriers, drivers and policies for energy efficiency.

The need to investigate the relationship that exists between drivers and barriers has been highlighted by Trianni et al. (2016). Furthermore, there is a further gap in the literature on the relationship that exists between policy acceptability, drivers and barriers. The analysis in this section explores this issue using a novel graphical approach to examine the association between policy acceptance and the most significant barriers and the most significant drivers. While no statistical relationship can be determined from such analysis, the figures demonstrate some interesting trends that are worthy of comment and further research.[3] It is anticipated that identifying the links between these factors would support policy makers in developing policy mixes which are both acceptable and effective at addressing the drivers and barriers to energy efficiency, both prerequisites for policy success.

The figures would suggest that the acceptability of policies is correlated with the specific barriers and drivers of energy efficiency faced by businesses. Figure 9 shows the relationship between energy efficiency barriers and policy acceptability. For example, the cost of energy-efficient equipment and lack of internal finance are the most significant barriers to energy efficiency for retailers. These are addressed by the policies that were also ranked as most acceptable: subsidies and the availability of ESCOs. There are also some alignments in the middle of the figure where uncertainty and lack of time are moderate barriers, while equipment standards and voluntary agreements with free energy audits are considered to be moderately acceptable policies.

Similarly, in Figure 10, the most significant drivers of investment in energy efficiency are reduced energy costs associated with energy efficiency and the availability of subsidies. Both are enhanced by the top policy that was deemed most acceptable, namely subsidies. In the middle of Figure 10, a moderate driver of energy efficiency investment is an expected increase in energy costs, while the introduction of energy tax with revenue recycled is considered moderately acceptable. At the other end, low energy costs were not found to be a significant barrier and energy taxes were not an acceptable policy; both results indicating that these businesses already think energy costs are sufficiently high.

[3] The relationship between the factors (barriers, drivers and acceptability) is illustrative rather than quantitative and based on their relative importance. For example the weighted score of the most acceptable policy (subsidies) is 300, while the weighted score of the most significant barrier (costs) is 55. What is notable is that subsidies are the most acceptable policy and costs are the most significant barrier.

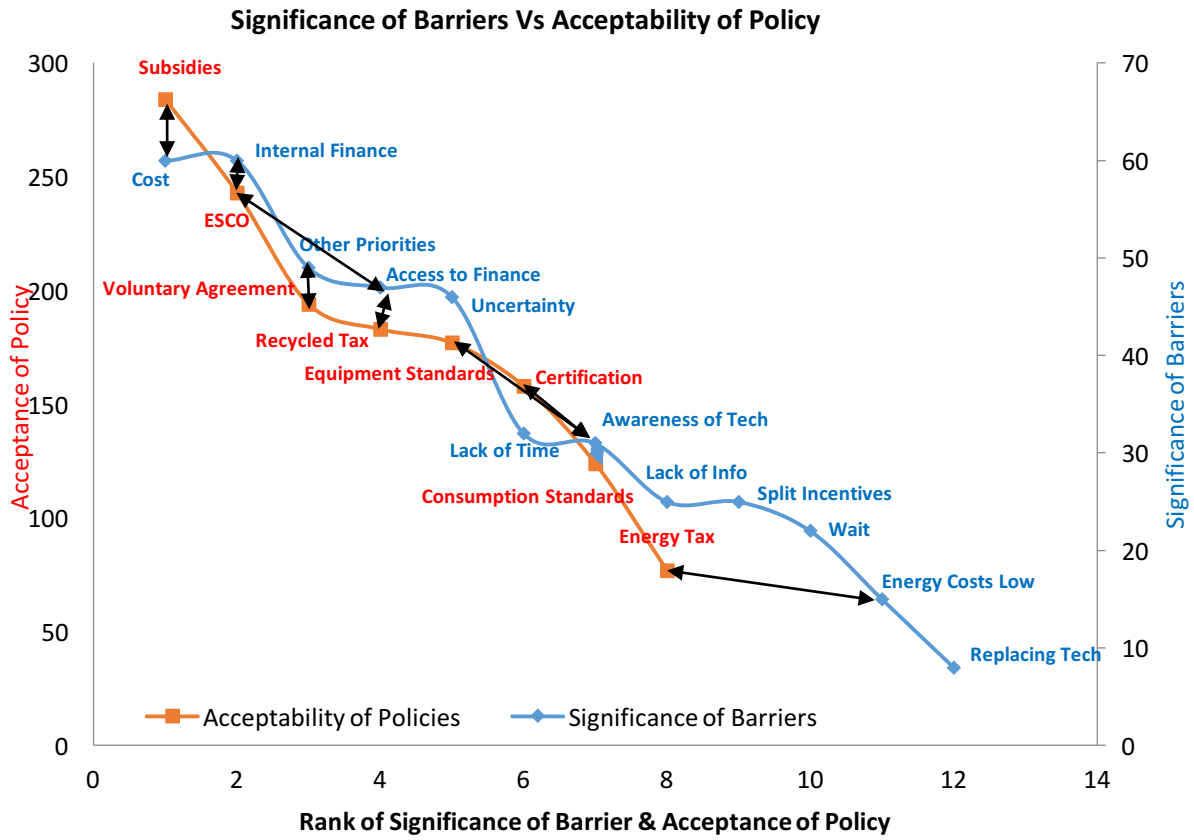


Figure 9: Relationship between barriers and policy acceptance

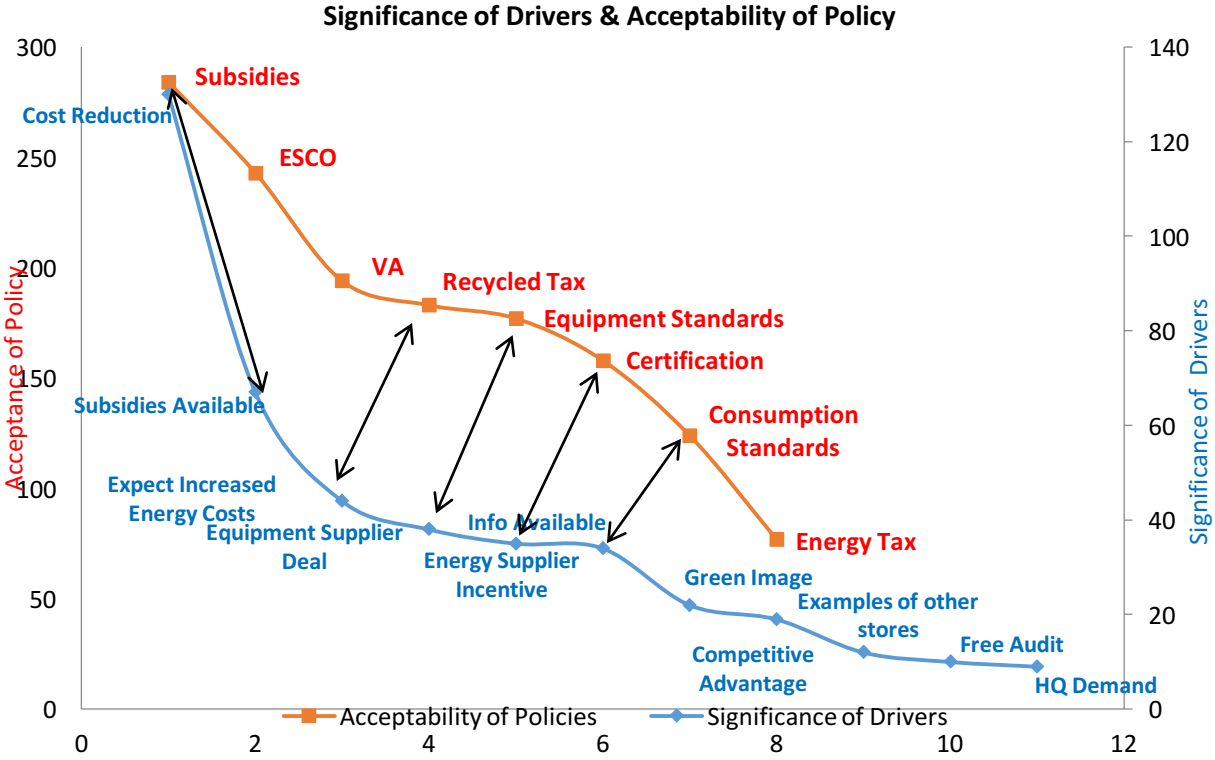


Figure 10: Relationship between drivers and policy acceptance

5. Conclusion and Policy Implications

This research provides new insights that will enable the design of more effective policies to support energy efficient improvements in the food retail sector in Ireland. This is achieved through examining simultaneously the barriers and drivers of energy efficiency, as well as the acceptability of a range of energy efficiency policies. This research has found that economic issues are the main barriers for the adoption of energy efficiency measures by food retailers, with the initial cost of energy-efficient equipment and lack of internal finance representing the most important economic barriers. The stakeholder interviews also corroborated the finding that smaller retailers are more vulnerable to economic barriers than their larger counterparts. In contrast to other sectors reported in the literature, non-economic barriers were also perceived by retailers to have a substantial influence over the inadequate adoption of energy efficiency. The lack of awareness of policies that support investment in efficient technology further compounds the impact of economic barriers.

Similarly, we find that the key drivers of the adoption of energy efficiency measures by food retailers also concerned economic considerations. In particular, the potential for energy cost reduction from energy savings was deemed the most significant driver. This was echoed by interviewed stakeholders who reflected on retailers' focus on bottom line profit. The findings suggest that in order to reinforce this driver, it may be effective to raise awareness of the cost-saving features of energy-efficient technology among businesses. The second highest driver was the availability of subsidies, yet the stakeholders interviewed expressed their frustration with the accessibility and application process of subsidies.

Unsurprisingly, retailers ranked subsidies as the most acceptable policy. It is notable that the policies most acceptable by the retailer do not include increased taxes, however taxes become more acceptable if the revenue is recycled. The reaction of retailers to a hypothetical energy tax, without recycling of revenues, was also explored. Investment in energy efficiency was the most common response, however it was only marginally higher than the intention to increase product prices and to reduce labour costs, both with negative socioeconomic effects. The survey also found that the acceptable payback period for energy-efficient equipment is short for most firms, with 66% of retailers selecting a period less than 3 years. However, a quarter of firms were willing to accept more than five years. This would imply that policies should clearly highlight the short-term cost-saving potential of energy efficiency but also the longer-term advantages in case firms are not aware of these.

Retailers' positions on energy efficiency barriers, drivers, and policy acceptability are found to be relatively consistent and provide some insights for "easy win" policies that would address all three objectives. First and foremost, retailers find that the additional costs associated with energy-efficient technologies act as the primary barrier to energy efficiency investment, while the main drivers are the energy cost savings associated with energy efficiency measures and the availability of subsidies. In parallel, subsidies for energy efficiency technology were found to be the most acceptable energy efficiency policy. Putting these together we find a coherent picture, namely that the total cost of energy – both capital and future operating costs - is what counts for retailers and therefore it is logical that subsidies would be the policy that is most acceptable, as they could change the balance for investment in energy efficiency measures.

Another case in point is found in the second tier of preferences. Lack of internal finance is the second most important barrier and this is emulated by the driver from an expectation of higher future energy costs. The support of ESCOs is the second most preferred policy, which aligns well with

this barrier and driver; ESCOs could provide financing for energy efficiency measures when it is lacking internally and the business model for ESCOs is also more lucrative with higher future energy prices, as the savings generated in the future have more value. Other moderately acceptable policies such as recycled taxes and voluntary agreements find clear matches in the barriers identified such as uncertainty and access to finance while supporting the next most important drivers, cheaper energy efficient equipment through a supplier deal and more information on energy efficiency.

Subsidies were clearly identified as a significant driver of investment in energy efficiency, yet public financing constraints mean that future policy development could focus on creating mechanisms that include the private sector for sustainable financing of energy efficiency projects. In addition, the potential for recycled energy taxes should be examined as an acceptable and efficient method to raise funds to promote energy efficiency in the retail sector while disincentivising energy profligacy. Although less popular than subsidies, policy makers should also consider investing heavily in energy efficiency information and awareness campaigns, since awareness and knowledge play a key role in determining whether firms engage with energy efficiency at all and that in the decision-making process economics comes later. We found that 50% of retailers surveyed were unaware of energy efficiency policies applicable to their business. Therefore, the provision of information relating to energy efficiency technology would be an essential complement to any economic policy instrument. The current policies implemented in Ireland primarily provide financial and informational support for energy efficiency measures. However, the lack of awareness of these policies could be undermining their effectiveness.

Integrating factors such as the barriers, drivers and perceptions and attitudes towards policy does not replace or outweigh the requirement for integrating cost benefit analysis in policy development, with cost effectiveness and efficiency remaining primary conditions for policy development. However, this study argues that more emphasis needs to be placed on methods to incorporate the individual factors of the energy consumer to ensure that policies are not only cost effective and efficient but targeted and acceptable.

The findings from this research should be beneficial for stakeholders in the energy efficiency industry who know the payback time of their products and could now market specific technologies to SME's based on these findings. For policy makers these findings are useful as it can support the adoption of financial incentives which result in acceptable payback times therefore promoting the adoption of energy efficiency technologies.

Further research is required across different sub-sectors of the services sector and different locations. This will establish a more comprehensive awareness of the priorities and circumstances of businesses for whom future energy efficiency policy can be targeted. This strengthens the argument that a deeper understanding of the businesses environment by policy makers is useful to develop effective energy efficiency policies. In addition, the questionnaire and interview methodologies applied in this research are somewhat subjective and therefore the results may be somwhat dependent on the individual participants involved. Future research in this area could also utilise alternative data such as financial reports and energy audits to determine the significance of barriers and drivers objectively.

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