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Drivers of Energy Efficiency in Small Companies

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Abstract

Despite the economic relevance of SMEs, which represent 99% of all companies in the European Union, only few studies have investigated the drivers of energy efficiency among them. While the focus of former studies lays on larger industrial SMEs with high turnovers and a high level of automation, this study focuses on the drivers of energy efficiency measures in smaller SMEs with comparatively low turnovers. Using in-depth interviews and a survey, I compare the importance of different drivers generally and to the results of former studies. The results suggest that management's environmental sensitivity is a key driver for energy efficiency measures in small companies with low turnovers which is mainly due to missing in-house capacities. These missing in-house capacities are also one of the reasons for the low importance of financial support programs. Instead, proactive and firm-specific consultations by external consultants are important drivers for smaller companies with low turnovers at certain points in time. Larger companies, on the other hand, prefer acquiring general information from outside in order to build up their in-house capacities. In these companies, financial support programs play a more important role in energy efficiency investments. Overall, the results suggest that in order to reach small companies, policymakers should focus on information campaigns to initiate management's own motivation. Furthermore, public financing programs should be customized according to the needs of these smaller companies by reducing the bureaucratic burden. In addition, offering firm-specific consultancy and close partnership should also be effective, whereas, for larger companies with high turnovers and high-cost investments, general information and support should be provided.

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1. Introduction

As a means of addressing climate change, the European Union set the goal to reduce energy consumption by 20% by the year 2020 (Dukan 2019). According to recent analyses, this goal will not be reached. However, the goal to reduce energy consumption and hazardous greenhouse gas (GHG) emissions remains one of the most important challenges on the political agenda. The new President of the European Commission, Ursula von der Leyen, has therefore declared the reduction of hazardous greenhouse gas emissions as the highest political priority and called for Europe to follow the energy-efficiency-first principle (Council of the European Union 2019). As SMEs represent 99% of all companies in the European Union (European Commission 2019), they need to be at the center of attention when discussing the promotion of energy efficiency measures as well as the reduction of carbon emissions in the private sector. However, SMEs often do not have the financial or temporal capacities to acquire the needed information to plan and finally implement energy efficiency measures in order to achieve major energy savings. In this context, it is of utmost importance to know how SMEs of different branches, sizes, scales of turnover and energy-intensity react and which factors are able to effectively drive energy efficiency measures.

So far, studies have focused almost exclusively on the barriers to energy efficiency in SMEs (Arens et al. 2017; Trianni and Cagno 2012; Sudhakara Reddy 2013; Hasanbeigi et al. 2009; Thollander and Ottoson 2008; de Groot et al. 2001; Önüt and Soner 2007) and found the lack of information and time as well as the costs or risks of production disruptions as the main barriers to energy efficiency investments.

While the barriers have already been widely analyzed, the drivers have so far been mostly neglected. Yet, in order to promote energy efficiency in SMEs, it could be more useful to know which factors foster energy efficiency in SMEs. There are only few studies which focus on certain drivers of energy efficiency in SMEs (Arens et al. 2017; Cagno and Trianni 2013; Tanaka 2011; Önüt and Soner 2007; Reddy and Assenza 2007). These studies considered mainly larger industrial companies with higher revenues which is probably due to the higher CO_2 emissions expected from larger industrial SMEs. However, in order to achieve the ambitious goals for mitigating climate change, all SMEs, including small, very small companies as well as those with lower turnovers and revenues, have to reduce their greenhouse gas emissions. Thus, there is the need for research to address these companies, too. Another limitation in the studies already carried out is that they focused on specific drivers, instead of comparing the effectiveness of the different drivers with each other.

Cagno and Trianni (2013) approached this by analyzing drivers of energy efficiency in 71 Italian manufacturing SMEs. After a comprehensive review of literature on drivers of energy efficiency in SMEs, they identified 14 drivers with allowances, public financing and external pressures being the major ones. Furthermore, the results suggested that there were differences in the drivers for energy efficiency depending on the size of the firms. However, the authors pointed out that the sample used was biased towards larger industrial SMEs with a high turnover.

Therefore, this study focuses on companies in segments of the SME sector which are often characterized by small companies with low turnovers. Understanding the needs of these companies and the drivers of energy efficiency within them is considered important for a holistic approach to promoting energy efficiency measures. Thus, the study analyzes the importance of the different drivers of energy efficiency measures in predominantly small companies.

For this purpose, qualitative methods are used consisting of in-depth expert interviews as well as a survey conducted in 80 companies which is extended by undertaking exploratory interviews in these same companies. The survey is based on that of Cagno and Trianni (2013) in order to make the results directly comparable to those for larger companies.

Due to the lack of theoretical groundwork and previous empirical studies, I choose an exploratory qualitative research method. This approach, while not leading to representative results in a statistical sense, provides some initial evidence for a specific and highly relevant sector and its SMEs. This evidence is used to generate hypotheses which can and should be tested by future quantitative studies to substantiate the drivers of energy efficient measures in SMEs identified in this study.

The remainder of this paper is structured as follows: Chapter 2 gives an overview of the methods, the sample specifics and description of the drivers used. The results are presented and discussed in Chapter 3 before the conclusions are drawn in Chapter 4. Tables of the results can be found in the appendix.

2. Method

2.1. Method

This study uses qualitative methods extended by a survey. In the first stage, in-depth expert interviews with energy efficiency consultants are conducted in order to obtain information on the relevant factors driving energy efficiency in small companies. In the second stage, a survey

based on the framework introduced by Cagno and Trianni (2013) is conducted and extended by exploratory interviews with the companies.

I consider 80 SMEs of different branches which are typically dominated by very small companies as well as those with low turnover and, thus, comparatively lower levels of profitability. Fifty-five of the companies were chosen randomly on the 2019 International Fair of Crafts and Trade in Munich. The other 25 companies were contacted by energy efficiency experts from the chambers of crafts and trade in order to reach companies from different branches. Only companies which implemented an energy efficiency measure within the past five years or had one planned for the upcoming one are considered for the survey. The interviews were conducted by myself and a trained student assistant so I was able to guarantee the correct classification of the answers given by the companies. Additionally, due to the open and exploratory nature of the interviews, I was able to receive more information on other factors which had not been considered in the survey.

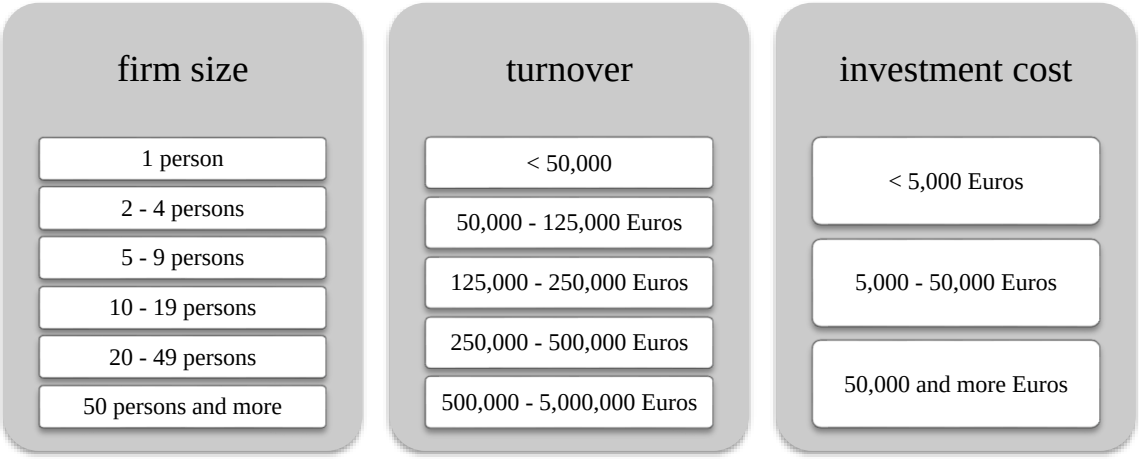
First, the companies were asked to define which energy efficiency measures they had undertaken in the past five years, while the second question asked for the overall costs of those investments. After these two entry questions, the importance of the different drivers were queried which will be presented in Chapter 2, Section 3. In order to make the results comparable to those of Cagno and Trianni (2013), I use the same drivers plus others as well as a four point Likert Scale with 1= not important, 2 = less important, 3 = somewhat important, and 4 = very important.[1]

The last part of the survey aimed at collecting company data to allow a statistical analysis. Questions were asked about the number of employees, turnover, the branch as well as the costs for last year's energy consumption. This way, the companies are assigned to different categories. Hence, I am able to present not only the general results, but also those related to firm size, turnover, energy-intensity and investment costs.

While Cagno and Trianni (2013) divided their sample into SEs (small enterprises) and MEs (medium –sized enterprises), my sample allow for a more detailed approach using six categories of company sizes.[2] Furthermore, I analyze the answers according to turnover, energy-intensity as well as the investment costs. Figure 1 displays the different categories defined for the analysis by firm size, turnover and investment costs.

[1] The four point Likert Scale using 1= not important, 2 = less important, 3 = somewhat important, and 4 = very important also represent the answer options.
[2] These classes are defined according to the definition of firm size classes by the Federal Statistical Office and the Crafts Census.

Figure 1
Definition of firm size, turnover and investment cost classes



2.2. Sample Specifics

The sample's particularity is that it consists of small companies with low turnovers. The majority of them are small companies with 1 to 19 employees. Only 10 companies had 50 or more employees. The average turnover per employee in these professions is around 110,000 Euros, while the average turnover per enterprise is approximately 1,000,000 Euros (Federal and State Statistical Offices 2019). Considering that in larger industrial companies turnover per employee is on average around 290,000 Euros and 39,000,000 per enterprise, the companies in this sample have to be considered as low turnover ones (Federal and State Statistical Offices 2019). Hence, the companies considered are those for which energy efficiency investments pose a larger financial burden.

Table 1 presents the different professions represented in the sample and the superordinate branches with the number of observations in the sample.

Table 1
Sample Structure

No	Branch	Examples of professions	Number of observations in the sample
I	Construction	Bricklayer and Concreter, Stonemason, Construction, Roofer	8
II	Finishing craft	Painter, Lacquerer, Installer and Heating Fitter, Electric Technician, Stove and Air Heating Mechanic, Carpenter,	22
III	Crafts for commercial needs	Metal Worker, Surgical Instrument Maker, Precision Engineer, Refrigeration Mechanic	15
IV	Motor Trades and Repairs	Automotive Mechatronics Technician	5
V	Food trades	Baker, Butcher, Pastry-cook	5
VI	Health trades	Dental Technician	2
VII	Crafts for private use	Hairdresser, Glass Blower, Locksmith, Smith, Ceramist	9

2.3. Drivers of energy efficiency in SMEs

The drivers used for the survey are based on those used by Cagno and Trianni (2013) who conducted a comprehensive literature review on the barriers and drivers of energy efficiency measures in SMEs. From this they derived 14 drivers based on the results from studies by Saygin et al. (2011); Thollander and Dotzauer (2010); Thollander and Ottoson (2008); CankaKilic and Kaya (2007); Reddy and Assenza (2007); del Rio Gonzalez (2005); Anderson and Newell (2004); Galitsky et al. (2004); de Groot et al. (2001); Worrell and Price (2001). Table 2 summarizes these 14 drivers (column 2) with a short description of each in column 3.[3]

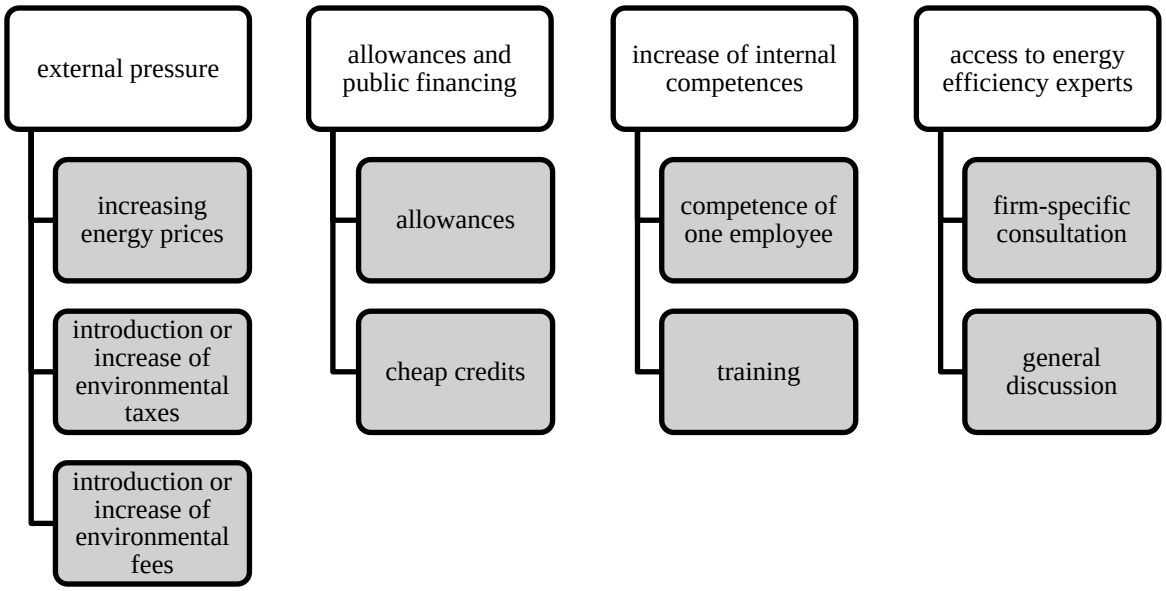
Table 2
Drivers for energy efficiency in SMEs used in the survey

No.	Driver	Description / sub-driver
1	Management sensitivity	Environmentally sensitized decision-maker / CEO / owner of the company
2	External Pressure	
		A: Increasing energy prices
		B: Introduction / increases of fees on energy sources or pollution / emissions
		C: Introduction / increases of taxes on energy sources, pollution or emissions
3	Clients	Clients interested in and valuing energy efficiency or environmental protection
4	Information on interventions	Information on experiences of other similar companies which have successfully implemented energy efficiency measures
5	Information on practices	Information on energy efficient behavior
6	Lower costs of consultancies	Importance of low-cost or free energy efficiency consultation
7	Access to energy efficiency experts	Importance of consultation about energy efficiency measures in own company
		A: Firm-specific consultancy
		B: General discussion about energy efficiency
8	Increase of internal competences	A: One employee: Competences of one employee being responsible for energy efficiency issues and searching for information on energy efficiency
		B: Training: Employee attending training in energy efficiency
9	Energy performance contracts	Energy performance contracting
10	Allowances or public financing	A: Allowances: Governmental allowances, financial grants, tax allowances
		B: Cheap credits: Access to cheap credits
11	Long-term benefits	Long-term benefits
12	New solutions	Developing own energy efficiency solutions
13	Anticipating regulatory issues	Anticipating planned or expected regulatory requirements
14	Great ambition and entrepreneurial mind	Open-mindedness of decision maker / management / owner for the adoption of new technologies
I		A: Initial idea of energy efficiency measure came from within the company
		B: Initial idea of energy efficiency measure came from outside the company
II		External consultation was decisive for final decision for the energy efficiency measure
III		One person in the company in charge of energy efficiency issues and searching for information

[3] For further description of the drivers see Cagno and Trianni (2013 p. 270).

I use sub-drivers to obtain more detailed results instead of only using the different drivers, namely, ‘external pressure’, ‘allowances and public financing’, ‘increase of internal competence’ and ‘access to energy efficiency experts’ (see Figure 2).

Figure 2
Sub-division of Drivers for energy efficiency in SMEs



Thus, ‘external pressure’ is sub-divided into ‘increasing energy prices’, ‘the introduction or increase of environmental fees’ on energy sources, pollution or emissions as well as ‘the introduction or increase of environmental taxes’ on energy sources, pollution or emissions in order to gather information on whether taxes, fees or prices are more relevant to the implementation of energy efficiency measures. The driver ‘allowances or public financing’ is divided into ‘allowances’ (including governmental allowances, financial grants and tax allowances) and ‘cheap credits’ as this sub-division is essential for policy makers in order to know which financial support programs to focus on. Furthermore, ‘increase of internal competencies’ is divided into the drivers ‘competencies of one employee’ and ‘training’. The former means one employee being responsible for energy efficiency issues and searching for information on the topic energy efficiency while the latter is controlling for the importance of employees attending training.

Finally, the driver ‘access to energy efficiency experts’ is split into ‘firm-specific consultation’ and ‘general discussion’ in order to determine whether it is more important for companies to receive firm-specific consultation or if they preferred general information on energy efficiency measures.

The last two subdivisions of the drives were added as the expert interviews suggested differences in the importance of the sub-drivers for SMEs. The expert interviews further pointed to the important role of external consultation for the company's decisions for adopting energy efficiency measures. Therefore, the following polar questions were added to the survey:

I. Did the initial idea for the energy efficiency measure come from within or outside the company?

This question allows me to draw conclusions on whether companies actually have an intrinsic motivation to invest in energy efficiency measure or whether its motivation first came from outside. The latter would imply a stronger focus on proactive information for SMEs.

II. Was external consultation decisive for the final decision for adopting an energy efficiency measure?

Although I control for the importance of access to energy efficiency experts and the costs of consultation, this question aims at learning whether a consultant brought to the company's attention the opportunities for energy efficiency measures and if this finally triggered the energy efficiency investment. If this was the case, it would indicate that the consultation was the decisive factor that led to the final decision for adopting an energy efficiency measure. This would imply stronger support for consultation regarding energy efficiency in SMEs.

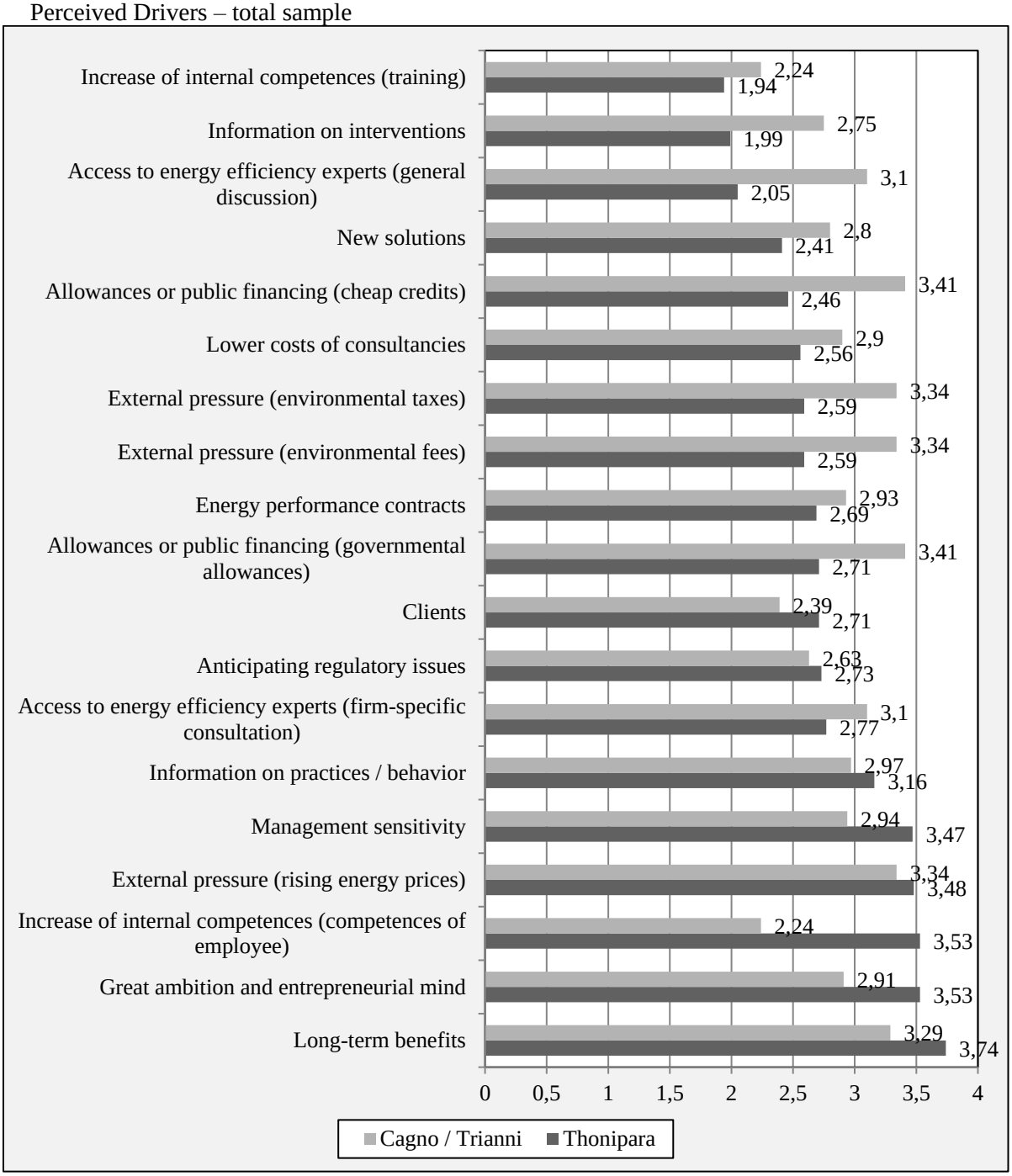
III. Is one employee or person responsible for energy efficiency issues by focusing particularly on this in the company and searching for such information, if needed?

If the company answered the question in the positive, they were further asked whether the competencies of this employee were important for the implementation of the energy efficiency measure ['increasing internal competencies (one employee)'].

3. Results

Figure 3 shows the results of the analysis using the data from all the companies. The drivers are ranked according to their importance for the companies with "1" meaning being not important at all and "4" being very important. The scores for each driver of Cagno and Trianni's study are represented by the light grey bars. The detailed results of the analysis by firm size (Table A1), turnover (Table A2) and energy intensity (Table A3) as well as investment costs (Table A4) are reported in the appendix.

Figure 3
Perceived Drivers – total sample



Note: "1" meaning "not important", "2" meaning "less important", "3" meaning "somewhat important" and "4" meaning "very important"

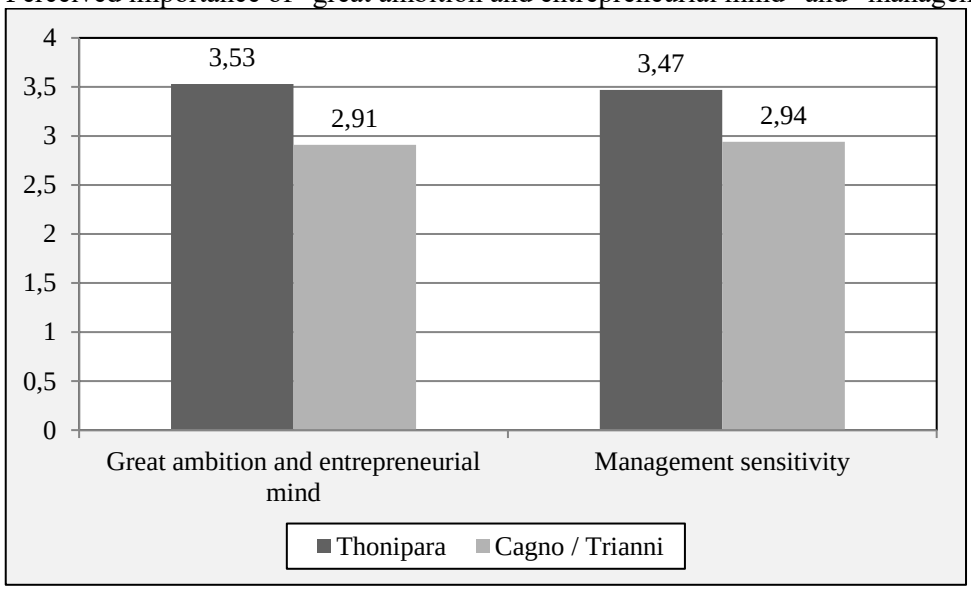
From the carried out analysis following results are obtained:

3.1. Management Characteristics

In this sample of small companies with low turnovers, 'management sensitivity' and 'great ambition and entrepreneurial mind', hence, management characteristics are ranked among the highest drivers, whereas these same drivers played a rather average role in the sample used by Cagno and Trianni (see Figure 4). The results show that even for very high investment costs,

management sensitivity was a very important driver. Thus, whether an energy efficiency measure is implemented or not is to a large extent dependent on the open-mindedness of the decision-maker toward the adoption of new technologies as well as the environmental sensitivity of this person. Within the sample, management sensitivity to environmental issues was ranked as the most important driver (4.00) by all one-person companies, all small companies with 10-19 employees (Table A1), and by all companies with low turnovers (< 50,000 Euros, Table A2). This is further evidence of the special importance of management sensitivity in small companies.

Figure 4
Perceived importance of "great ambition and entrepreneurial mind" and "management sensitivity"



Note: "1" meaning "not important", "2" meaning "less important", "3" meaning "somewhat important" and "4" meaning "very important"

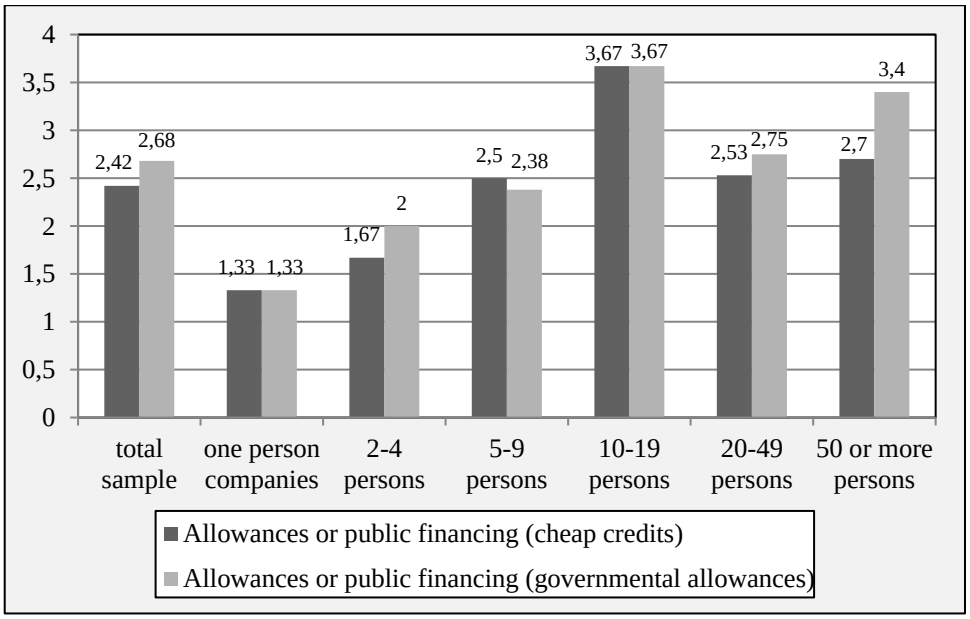
The interviews suggest that this is due to a lack of time and missing in-house capacities. Small companies, compared to larger ones, often do not have one or several employees who are in charge of energy efficiency matters. This argument is also reflected in the analysis of survey Question *III*. In small companies with up to four persons, only 25-33% have one employee responsible for energy efficiency matters and, with an increase in firm size, this number becomes larger. In companies with 50 or more persons, 78% of them have one person in charge of energy efficiency. Hence, with no employees assigned the responsibility for energy efficiency, decisions about the matter depends largely on the manager's motivation and environmental sensitivity.

Result 1: In small companies, energy efficiency measures are primarily driven by management's sensitivity.

3.2. Financial Support Programs

'Allowances and public financing' were perceived as the main driver in Cagno and Trianni's (2013) sample, while for this study, they were ranked below average with allowances being considerably more important than low-cost credits. This could be due to the fact that credits have been historically low in Germany in the past ten years. One would expect governmental allowances and financial support to be very important for small companies and those with low turnover. However, the results (see Figure 5) show that financial support by governmental allowances or low-cost credits did not play a role in one-person companies (1.33) and a rather subordinated one in small companies with up to 9 persons (1.67 – 2.50), whereas, they played a leading role in companies with 10-19 persons (3.67) and with more persons (~3.5).

Figure 5
Perceived importance of allowances or public financing



Note: "1" meaning "not important", "2" meaning "less important", "3" meaning "somewhat important" and "4" meaning "very important"

The analysis by firm size, turnover and investment costs further reasserts that public financing becomes more important with increasing firm size, turnover and investment costs. From the exploratory interviews and the survey, two explanations for these results are possible. First of all, the median values of investment costs show that smaller companies invest rather low sums in energy efficiency measures, whereas investment costs increase with the firm size. For example, a one-person company invests about 1,350 Euros and a company with more than 50 employees around 250,000 Euros. Furthermore, the results show that allowances and cheap credits were important drivers for high cost investments starting from 5,000 up to 500,000 Euros. For

investments with lower costs than 5,000 Euros, allowances and cheap credits were not important for investments. Thus, the low importance of public financing in small companies could be explained by the low investment costs for which no public financial support is needed. However, another factor is brought up by the companies during the in-depth interviews.

The exploratory interviews revealed that many of the interviewees do not feel that their needs were addressed by governmental allowances which seemed to be aimed at the bigger companies. On my broaching the subject again, the companies stated that the administrative burden was one of the main obstacles. The fixed costs for the applications for support programs are perceived more burdensome by smaller companies as in most cases, they are not likely to have one employee who specialized in applying for public financial support. On the other hand, the larger companies have the ability to overcome these hurdles as they can more easily dedicate an employee to the task. Thus, a lack of allowance or public financing programs tailored to the needs of smaller firms (with higher flexibility, lower bureaucratic burdens, and the inclusion of small investments) could be a reason for this driver's low score.

Again, these results point to the absence of in-house capacities in smaller firms compared to the larger ones which are able to put these in place for the application for public financial support programs.

Result 2: Financial support programs are less relevant for smaller SMEs due to missing in-house capacities and the high bureaucratic burdens.

3.3. Long-term benefits

The vast majority of the companies interviewed considered long-term benefits as a very important driver of energy efficiency measures in SMEs. This driver was also ranked high (rank 3) by the sample of Cagno and Trianni's study. They explain the importance of this driver as a strategic factor that would increase the company's competitiveness by reducing costs in the future. This argument was also brought forward by Cote et al. (2006), Thollander and Ottoson (2008) as well as Hasanbeigi et al. (2009).

For the SMEs considered in this study, this driver needs to be interpreted in a slightly different way as the exploratory interviews showed. For the interviewed companies long-term benefits does not necessarily mean a competitive advantage but rather the importance of the investment being paid off at all at some point in the future as the amortization time is longer in these companies. This is for two reasons. First, for the occupations represented in this sample, machines are only used for about 8 hours per day and stand idle during the other 16 hours. There are no night shifts as it is the case in larger industrial manufacturing companies with a high

level of automation. Therefore, the amortisation time takes about two to three times longer for these small companies (Schwartz and Weiss 2013). Second, the occupations considered in this study have high energy costs related to their revenues, however, these were comparatively lower when compared to other industrial companies. This means that the investments in energy efficiency measures create a higher financial burden and increases in their competitiveness can hardly be reached. Thus, long-term benefits are extremely important, in the sense of the investment costs being paid off. For this reason, some of the companies stated that larger investments are often done only as part of a replacement investment for which the costs would nevertheless have occurred.

Hence, the results suggest that small companies, unlike larger ones, do not constantly think about efficiency improvements and cost advantages gained through energy efficiency measures. Instead, they have a discrete point in time when replacement investments are necessary. Therefore, it is essential for policymakers to know these special moments in time as they are very important with regard to the openness of small companies to receive information or consultation on energy efficiency measures.

Result 3: **In small companies with low turnover, energy efficiency measures are implemented as part of replacement investments**.

3.4. Role of external consultants and access to information

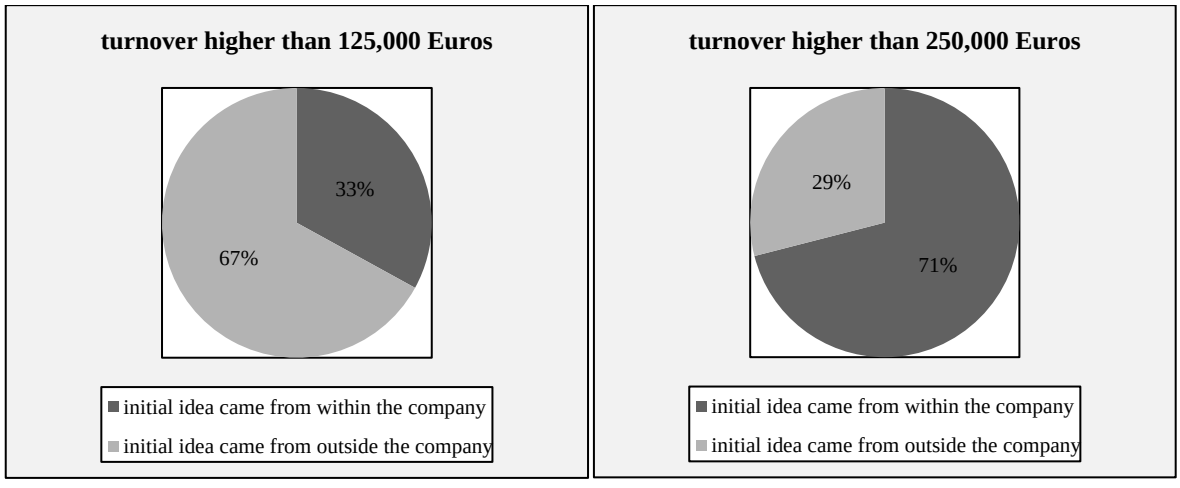
As Chapter 3.3 showed, it is essential to know at which point in time small companies need consultation and so here, the findings of the form of consultation are analyzed. The analysis shows that although access to energy efficiency experts is overall not ranked as high as in the sample by Cagno and Trianni (2013), a clear difference between general consultation (2.05) and firm-specific consultation (2.77) can be noticed. The subdivision into two drivers shows clearly that firm-specific consultancy is noticeably more conducive to the implementation of energy efficiency measures in smaller companies than general access to an energy efficiency expert or the general discussion about energy efficiency issues in a company with an energy efficiency expert.

On the other hand, factors which provide general information, such as, a lower cost of consultancy, talking to energy efficiency experts about general energy efficiency issues, and the training of employees in energy efficiency were for these companies relatively more important drivers than in smaller companies with low turnovers for which firm-specific consultancy was more important. This suggests that larger companies use different methods in order to increase internal competencies in order to prepare and plan an energy efficiency measure on their own.

This concurs with the results presented in Chapter 3.2 which showed that building up in-house capacities could be more cost-effective in the long-run for larger companies which have the capacity to have one employee dedicated to energy efficiency issues and acquiring information. By continuously optimizing, applying for financial support and becoming more energy efficient, these companies can reduce their costs and become more competitive.

Furthermore, the results suggest the presence of strong differences between companies with low turnovers and larger ones with higher turnovers in the terms of the role of external consultation. For 67% of the companies with a turnover of less than 125,000 Euros, the initial idea of an energy efficiency measure came from outside the company. In addition to this, in 75% of the companies with a turnover between 50,000 and 125,000 Euros, external consultation was decisive in the implementation of an energy efficiency measure. Thus, whether an energy efficiency investment was implemented or not was highly dependent on the role of external consultants. In contrast to this, the results show that in the companies with more employees and higher turnovers and/or higher investment costs, the initial idea for an energy efficiency measure comes in almost all cases from within the companies. In these companies, external energy consultants did not have a triggering effect on the implementation of an energy efficiency measure. However, the companies use information from outside in order to build up in-house capacity. General consultation was conducive to this, but not for triggering it.

Figure 6
Share of companies with initial idea from within or outside the company by turnover



Therefore, these results combined with those of Chapters 3.1.-3.3, would seem to suggest that small companies do not want to build up in-house-capacities with regards to information on energy efficiency measures. Instead, these companies have certain points in time when replacement investments are necessary. At these moments, small companies need concrete, firm-

specific consultation for this particular investment which would be a more rational and cost-efficient way for them than building up in-house capacities in the long run. Larger companies, on the other hand, use general information from outside to build up their in-house capacities.

Result 4: Proactive and firm-specific consultation by external consultants at specific points in time is particularly important for small companies with low turnovers.

Result 5: Building up in-house capacity and acquiring information are important drivers for energy efficiency measures in larger companies with higher turnover.

4. Conclusion and implications for policy and research

This paper analyzed the importance of different drivers of energy efficiency in SMEs and serves the purpose to generate hypotheses for further research. As former studies have focused on larger SMEs with higher turnovers, this one uses a sample of smaller SMEs with lower turnovers. The method used for the research is based on Cagno and Trianni's (2013) study on the drivers of energy efficiency in high-turnover and high-tech industrial SMEs. This was done in order to allow for a direct comparison between the samples in both studies. Additionally, I also conducted in-depth expert interviews and a survey extended by open and exploratory interviews with the companies.

While Cagno and Trianni (2013) argue that energy efficiency measures were mainly driven by financial support programs and other economic drivers as a strategic step towards more competitiveness. However, the results of this study suggest that managerial characteristics are more important for small companies with low turnovers. This is due to the missing in-house capacities in smaller SMEs which then requires management's own motivation or environmental sensitivity for initiating energy efficiency measures. These missing in-house capacities are also one reason for the low importance of financial support programs which are not attractive to small companies due to their high bureaucratic burden. Instead, smaller companies with low turnovers appreciate firm-specific consultancy by external consultants at a certain point in time when replacement investments are necessary. On the other hand, larger companies build up long term in-house capacities by acquiring general information. These in-house capacities are particularly important for applications for public financial support programs which are a key driver in larger companies. Given that these companies are in most cases, intrinsically motivated and external

consultants play a minor role, building up in-house capacities is essential for continuous energy efficiency improvements.

The results can be summed up in five preliminary conclusions which should be understood as hypotheses which further quantitative research should validate:

Result 1: In small companies, energy efficiency measures are primarily driven by management sensitivity.

Result 2: Financial support is less relevant for smaller SMEs due to missing in-house capacities and high bureaucratic burdens.

Result 3: In small companies with low turnover, energy efficiency measures are implemented as part of replacement investments.

Result 4: Proactive and firm-specific consultation by external consultants at definite points in time is particularly important for small companies with low turnovers.

Result 5: Building up in-house capacity and acquiring information is an important driver for energy efficiency measures in larger companies with higher turnover.

The results have several implications for policies promoting energy efficiency measures in SMEs. First, the results suggest that policymakers should focus on tools targeting the management's sensitivity as most energy efficiency measures are driven by the management's own motivation. This could be done by having campaigns to disseminate information and raise awareness through consultations with chambers of crafts and by holding information events or showcases.

Second, policymakers can further promote investments in high-cost energy efficiency measures through public financing programs which should be designed more flexibly and be less bureaucratic. This could motivate smaller companies to take advantage of these programs as they have so far perceived public financing programs as not being suitable for their firm size. Higher acceptance could also be achieved by marketing activities targeted specifically at these small businesses. The analysis shows that larger companies, companies with high turnover and investment costs can best be supported by general information and mentoring programs Therefore, for smaller companies and those with lower turnover, policymakers should focus on firm-specific consultancy and close partnership during the planning and implementation process. In these companies, it would also be advisable to proactively approach the companies and suggest company specific energy efficiency measures because the first idea for doing this often comes from outside the company.

Last but not least, moments in time play an important role. The findings from the study suggest that small companies only become involved in energy efficiency measures once replacement investments are necessary. At this specific point in time, small companies need firm-specific consultation. Hence, it would be necessary to reach the companies at this very moment in time.

With the results, I contribute to the general understanding of the drivers of energy efficiency in SMEs. Earlier research focused on high-tech, high-turnover and larger companies, therefore, these results are a first step towards a more comprehensive understanding of the drivers of energy efficiency in SMEs by shedding light on SMEs that are smaller, mostly labor-intensive, and with low turnover. The exploratory and qualitative approach of this study, however, does not allow drawing representative conclusions. Therefore, the results should be understood as hypotheses which should be validated by a broader quantitative analysis.

Given that the results have shown that the effects brought about by firm size often correlated with those from turnover size and investment costs, it would be necessary to further quantitatively assess whether the effects are driven by firm size, turnover or investment costs. For this purpose, an instrumental variable approach could enhance clearer assertions.

In light of the current global efforts to reduce carbon dioxide emissions and the urgency to mitigate climate change, the findings from this study serve as a valuable contribution to the body of knowledge about how to achieve a low carbon and energy efficient SME sector.

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Appendix

Table A1
Perceived drivers in companies by firm size

Rank	Driver	Total sample	one person N=3	2-4 persons N=9	5-9 persons N=16	10-19 persons N=16	20-49 persons N=16	50 or more persons N=10
1	Long-term benefits	3.73	3.33	3.44	3.75	3.67	4.00	3.78
2	Great ambition and entrepreneurial mind	3.55	3.33	3.63	3.50	3.67	3.50	3.70
3	Increase of internal competences (competences of employee)	3.53	1.00	4.00	3.67	3.00	3.29	3.43
4	External pressure (rising energy prices)	3.47	2.67	3.78	3.63	3.33	3.38	3.50
5	Management sensitivity	3.46	4.00	3.22	3.56	4.00	3.38	3.40
6	Information on practices / behavior	3.16	3.00	2.75	3.38	3.67	3.00	3.40
7	Access to energy efficiency expert (consultancy)	2.77	3.00	2.00	2.50	2.00	3.33	2.60
8	Anticipating regulatory issues	2.73	1.67	2.50	2.81	3.00	2.81	3.10
9	Clients	2.72	1.67	2.89	2.56	3.33	2.69	3.30
10	Energy performance contracts	2.68	1.33	3.00	2.75	3.00	3.19	2.30
11	Allowances or public financing (governmental allowances)	2.68	1.33	2.00	2.38	3.67	2.75	3.40
12	Lower costs of consultancies	2.56	2.00	1.78	2.88	2.67	2.57	2.30
13	External pressure (environmental taxes)	2.55	2.00	3.00	2.47	2.67	2.25	2.67
14	External pressure (environmental fees)	2.55	2.33	2.22	2.73	3.33	2.38	2.30
15	Allowances or public financing (cheap credits)	2.42	1.33	1.67	2.50	3.67	2.53	2.70
16	New solutions	2.41	2.33	2.22	2.63	3.00	2.38	2.80
17	Access to energy efficiency experts (discuss / talk to …)	2.05	1.33	1.11	2.00	2.33	2.38	2.20
18	Information on interventions	1.99	2.33	1.67	1.69	3.00	2.19	2.30
19	Increase of internal competences (training)	1.94	1.00	1.50	1.94	2.00	1.75	2.38
	Idea of energy efficiency measure came from within the company	72%	67%	71%	71%	67%	75%	87%
	Idea of energy efficiency measure came from outside the company	28%	33%	29%	29%	33%	25%	13%
	Idea of energy efficiency measure came from external consultant	27%	33%	37%	13%	33%	21%	22%
	One person in company in charge of search for information on energy efficiency measures	56%	33%	25%	75%	33%	44%	78%
	Median of yearly energy costs	15,000	1,900	3,500	6,000	25,000	17,500	900,000
	Median of investment costs	16,000	1,350	3,000	11,500	16,000	105,00	250,000

Table A2
Perceived drivers in companies by turnover sizes

Rank	Driver	Total	less than 50,000 Euros N=4	50,000 – 125,000 Euros N=4	125,000 - 250,000 Euros N=3	250,000 – 500,000 Euros N=10	500,000 – 5,000,000 Euros N=32
1	Long-term benefits	3.73	4.00	3.50	3.33	3.40	3.81
2	Great ambition and entrepreneurial mind	3.55	4.00	3.67	3.33	3.20	3.59
3	Increase of internal competences (competences of employee)	3.53	4.00	3.00	4.00	4.00	3.56
4	External pressure (rising energy prices)	3.47	3.50	3.50	3.33	3.70	3.38
5	Management sensitivity	3.46	4.00	3.00	3.00	3.10	3.47
6	Information on practices / behavior	3.16	3.33	3.00	3.33	2.70	3.16
7	Access to energy efficiency experts (consultancy)	2.77	2.79	3.00	2.50	3.00	2.79
8	Anticipating regulatory issues	2.73	2.33	3.00	3.00	2.10	2.84
9	Clients	2.72	3.25	3.25	2.67	2.50	2.56
10	Energy performance contracts	2.68	2.50	3.25	2.67	2.30	2.75
11	Allowances or public financing (governmental allowances)	2.68	2.50	1.50	2.67	2.40	2.72
12	Lower costs of consultancies	2.56	3.25	1.00	3.33	2.70	2.58
13	External pressure (environmental taxes)	2.55	3.25	2.50	2.00	2.60	2.48
14	External pressure (environmental fees)	2.55	3.00	2.00	2.00	2.70	2.66
15	Allowances or public financing (cheap credits)	2.42	2.00	1.50	2.67	2.30	2.42
16	New solutions	2.41	3.50	2.25	2.67	1.60	2.50
17	Access to energy efficiency experts (discuss / talk to …)	2.05	1.25	1.00	3.00	2.40	2.19
18	Information on interventions	1.99	1.75	2.25	2.00	2.10	1.91
19	Increase of internal competences (training)	1.94	2.67	1.25	1.33	1.80	1.88
	Idea of energy efficiency measure came from within the company	72%	33%	33%	67%	70%	71%
	Idea of energy efficiency measure came from outside the company	28%	67%	67%	33%	30%	29%
	Idea of energy efficiency measure came from external consultant	27%	33%	75%	33%	30%	28%
	One person in company in charge of search for information on energy efficiency measures	56%	33%	75%	33%	50%	50%
	Median of yearly energy costs	15,000	2,750	1,300	18,750	5,000	20,000
	Median of investment costs	16,000	1,000	2,500	6,400	5,000	41,000

Table A3
Perceived drivers in *energy intensive* companies

Rank	Driver	Total	energy intensive companies N=26	not energy intensive companies N=40
1	Long-term benefits	3.73	3.73	3.78
2	Great ambition and entrepreneurial mind	3.55	3.31	3.65
3	Increase of internal competences (competences of employee)	3.53	3.36	3.52
4	External pressure (rising energy prices)	3.47	3.46	3.51
5	Management sensitivity	3.46	3.38	3.44
6	Information on practices / behavior	3.16	3.08	3.23
7	Access to energy efficiency experts (consultancy)	2.77	2.53	3.33
8	Anticipating regulatory issues	2.73	2.54	2.83
9	Clients	2.72	2.46	2.90
10	Energy performance contracts	2.68	2.81	2.68
11	Allowances or public financing (governmental allowances)	2.68	2.73	2.66
12	Lower costs of consultancies	2.56	2.68	2.38
13	External pressure (environmental taxes)	2.55	2.38	2.69
14	External pressure (environmental fees)	2.55	2.38	2.73
15	Allowances or public financing (cheap credits)	2.42	2.60	2.32
16	New solutions	2.41	2.31	2.41
17	Access to energy efficiency experts (discuss / talk to …)	2.05	2.38	1.78
18	Information on interventions	1.99	2.38	1.80
19	Increase of internal competences (training)	1.94	1.84	1.95
	Idea of energy efficiency measure came from within the company	72%	100%	58%
	Idea of energy efficiency measure came from outside the company	28%	0%	42%
	Idea of energy efficiency measure came from external consultant	27%	37%	21%
	One person in company in charge of search for information on energy efficiency measures	56%	44%	55%
	Median of yearly energy costs	15,000	31,800	7,000
	Median of investment costs	16,000	20,000	12,500

Table A4
Perceived drivers in companies with energy efficiency investment costs of

Rank	Driver	Total	up to 5,000 Euros N=18	5,000 Euros – 50,000 Euros N=20	more than 50,000 Euros N=15
1	Long-term benefits	3.73	3.73	3.78	
2	Great ambition and entrepreneurial mind	3.55	3.57	3.50	3.67
3	Increase of internal competences (competences of employee)	3.53	3.29	3.64	3.67
4	External pressure (rising energy prices)	3.47	3.50	3.50	3.80
5	Management sensitivity	3.46	3.43	3.50	3.33
6	Information on practices / behavior	3.16	3.08	3.16	3.27
7	Access to energy efficiency experts (consultancy)	2.77	3.00	2.46	2.75
8	Anticipating regulatory issues	2.73	2.85	2.32	3.20
9	Clients	2.72	3.21	2.65	2.93
10	Energy performance contracts	2.68	2.86	2.80	3.07
11	Allowances or public financing (governmental allowances)	2.68	2.14	2.90	3.13
12	Lower costs of consultancies	2.56	2.15	2.79	2.60
13	External pressure (environmental taxes)	2.55	3.21	2.35	2.87
14	External pressure (environmental fees)	2.55	2.93	2.55	3.00
15	Allowances or public financing (cheap credits)	2.42	2.50	2.50	2.93
16	New solutions	2.41	2.23	2.74	2.73
17	Access to energy efficiency experts (discuss / talk to …)	2.05	1.46	2.63	2.40
18	Information on interventions	1.99	1.77	1.95	2.20
19	Increase of internal competences (training)	1.94	1.92	2.21	2.07
	Idea of energy efficiency measure came from within the company	72%	58%	67%	86%
	Idea of energy efficiency measure came from outside the company	28%	42%	33%	14%
	Idea of energy efficiency measure came from external consultant	27%	25%	42%	21%
	One person in company in charge of search for information on energy efficiency measures	56%	54%	58%	60%
	Median of yearly energy costs	15,000	2,750	20,000	31,210
	Median of investment costs	16,000	1,000	20,000	200,000