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The theoretical and practical motives for energy efficiency at SMEs and the effects on their business operations.

Energy Efficiency at SMEs in Fryslân

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Abstract

The term energy efficiency refers to the practice of using a smaller amount of energy to accomplish the same activity. There are numerous benefits to reducing greenhouse gas emissions, decreasing the demand for imported energy, and cutting our expenditures on a household and economy-wide basis. One of the most cost-effective initiatives a country can take is to improve energy efficiency. Lighting based on LEDs, for example, consumes less energy while yet delivering the same or better light output. The current study focuses on practical and theoretical approaches that are used by Small and Medium Enterprises (SMEs) in the province of Fryslân in the Netherlands. The research objective is to find out why small and medium enterprises in Fryslân do look for ways to improve their energy efficiency and what influence does this have on business operations of these enterprises. By doing a survey at small and medium enterprises in Fryslân we try to get the reason or reasons why they do or do not improve energy efficiency and to find out what influence energy improvement has on business operations.

The study utilizes three research questions, which are answered by means of conducting a comprehensive literature review and using surveys. Research question one: What drivers and barriers for energy efficiency in businesses are identified in literature and to what extend are they relevant for (which type of) SMEs? Research question two: How far, and why do SMEs do look for ways to improve energy efficiency, particular in the Dutch province of Fryslân? And research question three: Do measures to improve energy efficiency influence their business operations, and how is this related to their motives to look for improving energy efficiency? In order to answer the research questions identified, a mixed method approach was utilized, which included inductive methods and descriptive analysis. Content analysis of the literature was also utilized.

Results from the surveys and the literature analysis indicated that there are both benefits and barriers SMEs face when they try to implement energy efficiency programs. Additionally, the companies in the Netherlands that have utilized energy efficiency programs have been discussed. The research concluded that there are several energy efficiency related factors that influence business processes in companies in Fryslân. Companies that are already working on measures to improve energy efficiency can be directly linked to their motives to improve energy efficiency even more. Some companies are also opting for an energy system or energy certificate, and this may be directly related to companies' motives to improve energy efficiency.

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Acronyms list

CMS: climate change conference

CO2: carbon dioxide

EDE: European department of energy

EED: energy efficiency directive

EEMs: energy efficiency measures

EEP: energy efficiency plan

ESD: effort sharing decision

ETS: emission trade system

EV: electric vehicle

Fte: fulltime-equivalent

GHG: greenhouse gasses

IPCC: intergovernmental panel on climate change

IT: information technology

LED: light-emitting diode

MJA3/MEE: meerjarenafspraken energie-efficiëntie

n.d. : no date

PDCA: plan-do-check-act

R&D: research and development

RVO: rijksdienst voor ondernemend Nederland

SMEs: small and medium enterprises

TSO: transmission system operator

Acknowledgement

I would like to express my special thanks to professor Frans Coenen, who helped me through this thesis with tips, advice and guidance. Despite for the fact that it took me years and years to complete the thesis. For example, he taught me not to come up with an answer too quickly, but to describe topics and issues clearly and in detail. One of my biggest weaknesses, is that I can sometimes be too brief in my answers.

I also would like to thank my mother, who took the trouble to read through the thesis thoroughly and provide comments, despite finding it a sometimes tough and slow subject to get through. In addition, of course, I want to thank all the people who have given me advice or have been supporting me in one way or another.

I found it very interesting to research companies in the region where I reside personally. During the research, I learned a lot about what drives companies to improve energy efficiency. It was a small but positive surprise for me to find out that many companies do this mainly because they want to make the world a better place. This gives me hope that together we can solve the problems, which are coming our way due to climate change, loss of biodiversity and other environmental problems.

1 Introduction

In the introduction the background of the topic and the knowledge gap that is going to be addressed by the thesis are described. This leads to the goal and research questions of the thesis and how these research questions are going to be answered. Finally, in the last paragraph of the chapter the outline of the thesis is briefly described.

1.1 Background

As part of the European Energy Efficiency Directive (EED) large companies have to make audits of their energy consumption to help them identify ways to reduce it. The execution of this energy audit is mandatory for companies with more than 250 fulltime-equivalent (fte) or companies with a turnover of more than €50 million per year and an annual balance sheet total of more than €43 million, including participations in or by partner companies and affiliated companies. Small and medium-sized companies (SMEs), being smaller than 250 fte and having a lower turnover than mentioned previously, therefore have no obligation to carry out the EED audit.

In an energy audit, the energy flows within a company are mapped out. It analyses how much energy is consumed and what it is used for. The purpose of this audit is to provide insight into energy consumption as well as to raise awareness of the energy consumption. With this insight it can be made clear where energy is wasted and where energy saving opportunities are. In addition to saving energy, this can also be used by organizations to save on costs as energy can be a major expense.

Because companies that have to carry out the mandatory energy audit also have to carry out a chain analysis, i.e. suppliers, customers and distributors, there is a good chance that SMEs, being part of the chain, will (indirectly) have to deal with energy audits by having to look for ways to improve their energy efficiency as a result of this.

In addition to the EED, companies in the Netherlands have to deal with additional regulations relating to energy. For example, the Dutch law includes the *Energiebesparingsplicht en informatieplicht in het Activiteitenbesluit* (Energy Saving Obligation and Information Obligation in the Activities Decree). In this so-called Activities Decree it is included that the operator of a facility takes all energy saving measures that pay for themselves in five years or less. This only applies to commercial consumers above 50,000 kWh of electricity and above 25,000 m^3 of gas. In addition, there is the information obligation for organisations to report which energy saving measures they have taken. This reporting must take place every four years (Ministry of Infrastructure and Water Management, no date (n.d.)).

Furthermore, there are alternatives for carrying out an EED energy audit in the Netherlands in order to meet this obligation. One of the alternatives mentioned in the implementation decree is ISO 50001. ISO 50001 is a certification for energy management. In addition, the quality mark for CO2 reduction management scheme of SCCM (*Stichting Coördinatie Certificatie Managementsystemen voor milieu en gezond en veilig werken)* is mentioned, with this in combination with ISO 14001 the EED is also met. Whereas ISO 50001 mainly focuses on reducing energy consumption, ISO 14001 in combination with SCCM is based on the continuous reduction of energy usage and CO2 emissions from all environmental aspects. For the continuous reduction of energy consumption and CO2 emissions, the Plan-Do-Check-Act cycle (PDCA) is used (SCCM, n.d.). PDCA allows you to steer towards continuous improvement. It is a cyclical process approach consisting of four steps. Plan: plan how much and how you want to reduce energy/CO2. Do: carry out the plans you have made. Check: check whether you have actually achieved what you had planned. Act: if you have not achieved what was planned, make adjustments or take measures to achieve the desired result (Nieuwenhuis, 2010).

After the four steps have been performed, it is then again possible to start at step 1. New, and more ambitious goals can be set. Often when executing the steps of the cycle, new ways of further improving a process are already found/seen. In theory this then leads to a follow-up with sharper goals and other methods for process improvement.

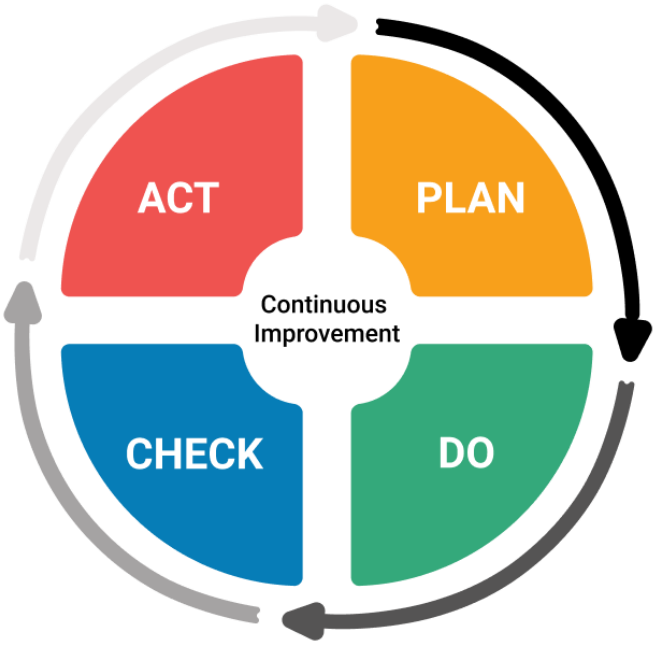


Figure 1.1 Plan-Do-Check-Act cycle (Deming, W. Edwards, 1986)

The Netherlands also has the Long-Term Energy Efficiency Agreements (MJA-3) and the Energy Efficiency of ETS (Emission Trade System) companies (MEE) covenant. Companies are required to draw up an Energy Efficiency Plan (EEP). Both the MJA-3 and the MEE will expire in 2020. Companies that take part in this now must determine for themselves whether they will fall within the EED or within the Energy Saving Obligation and Information Obligation in the Activities Decree.

In the Netherlands, the Rijksdienst Voor Ondernemend Nederland (RVO) and the Omgevingsdienst are responsible for the supervision and enforcement of the various obligations aimed at energy conservation. The RVO is an executive service of the Dutch Ministry of Economic Affairs and Climate and the Ministry of Agriculture, Nature and Food Quality. The Environment Service is a body that, on behalf of municipalities and provinces, is responsible for granting permits, supervision and enforcement in the field of the environment.

By making energy audits compulsory only for large companies, it is indirectly suggested that doing an energy audit is not, or less, interesting for small and medium-sized companies. But is this really the case?

If an organization is not required to conduct an energy audit or take other measures to save energy from legislation or permits, why are these organizations still involved in the process of doing an energy audit? One of the reasons could be greenwashing, making a company look more sustainable than it actually is. Other reasons may be that a company has to meet certain requirements from purchasers or consumers. Why are there companies that are not obliged to do an energy audit, but that do look for ways to improve their energy efficiency? For example, are these companies only

doing this so that they can obtain certain certificates in order to meet specific client requirements? Or is it a way to save money by using energy more efficiently? Or is the reason for certain companies to be more sustainable?

Municipalities could avoid just providing audits when implementing SME energy-efficiency programs. For example, they could look for approaches that allow participants to share knowledge and experience with each other and with experts, as well as to take home ideas, test them out in their own situations, and then share their findings. Rather of being a hindrance, communication may become an asset (Palm & Backman, 2020).

This study is intended to find out why certain SMEs do look for ways to improve their energy efficiency. And if it does so, what effect does this have on business operations. Business operations refer to activities that companies undertake on a daily basis to increase the value of the company and make a profit. Effect or influence on business operations refers to everything that is affected by the measures to improve energy efficiency in the business process, both consciously and unconsciously. The research will take place in the province of Fryslân.

1.2 Research objective and questions

It has long been considered that governments should only intervene in the market when so-called market failures occur in energy efficiency management in industry (Palm & Thollander 2020). Information asymmetries and information flaws are two of the most common market failures when it comes to energy efficiency. Both a lack of knowledge and the high expense of gathering data on energy-efficient solutions represent flaws in the information we do have. For instance, if a supplier has more information about an item's energy efficiency than the buyer has, the buyer may choose an item based on other factors, such as the price (Palm & Backman, 2020). Energy-efficiency programs, including the identification of potential for technology improvement, often through energy audits or other professional support, and direct financing or other facilitation of recognized opportunities are common policy proposals to overcome these impediments (Thollander et al. 2010). In addition to a lack of information and understanding, the way this information is conveyed is also a hindrance. In order to understand how small businesses in Fryslân may increase their energy efficiency and what impact this has on their business operations, it is important to understand how this information is communicated.

The thesis ultimately revolves around answering a research objective. The research objective identified will be answered by means of three research questions, which were developed after identifying the problem SMEs face regarding practical and theoretical approaches of energy efficiency. The research objective is to find out why SMEs in Fryslân do look for ways to improve their energy efficiency and what influence this has on business operations of these SMEs. By doing a survey at SMEs in Fryslân we hope to get the reason why they do or do not improve their energy efficiency and to find out what influence these energy audits have on business operations. Eventually, three different research questions were formulated. Completing the research questions correctly will be useful in identifying what the researcher wishes to investigate. Answering the research questions will help structure the thesis, but it may also help foresee any potential future obstacles or difficulties. Answering the research questions will lead to providing an answer to the research objective.

1. What drivers and barriers for energy efficiency in businesses are identified in literature and to what extent are they relevant for (which type of) SMEs?
2. To what extent, and why do SMEs look for ways to improve energy efficiency, particular in the Dutch province of Fryslân?

3. Do measures to improve energy efficiency influence their business operations, and how is this related to their motives to look for improving energy efficiency?

1.3 Approach and methods

Data and information will be collected via multiple methods, such as literature reviews on documents and literature and a survey of small and medium-sized organizations in Fryslân.

Research question one will be answered with a literature review. To gain a deeper understanding of the subject matter and the jargon that is commonly used to describe it, it is critical that you conduct preliminary research. Review articles on related topics that have already been published can help you get a better understanding of a specific aspect of your own topic. The definition and understanding of terms and concepts can also be found in dictionaries, encyclopedias, and handbooks. Preliminary researching is necessary to get a sense of how much literature there is in your area of interest, and to provide the groundwork for more advanced searching when you've developed your search strategy in more depth. Searching in this manner sometimes includes a succession of highly specific queries, such as checking for your primary keywords in the article's headline, for example. Search catalogs such as Google Scholar and huge databases like Scopus or ProQuest central may be effective options for initial searches. Moreover, the answering of research question one is the basis for drawing up the survey of research question two.

Research question two is answered by means of a survey. Also, the literature gathered on research question one will be examined. A survey is used to find out the reasons why SMEs in Fryslân try to improve energy efficiency. The reason that a survey is used is that a lot of data can be collected in a relatively short period of time. Survey research is the practice of gathering data via the use of surveys that are sent out to potential organizations. This information is then used to draw significant research conclusions from the data acquired through these surveys. The survey questions will be administered through three categories. The surveys will be completed via an online form, that is shared by e-mail and LinkedIn, to collect the data that will be required to answer the research question two. The operationalization of concepts in the survey questions is explained in chapter three.

Research question three is answered by use of the same survey that is used for research question two (see Table 1.1). The survey has to lead to insights in the influence of energy efficiency measures on the business operations and how this is related to the companies motives to look for improving energy efficiency.

Table 1.1: Research Material per Research Question

Research question	Data/Information required	Sources of Data	Accessing Data
What drivers and barriers for energy efficiency in businesses are identified in literature and to what extent are they relevant for (which type of) SMEs?	Regulations from RVO	Secondary data: Documents	Content analysis
	Available literature on drivers for energy efficiency in businesses	Secondary data: Literature	Content analysis and Search method
	Input from SMEs that improve energy efficiency at their company	Primary data: SMEs	Questioning: Survey
To what extent, and why do SMEs look for ways to improve energy efficiency, particular in the Dutch province of Fryslân?	Available literature on drivers for energy efficiency in businesses	Secondary data: Literature	Content analysis and Search method
	Input from SMEs that improve energy efficiency at their company	Primary data: SMEs	Questioning: Survey
Do measures to improve energy efficiency influence their business operations, and how is this related to their motives to look for improving energy efficiency?	Input from SMEs that improve energy efficiency at their company	Primary data: SMEs	Questioning: Survey

1.4 Outline

The thesis consists of six different chapters. Chapter one is the introduction that gives a background of the thesis, the goal and questions which are answered, and the approach and methods that are used in the thesis. Chapter two describes the research methodology, research methods and research choices that are made in this thesis. Chapter three answers sub-question one: what drivers and barriers for energy efficiency in businesses are identified in literature and to what extent are they relevant for (which type of) SMEs? The outcome of chapter three is then used in the fourth chapter, for the operationalization into a survey. The outcome of the survey is used to answer sub-questions two and three in the following chapters five (sub-question two) and six (sub question three). In chapter seven, the conclusion, the research objective is addressed with use of the sub-questions.

2 Methodology and research

In this chapter the research methodology, research methods and the choices that are made during the research are described.

2.1 Research methodology

The research methodology answers how this study is being completed. It explains and justifies the techniques and tools which are used. The research methodology ensures the employment of the correct procedures to answer the research questions. The research methodology gives a guidance on which research methods can be used. The methodology section will also give us a path. Choosing an entirely suitable and sound method that is right for the thesis and the research questions will give path that will assist in completing the thesis successfully. The research methodology chosen will provide guidelines that will make the thesis manageable, smooth, and effective. Finding a solution to a problem is made possible through the use of research methods. Studying the methods of research provides practice in using them in a problem-solving context. Methods, materials, scientific tools, and relevant techniques can all be learned through the study of research methodology.

The thesis partly consists of basic research. In the basic research part knowledge is developed about the reasons why SMEs in a particular region improve their energy efficiency. In addition, knowledge is developed about what influence this improvement of their energy efficiency has on business operations. The current research has characteristics of an exploratory research. The particular region that is researched, is, as far as can be found, not researched before concerning this object. That is why it is exploratory research; it explores the aspect of an under researched subject. In addition, the results can provide insight into regions with similar characteristics.

The thesis is inductive research and aims to discover the exploratory factors. The thesis aims to discover the exploratory factors why those companies in that particular region do try to improve their energy efficiency and what the influence of practical and theoretical approaches of energy efficiency has on their business operations. As with inductive reasoning, the research process begins with observations, and theories are developed at the end as a result of those observations. Inductive research is based on the observation of patterns and the formulation of hypotheses to explain those patterns. There are no preconceived theories or assumptions in inductive investigations, therefore the researcher has complete freedom to adjust the study's course once it has begun. It is critical to emphasize that an inductive approach does not imply that theories should be ignored when coming up with research questions and goals. For this strategy, the goal is to uncover patterns and relationships in a dataset so that a theory can be developed; nevertheless, this approach does not restrict the researcher from using an existing theory as a basis for the research topic. Starting with precise observations of the world, inductive reasoning proceeds on to more abstract generalizations and concepts. It's common for a researcher to develop empirical generalizations and identify preliminary links while conducting inductive research, which begins with a topic. At the beginning of the investigation, no hypotheses can be found, and the researcher does not know what kind of findings to expect until the study is complete.

Primary and secondary data sources were used in this investigation. First-hand information and raw information can be found in primary sources. Using a primary source gives you unfiltered access to the subject matter of your investigation. A survey of small and medium-sized businesses in Fryslân is being conducted in order to gather primary data. One advantage of collecting primary data is that the researcher will be able to collect information that is specific to the current study's objectives and needs. Overall, the questions that will be asked by the researcher will be customized to elicit the

information that will be used to answer the research question that is the focus of the current study. The data will be gathered by the researcher himself, through the use of surveys, as previously stated. Documents and literature are being researched for secondary data, which is being compiled. Secondary sources are sources of information and commentary from other researchers who have obtained information and commentary from other scholars. Journal articles, book reviews, and academic books are just a few examples. A secondary source is a source that describes, interprets, or synthesizes information from primary sources. Second-hand information, as opposed to primary information, is more widely available and less expensive to obtain. Because administrative data is collected in a comprehensive and routine manner, administrative data tend to have high sample sizes as well. Furthermore, administrative data as well as many different forms of secondary data are collected over an extended period of time. The researcher will be able to discover changes over time as a result.

The current thesis will rely on a mixed method approach. Mixing quantitative and qualitative data within a single investigation is known as a mixed methods research methodology that has emerged in recent years. The main idea of this methodology is that integrating quantitative and qualitative data collecting and analysis provide for a more full and synergistic exploitation of data. Mixed method of data collection in the current study will have the following characteristics:

1. Quantitative (closed-ended) and qualitative (open-ended) data collection and analysis.
2. Making sure that each method's tradition is followed when it comes to collecting and evaluating data, such as guaranteeing the suitable sample size.
3. Assembling information from various sources to form a complete picture
4. Procedures involving the simultaneous or sequential application of qualitative and quantitative components to either a single sample or to a variety of samples
5. As a social constructionist paradigm tries to understand many viewpoints on a particular subject, the techniques are framed within philosophical/theoretical models of research.

Mixed methods will be ideal for this study because it is a technique to assess complex interventions such as practical and theoritical motives for energy efficiency at SMEs in Fryslân. Through the use of mixed method, the researcher will use any of the following methods for the research question.

The use of both quantitative and qualitative data sources helps to support your conclusions and strengthen your case. A convergent design will be used to compare qualitative and quantitative data findings. Gathering both types of data simultaneously; using parallel constructs for both types of data to assess information; analyzing both types of data; and using procedures such as side-by-side comparisons in discussion, transforming qualitative data into quantitative scores or jointly displaying both forms of data are some of the ways in which this approach can be utilized. For example, the two types of data can be used to validate each other and to form the basis for forming conclusions about the intervention.

In mixed approaches, the researcher examine quantitative findings by analyzing qualitative information. It is common for this sequential design to have two stages: an initial quantitative instrument phase, followed by a qualitative data collecting phase, in which the qualitative phase builds immediately on the quantitative phase's results. Qualitative data helps to illuminate quantitative findings in this way. Focus groups can be used to further investigate conclusions from instrument data, such as expenses, in order to better understand how the personal experiences of individuals match up with the instrument results. Mixed techniques can be used to describe quantitative mechanisms qualitatively, as demonstrated in this study. When conducting an explanatory sequential design, there are two phases: (1) an initial quantitative instrument phase,

followed by (2) a qualitative data collecting phase, in which the qualitative phase builds directly on the quantitative phase. Qualitative data is used to describe quantitative outcomes in greater detail. This can be done by conducting qualitative focus groups to better understand how the instrument results match up with the personal experiences of individuals. Mixed methods can be used to describe quantitative mechanisms in a way that can be understood qualitatively.

1. Create survey instruments. Another mixed methods study design could aid in the creation of appropriate quantitative instruments that provide accurate assessments for both practical and theoretical motivations for energy efficiency at small and medium-sized enterprises in Fryslân, Netherlands.
2. Complement a quantitative investigation with qualitative data. An embedded design is a type of outcomes study that includes qualitative data collecting and analysis. Qualitative and quantitative data are used in this type of investigation. The qualitative data might be included at the beginning of the investigation. It is common in implementation and dissemination research for qualitative data to be incorporated into an outcomes study.
3. Involve community-based stakeholders. An example of a multiphase design is a community-based participative method. The community is involved in several quantitative and qualitative phases of research in this sophisticated mixed methods approach to bring about change.

The research is a descriptive data research. The goal of the research is to try to identify characteristics and patterns instead of testing causal relationships between variables. Using descriptive analysis to analyze your data will help an individual discover patterns in the data that satisfy all of the conditions set for the data. Descriptive data analysis is one of the most crucial phases for undertaking statistical data analysis. It provides you a conclusion of the distribution of your data, helps you spot typos and outliers, and enables you to identify commonalities among variables, therefore making you ready for undertaking further statistical analysis. Ultimately, research is about answering societal questions. Answering the research questions leads to results that can be used, for example, to formulate or adjust policy. It can therefore be classified under applied sciences.

2.2 Research methods

In Chapter 3 ”Drivers for energy efficiency in literature” the first research question: “What drivers and barriers for energy efficiency in businesses are identified in literature and to what extent are they relevant for (which type of) SMEs?” is being answered. The research question is being answered with content analysis. Published articles and documents regarding energy efficiency, benefits of energy efficiency, barriers to improving energy efficiency, drivers for energy efficiency, energy measures in SMEs, and the difference in drivers and barriers for energy efficiency between sectors are being analyzed. These articles were found through scientific databases such as: ScienceDirect, Elsevier, PUBMED, and Google Scholar. This chapter three also partly gives answer to the second research question “To what extent, and why do SMEs look for ways to improve energy efficiency, particular in the Dutch province of Fryslân?”, by showing what drivers there are in literature for companies to improve their energy efficiency.

The second and third research question are mainly being answered by a survey at SMEs in Fryslân. The purpose of the study is to be able to make statements about all SMEs in Fryslân. Using a survey, it is possible to question a large group of respondents in an easy way. Answering the questions leads to quantitative data which can be used to uncover trends and relationships in the research object, specifically SMEs in Fryslân.

2.3 Research choices

This section answers how certain research choices were made and why the choice was made to do it that way.

Why was the choice made to survey small and medium-sized enterprises, rather than, say, large enterprises?

SMEs are very important to the economy. For example, SMES make up 99% of all businesses in the EU. SMEs are responsible for about two thirds of private sector jobs in the EU. Moreover, they account for half of the total value added of companies in the EU (IQualifyUK, n.d.). This makes SMEs, despite not always having the greatest impact as individual companies, a key part to the economy in a broad sense and therefore interesting to be investigated.

Why was it chosen to investigate SMEs in the province of Fryslân?

The province of Fryslân has a rural character and has a relatively low population density compared to the rest of the Netherlands. The population density is 195 inhabitants per square kilometer compared to an average of 416 inhabitants per square kilometer in the Netherlands (CBS, 19-3-2021). Because of this relatively low population density, large companies are more likely to relocate. As a result, the province is mainly characterized by SMEs. The companies are also easily accessible from the researcher's point of view due to its localization.

How were companies found to survey?

After delineating the area to be surveyed, a way had to be determined to approach as many companies in the research region as possible to survey. In the end, the choice was made to search for SMEs through various channels. For example, a number of companies were found through Google's search engine. This gives the possibility to find local companies. Subsequently, these were assessed with a short scan to see if they would be meeting the requirements for an SME. In case of doubts, these companies were still approached via the survey. After completing the questionnaire there is always a possibility to filter these companies out. Google maps also helped in finding businesses. Most businesses today are visible on the map, this makes it immediately clear if a business is really located in the region being researched. In addition, the researcher's personal network and knowledge of companies in Fryslân was used to write to companies. Eventually, a list was created with about 200 companies from all over Fryslân and from different sectors.

How were these companies subsequently approached?

The companies in the list were written to with the request to complete the survey. After a few weeks this was repeated to get as many companies as possible to fill in the questionnaire. The companies were approached via email, where possible directly sent to the person responsible for sustainability and the processes within the company. If this was not possible, for example because contact details were unfindable, a company was written to via the general email address.

In addition, a request was made via LinkedIn for SMEs in Fryslân to fill out the survey for the study. How many respondents found the survey through this way is unknown. The message was viewed by 995 people.

How did this process go?

In the process of approaching the companies, the researcher ran into the fact that ultimately, out of about 200 companies, only about 20 responded initially. Despite approaching people personally rather than writing to the company, there was little response. Eventually after one month, the

researcher was able to increase this by again approaching the individuals/companies who did not initially respond. Approaching the companies and getting them to fill out the survey took a lot more time and effort than was anticipated. This possibly leads to a non-response bias. This is because there is a large difference in the composition of the group of organizations that did participate in a survey and those that did not. And this while both groups are part of the research population (see 5.2, remarks).

3 Drivers for energy efficiency in literature

In this chapter the first research question will be answered. The first research question being:

"What drivers and barriers for energy efficiency in businesses are identified in literature and to what extent are they relevant for (which type of) SMEs?"

3.1 European Energy Directive

The EED was adopted in 2012. The directive states the European target of a 20% reduction in European energy consumption by 2020, and contains obligations for both member states and companies.

As of July 2015, companies will be subject to two obligations: Articles 8 and 14. Article 8 deals with the performance of energy audits by large companies. Article 14 concerns the cost-benefit analysis for new construction and renovation of larger combustion plants. This research mainly concerns Article 8 which deals with energy audits (RVO, n.d.).

The study by Kanellakis et al. (2013) provides an overview of the EU's policies in the sphere of energy, as well as a picture of the EU's overall strategy. There is a brief overview of the Union's history, spanning from its founding in 1951, when coal was seen as the engine of its economic expansion, to the present day. The principles of policy formation, as well as the pre-proposal consultations, are also discussed. There are seven basic areas of policies that have been implemented: renewable energy, energy efficiency and savings, internal energy market, energy security, environmental protection and nuclear energy. An overview of the category's development is followed by a presentation of relevant policies and a discussion of their purpose for each category in the report (Kanellakis et al., 2013).

Another study by Rocchi et al. (2014) analyzed the reforms of the European energy tax that were proposed in 2011 but then rejected in 2012. The authors simulated what potential economic effect the reforms and directives would have brought if they were implemented. From the article, the authors indicated that they found that the reforms and directives will have weak effects on prices of efficient energy sources in EU countries (Rocchi et al.,2014).

Under Directive 2006/32/EC of the European Parliament and Council on energy efficiency and energy services, Kollmann and Reichl (2012) conducted a study on the evaluation of alternative ways to improve end-use efficiency of energy under the European Parliament and Council (ESD (Effort Sharing Decision)). Only in Austria was the research conducted. However, despite the study's concentration being in Austria, some of the instructions mentioned in the study might be applied to the current study. Among the key goals of the ESD is to encourage EU Member States to reduce their ultimate energy consumption by 9% over the next nine years. Because the European Parliament and the Council were unable to agree on the required energy reductions for the Member States, the focus is on inviting them to participate. Accordingly, Member States are only required to implement adequate measures in the field of end-use energy efficiency and submit interim reports to the European Commission every three years under the ESD. ESD's primary goal is to improve energy efficiency and end-user cost-effectiveness. Therefore, the ESD provides a framework for the creation and promotion of an energy services market, which is why it exists. Kollmann and Reichl (2012) posit that a significant issue here is that member states might include energy efficiency gains made prior to 2008 in their reporting of improvements in energy efficiency.

The purpose of an energy audit is to increase insight into one's own energy consumption and the potential for savings measures. Under legislation other than the temporary scheme, most companies

are required to implement cost-effective energy-saving measures. In this case, the company will coordinate the selection and pace of implementation of these measures with the competent authority in a so-called "plan of action". This plan of action then constitutes the energy assessment framework in the context of the activity decision or the environmental permit. The competent authority can take enforcement action against companies that are lagging behind in their implementation (RVO, 2014).

3.2 Energy efficiency

The use of energy as such is not a problem. However, the high greenhouse gasses (GHG) emissions involved are. The production of energy using fossil fuels leads to a large emission of GHG. The emission of GHG leads to climate change and is a threat to our environment. In 2015 almost 80 percent of all energy consumption worldwide is produced with fossil fuel (World Bank, n.d.). IPCC (Intergovernmental Panel on Climate Change) (2007) shows that 40% of the total global energy consumption is used by industries. In addition, the same report shows that industries consume 78% of the total coal consumption, 41% of the total electricity consumption, 35% of the total natural gas consumption and 9% of the global oil consumption. Reducing energy consumption would lead to a reduction in the use of fossil fuels and thus lower emissions of GHG. This makes energy efficiency one of the key strategies of a solution to the GHG problem (World Bank, 2009).

An assessment of the energy efficiency gap was made by Gerarden and co-authors in 2017. For many years, it has been noticed that individuals and organizations may not embrace energy-efficient technologies to the amount that is justified, even if only on an entirely financial basis. The authors conducted a literature assessment on the "energy-efficiency gap" using two complementary approaches. Market failures, behavioral reasons and model and measurement errors can all contribute to the energy efficiency gap, according to Gerarden et al (2017). They also analyzed past studies to determine the most critical factors of making cost-effective energy efficiency selections, which they did. One's thoughts are better organized using this four-question decomposition. First and foremost, are the product options and pricing in line with industry standards? Other questions include whether or not energy expenses are exorbitant or poorly understood. Is a product's current value considered when making a purchase? Are there additional fees that impede people from adopting more energy-efficient decisions? Researchers have consolidated academic studies on these concerns, as well as making recommendations for further study.

Studying the energy efficiency gap through economic theory and empirical evidence, Gillingham and Palmer (2020) complimented Gerarden et al. (2017), which looked at initiatives to bridge the gap through policy ideas. Energy efficiency initiatives have been implemented for decades, but the costs and benefits of these policies are still up for debate. "Energy efficiency gap" discussion concentrates on whether or not consumers and businesses are failing to make evident net present value energy savings investments. It has been shown that there is a gap by the high implicit discount rates, undervaluation of future fuel savings, and negative cost energy efficiency initiatives. Energy efficiency gaps can be explained in several ways, from neoclassical explanations to behavioral economic data that could help us better understand why there is one. However, the assessment found that the alternatives to traditional welfare analysis are not yet ready for use in policy analysis. Options for politicians and economists to examine (Gillingham & Palmer, 2020).

Lovins (2018) conducted a study to determine the magnitude of the available resources for energy efficiency. Energy efficiency, according to this article, is a finite and declining resource that most economic theorists predict will eventually deplete its potential and raise its prices due to price and policy driven adoption. Traditional energy efficiency analysts and implementers see and use just a small fraction of the relevant efficiency resource, resulting in lower savings and higher costs. In

contrast, modern energy efficiency looks to be a resource that is both expanding and diminishing at the same time. Major but fixable market failures and positive externalities have hampered the adoption of it. Its volume and cost are far more and lower than most in the energy and climate communities are aware of in both new build and retrofit applications. It is possible to save more energy at a cheaper cost by installing fewer, simpler technologies that are combined, sequenced, and timed correctly. Efficiency resources are more than the sum of various technologies. There are evident advantages to integrative design even though it is a relatively new idea, and its use is increasing in frequency. Although economic models failed to forecast the renewable energy revolution, they do not even recognize the great majority of efficiency resources or reserves that exist. Despite this, delaying action on climate change is made more difficult and expensive by inaccurate analysis, which diverts resources away from more effective solutions. To safeguard the environment from the effects of climate change, it is imperative that the complete efficiency resource is viewed and utilized. As a result, it would be better if we change our focus from individual technologies to the larger systems in which they operate and replace theoretical assumptions about efficiency's declining returns with real facts from the field.

Palm & Backman (2020) explore the necessity of good knowledge & information communication and consider ways to make functional communication an enabler of future SME energy-efficiency programs to enhance energy efficiency in small and medium-sized firms. Engineers are often hired to conduct energy audits, which might be difficult to understand because they don't have a background that matches that of those receiving the audit. By actively analyzing and connecting the material, SMEs must be able to apply their own past knowledge. Small and medium-sized businesses are benefiting from two different approaches to reducing their energy consumption. Small-business energy-efficiency outcomes were lower in the program where businesses were given third-party information but were unable to process it, whereas in the program where businesses were actively involved in all stages and could discuss problems and results with peers, the results were better. When it comes to executing SME energy efficiency initiatives in the Netherlands, businesses could avoid just offering audits. SMEs participating in the program can learn from one other and from experts, as well as bring back ideas and test them in their own environments, if they use approaches that make it easier for participants to exchange and create new knowledge. It's a method to use communication as a tool rather than a roadblock (Palm & Backman, 2020).

Industrial SMEs, according to a study by Johansson et al. (2020), can profit from better policies and initiatives on energy efficiency. As a result of human emissions of greenhouse gasses, climate change influences politicians to adopt decisions that promote more efficient energy use, according to their research findings. Improved industrial energy efficiency is predicted to facilitate the transition to carbon-neutral energy systems. The majority of firms in most nations are small and medium-sized enterprises. In turn, small and medium-sized businesses are big energy consumers, but also major contributors to economic growth, job creation, investment and exports. In spite of this, there have been few studies and policy initiatives devoted to SMEs. As a result, the purpose of this article is to critically examine how energy efficiency policy programs for industrial SMEs could be implemented. On the subject, there is an abundance of academic research that focuses on the hurdles and drivers to energy efficiency. Studies of energy policy programs suggest that the bulk of industrial SMEs' energy efficiency initiatives are implemented through support mechanisms. Currently, more than half of the papers in this topic are published in Europe, which necessitates the inclusion of more scientific publications from other regions. Designing sector-specific efficiency initiatives can be simplified using a standard strategy.

The essence of energy efficiency is to do the same thing using less energy. For example, an LED lamp is much more energy efficient than an incandescent lamp, an LED lamp can produce the same amount of light with much less power than an incandescent lamp. Energy efficiency can be defined as: *energy efficiency is used to describe things that use only as much energy as is needed without wasting any (Cambridge Dictionary, n.d.).* Energy efficiency is the ratio of useful output to energy input for a system. For example, the conversion of energy to the usable light of a lamp. However, the measurement of energy efficiency is highly dependent on what is defined as usable (Patterson, 1996). Energy efficiency can be measured in physical units such as the number of kilometers driven, or value added. The concept of energy efficiency has a vital application in the industrial sector, as it is one of the most important and cost-effective options to reduce greenhouse gas emissions (Khan, 2016) and, often more interesting for businesses, energy costs.

3.2.1 Benefits of energy efficiency

Improving energy efficiency has several advantages. Table 2.1 shows the main environmental, economic and social benefits of energy efficiency.

Table 3.1: Energy Efficiency Benefits (UNEP, 2015)

Category	Benefits
Environmental	• Improved capacity for compliance with environmental demands. • Reduction in GHG emissions.
Economic	• Reduced operational or production costs. • Reduced risks through decreased dependence on volatile and rising energy prices. • Increased energy security. • Improved reliability of equipment and production processes. • Better positioning in production chains. • Better sells and marketing opportunities due to improved energy efficiency. • Gaining competitiveness in the market. • Improved image of the factory.
Social	• Improved working environment for employees. • Improved personnel attitudes of employees. • Minimized personnel fluctuations.

3.2.2 Barriers to improve energy efficiency

Despite the fact that improving energy efficiency has several advantages (see table 3.1), there are also factors that hinder investment in energy efficiency, known as barriers. In table 3.2, the different barriers for energy efficiency are summarized in three different categories, namely: economic, organizational and behavioral barriers.

Table 3.2: Barriers to Energy Efficiency Implementation (SPRU, 2000)

Category	Sub-division	Barrier	Description
Economic	Market or organizational failure	Imperfect information	Agent lacks sufficient information to make economically efficient decisions.
		Split incentives	Agent cannot make appropriate benefit of investment, landlord-tenant type relationships.
		Adverse selection	Agent cannot transmit or discover energy properties of equipment.
		Principal- agent relationships	The principal may impose strict investment criteria to compensate for imperfect information.
	Non-market or rational behavior	Heterogeneity	Technology may not be cost-effective in a particular case.
		Hidden cost	Technology investment entails additional costs or benefits loss not usually reflected in models.
		Access to capital	Some agents cannot obtain capital to invest.
		Risk	Stringent investment criteria may represent a rational response to risk.
Organizational	-	Power	Agent lacks sufficient power within an organization to initiate action.
		Culture	Environmental awareness and energy efficiency play no part in a factory culture.
Behavioral	Human dimension	Forms of information	Forms of information may be inadequate to stimulate an action.
		Credibility and trust	Agent may not trust the source of information.
		Values	Lack of environmental awareness leads to neglect of energy efficiency opportunities.
		Inertia	Agents resist change because they are committed to what they are doing and justify inertia by downgrading contrary information.
	Bounded rationality	Bounded rationality	Cognitive limitations lead to agents satisficing rather than optimizing and relying on routines & rules of thumb. Organizational routines may systematically neglect energy efficiency.

3.2.3 Drivers for energy efficiency

In addition to the barriers listed in Table 3.3, there are also factors that encourage companies to actively implement energy efficiency in their business processes. Table 3.3 shows motivating factors for companies to embrace energy efficiency.

Table 3.3: Motivators and Drivers for Energy Efficiency Implementation (Reddy, 2013)

Drivers Internal to the Factories	**Drivers External to the Factories**
• Financial motives of the factory. • Energy consumption or energy bills. • Cost savings. • Departmental performance motives. • Factory commitment to achieve energy efficiency and environmental standards. • Technology advancement motive. • Government supports seeking motive. • Factory image promotion motive. • Avoiding development risk motive.	• Government policy regulations to achieve current and future environmental compliances. • Environmental regulations for GHG emissions. • Rising energy costs. • Energy security. • Market competition. • Public and market demand. • Social pressure or social values.

3.2.4 Energy efficiency measures in SMEs

In 'Adoption of energy-efficiency measures in SMEs—An empirical analysis based on energy audit data from Germany' (Fleiter et. al., 2012) the effects of a broad range of factors on the adoption of energy efficiency measures (EEMs) in Germany SMEs are studied.

The results of this study tell that high initial investment costs are a main barrier to the adoption of EEMs. The study suggests that to accelerate the adoption of EEMs via audit programs, these should be accompanied by financing programs.

The study found evidence that a higher level of satisfaction with the energy audit would help companies to implement the proposed EEMs more quickly. Assuming that higher satisfaction scores indicate a higher audit quality, this result rationalizes the policy regulations. For example, in the Netherlands RVO has developed a reporting format for energy audits to improve quality (RVO, 2016).

A study about drivers for energy efficiency within SMEs (Cagno & Trianni, 2012) shows what drivers for energy efficiency are perceived by SMEs (table 3.4).

Table 3.4: Perceived drivers for energy efficiency within SMEs (Cagno & Trianni, 2012)

Driver Rank	No. of enterprises
1	Allowances of public financing
2	External pressures
3	Long-term benefits
4	Access to energy efficiency experts
5	Info on practices
6	Management sensitivity
7	Energy performance contracts
8	Great ambition and entrepreneurial mind
9	Lower costs of consultancies
10	New solutions
11	Info on interventions
12	Anticipating regulatory issues
13	Clients
14	Increase of internal competences

3.3 Differences between sectors

Drives and barriers for energy efficiency may vary from sector to sector. Research by Cagno and Trianni (2011) shows the difference in importance of barriers between multiple sectors (table 3.5). A higher score means the more important the barrier is for that sector. The research is focused on non-energy intensive manufacturing SMEs in multiple sectors and was carried out in Northern Italy. In table 3.5 the sector with the highest score is indicated with green, the sector with the lowest score is indicated with orange.

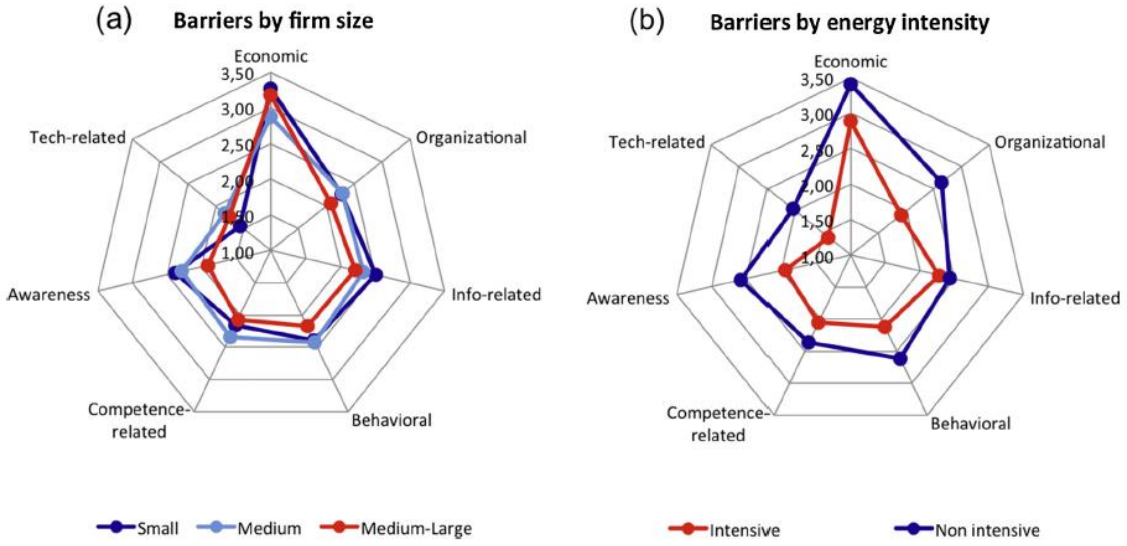
Table 3.5: Barriers to energy efficiency, difference between sectors (Trianni & Cagno, 2011)

	Average	Textiles	Wood	Plastics	Basic Metals	Primary metals	Others
Lack of time or other priorities (comparing energy efficiency efforts with respect to production efforts)	2,53	1,95	2,83	2,59	2,83	2,58	2,62
Access to capital (lack of capital - public and/or private - to be devoted to energy efficiency investments)	3,03	2,74	3,14	3,23	3,13	3,12	2,92
Lack of internal technical skills	2,7	2,39	2,86	2,71	2,88	2,84	2,69
Difficulty of gathering external technical skills	2,35	2,13	2,29	2,33	2,27	2,4	2,58
Poor information for the energy efficiency decisions	2,77	2,39	2,86	3,24	2,67	2,64	2,88
Lack of personnel awareness	2,25	2,05	2,33	2,29	2	2,36	2,42
Lack of managerial awareness	2,03	1,82	2,33	2,2	1,6	2,17	2,12
Other priorities for capital investments (low returns for energy efficiency investments)	2,61	2,05	3,43	2,62	2,53	2,68	2,81
Scarce information regarding energy efficiency opportunities and winning solutions	2,85	2,68	3,29	3	2,59	2,83	2,96
Difficulty in implementing management interventions	2,35	2,14	2,86	2,43	2,07	2,25	2,58
Difficulty in implementing technical interventions	2,59	2,24	3	2,57	2,6	2,67	2,69

The reason why the textile sector does not give the barriers a high score appears to be because this sector has weathered a crisis due to increased competition from abroad. During this crisis, many companies closed down and those that remained have taken significant steps to improve energy efficiency. Companies that give barriers a high score are likely to be less competitive when it comes to production costs (Trianni & Cagno, 2011).

Figure 3.1a shows the difference in barriers between the different firm sizes. What is noticeable is that there is a small to almost no difference in this. The biggest difference is in awareness. For Medium-Large enterprises this seems to be a less important barrier than for small and medium enterprises. Figure 3.1b shows the difference in barriers between companies that differ in energy intensity. Here it is immediately noticeable that energy-intensive companies give less value to most barriers. One explanation for this is that energy intensive companies have higher energy costs and therefore spend more time and money on making the company more energy efficient. Because there is more knowledge about this, barriers become less overwhelming (Trianni, Cagno & Farné, 2015).

Figure 3.1: Barriers to energy efficiency by firm size and energy intensity (Trianni, Cagno & Farné, 2015)



3.4 Conclusion

The research question of this chapter is: “What drivers and barriers for energy efficiency in businesses are identified in literature and to what extent are they relevant for (which type of) SMEs?”

In the literature found, different categories of drivers and barriers can be distinguished. The identified types of drivers and barriers are: environmental, economical, social, regulational, behavioral and business operations (organizational).

The relevance for different types of SMEs can be divided in SME size, energy intensity of the SME and different types of sectors.

For the various sizes of SMEs, little difference can be found in the relevance of barriers and drivers for energy efficiency. The perceived importance of barriers for small, medium and medium-large enterprises are as good as similar.

For companies that differ in energy intensity a distinction can be found. For companies that are energy intensive, the possible barriers to energy efficiency are less important than for companies that are non-energy intensive.

Moreover, literature research shows that there is a difference between distinct sectors. Business sectors with a relatively good competitive position are likely to see barriers to energy efficiency as less significant than sectors that are less competitive.

4 Operationalization of the survey

The questions for the survey are derived from the literature in chapter 3. This chapter discusses the operationalization of the survey.

The survey is divided into different topics. These topics are based on the theory as found in chapter 3. The following topics, derived from literature, are covered in the survey:

- Environmental
- Social
- Economical
- Behavioral
- Regulations
- Business operations

In addition, general questions are asked. The general questions are intended to get a picture of the company, such as turnover, number of employees and business sector. This may lead to interesting findings later on.

4.1 General

1. Size of the organization in ft (approximately):
2. Size in turnover per year (approximately):
3. Zip code:
4. Describe the organization in a few words (e.g.: metalworking or sale of furniture):
5. The organization looks for ways to improve energy efficiency and carries this out where possible: Yes / No

4.2 For organizations that do not look for ways to improve energy efficiency

It is important for companies that do not do energy efficiency improvement measures to find out why they do not do so. Therefore, for companies that answer with "No" to the previous question, the following question applies:

1. Why not?

4.3 For organizations that do look for ways to improve energy efficiency

Companies that do take measures to improve energy efficiency are asked to answer 16 questions. The first 14 questions have to be answered with a score from 1 to 5, where 1 corresponds the least to the situation of the company and 5 corresponds the most to the situation. These questions are based on the different topics that have been found in chapter 3, that is to say: environmental, social, economical, behavioral, regulations, and business operations.

The first 12 questions form the base for answering the second research question, it answers why organizations look for ways to improve their energy efficiency.

Why to look for ways to improve energy efficiency.

1. Because we, as an organization, consider the environment/the earth to be very important.
2. We feel a certain social pressure from society to improve energy efficiency.
3. Because of the reduction of operational and/or production costs.
4. To be less dependent on fluctuating energy prices.
5. Improving energy efficiency ultimately results in increased turnover.

6. Because of the financial advantages it gives the organization.
7. It is important for certain customers that we meet certain energy requirements.
8. Energy efficiency improvement measures are expected by the market.
9. Improving energy efficiency gives us an improved competitive position.
10. Taking energy efficiency improvement measures leads to a better image of our organization.
11. The implementation of energy efficiency improvement measures provides us with additional customers.
12. We implement energy efficiency improvement measures in anticipation of future legislation.

Influence on business operations.

Question 13 and 14 of the survey help to answer the third research question, the influence of energy efficiency measures on business operations.

13. Energy efficiency improvement measures result in greater awareness of the use of energy and other raw materials.
14. We expect that implementing energy efficiency improvement measures will yield long-term benefits.

Business operations

The last two questions should provide more insight into what companies are currently doing to make their energy consumption visible and manage it.

15. Does the organization have an energy management system?
16. Does the organization have energy certification or is it considering doing so?

4.4 Operationalization

There was an urgent need to close the energy efficiency gap that occurs when trying to tackle the problem, as suggested by the literature. Small and medium-sized enterprises (SMEs) in the Netherlands need more rules and directives to adopt theoretical and practical approaches to energy efficiency. For Dutch SMEs one of the fastest and most cost-effective methods to save money, reduce greenhouse gas emissions, generate jobs, and satisfy rising energy demand is to use energy more efficiently. It's also possible for local businesses in the Netherlands to increase their energy efficiency. SMEs in local areas might use a variety of ways to promoting energy efficiency.

More energy efficiency rules and directives for small and medium-sized businesses in the Netherlands will have a multiplier effect on the local economy. Study after study has shown that those who improve their home's efficiency have more money to spend locally. This helps to maintain and create new jobs in the economy. Increased efficiency in the workplace results in lower production costs, which in turn leads to increased profitability and productivity (Resource Innovation, 2019).

The electric power system benefits from energy efficiency by reducing peak loads and electricity consumption in a long-term, reliable, and verifiable manner. Traditional infrastructure investments can be postponed, lowered, or even eliminated as a result of the lower demand, making the grid more stable and robust. As an alternative to the traditional concept of laying new wires and capacity to keep up with demand growth, this method of optimizing the grid by utilizing efficiency, demand response, and distributed generation is known as Non-Wires Alternatives (Resource Innovation, 2019).

In the preceding section on literature, it was said that a wide range of actions could be taken to help industry SMEs improve their energy efficiency. Policy and directive implementation is essential to enhancing energy efficiency initiatives, but financial assistance to small and medium-sized enterprises is also necessary. In most countries, financial aid is an essential component of the policy mix. Energy audits, information campaigns, and worker training in energy efficiency can all be part of a wide range of educational and training programs. Subsidy-based incentives for industry SMEs are provided through financial or fiscal measures that are part of the policy mix.

SMEs in Fryslân will reap a number of advantages if they implement energy-efficiency strategies. In the world of business, energy is an unavoidable overhead expense. From lighting and air conditioning to machinery and industrial lines, an enterprise's energy usage is wide-ranging. SMEs in Fryslân will obtain numerous benefits as a result of increasing their energy efficiency.

As a result of these changes, the first benefit of implementing energy-efficiency strategies is that operational costs will be reduced. It is one of the most common misconceptions about energy efficiency that only governments and large enterprises have the financial resources necessary to make their processes more energy efficient. The high upfront expenses of implementing renewable and green energy technology were a major factor in this debate. Even if this may have been true in the past, the cost of eco-friendly energy systems has substantially decreased over the years (Lipman, 2021). Even SMEs may save money on energy expenditures by switching to more environmentally friendly solutions, thanks to energy efficiency enablers that are now at their lowest prices ever.

The second benefit that business owners will get from implementing energy efficiency programs is improved staff health, as documented in the literature. A company's employees, as well as its customers, are drawn to brands that exhibit a dedication to environmentally sustainable living (Lipman, 2021). There's a reason for that. Improved building insulation, efficient heating and cooling systems, optimized electrical equipment, and better lighting all contribute to greater health for workers. A wide range of illnesses can result from long-term exposure to freezing temperatures. Dehydration, on the other hand, can be a result of excessive heat. Toxins, particulate matter, and gases that are detrimental to workers' health can be reduced with good air quality. Employees will be happier and healthier if the indoor conditions are kept within the recommended parameters (Lipman, 2021).

As a third benefit, Fryslân's small and medium-sized enterprises (SMEs) will be less vulnerable to fluctuations in energy prices thanks to increased energy efficiency. All energy sources are subject to fluctuating pricing (Lipman, 2021). Annual and seasonal price swings can be rather dramatic, and they can be quite large. When these energy sources' prices rise, the cost of electricity and gas is passed on to consumers. When energy bills account for a large amount of a household's budget, planning and forecasting become more difficult. Protecting your organization from rising energy costs can be achieved through the use of environmentally friendly technologies.

The market worth of specific enterprises will rise as a result of implementing energy efficiency strategies. Energy efficiency is a sign of a company's commitment to providing maximum value to its shareholders, research shows (Lipman, 2021). While many investors perceive green energy as a desirable thing, they also see it as a sign that a company is ready for a future in which energy efficiency is the rule rather than the exception.

An additional benefit is that businesses who implement energy-efficiency programs will be able to compete more effectively. According to Lipman (2021), businesses can accomplish more with less energy thanks to energy efficiency. It is possible for businesses to reduce the amount of energy they use, as well as the amount of resources they waste. Products and services can be traded more easily

and at a lower cost because of the lower operating costs of equipment (Lipman, 2021). All of these things help the company stand out from the crowd. Today, even the tiniest of operational advantages over your rivals can have a significant impact on both sales and speed.

4.5 Barriers to energy efficiency

SMEs in the Netherlands were surveyed and hurdles to accessing and executing energy-efficiency programs were discovered. In addition, there were disparities in the implementation of energy efficiency programs between SME sectors. Their efforts to improve energy efficiency face numerous obstacles. Identifying impediments might lead to policymakers decreasing their ambition or implementing measures to minimize barriers into their goals (Bagaini et al., 2020). Barriers include, but are not limited to, the following:

1. Lack of time or other priorities.
2. No/not enough access to capital.
3. Lack of internal technical skills.
4. Difficulty of gathering external technical skills.
5. Poor information for the energy efficiency decisions.
6. Lack of personal awareness.
7. Other priorities for capital investments.
8. Scarce information regarding energy efficiency opportunities and winning solutions.
9. Difficulty in implementing management interventions.
10. Difficulty in implementing technical interventions.

Energy-efficient technology and practices in the Netherlands' small and medium-sized enterprises are hindered by the hurdles outlined. The impediments to further energy savings have been identified. It is acknowledged by the European Department of Energy (EDE) that industrial energy efficiency implementation is complicated and often controversial. Industrial end-use efficiency implementation is hindered by economic and financial, regulatory, and informational obstacles.

Some of the economic and financial impediments may include program planning cycles, split incentives, energy price patterns, and a failure to appreciate the non-energy benefits of energy efficiency. There are a number of regulatory impediments, including energy resource planning, environmental permitting, and the utility business model. Awareness of incentives and hazards, metering and energy consumption statistics, and the adoption of a systematic energy management system are related with informational barriers for data. Industrial end-use energy efficiency is the emphasis of the barriers outlined above. If you are a member of an energy efficiency group, you will notice that there are some common restrictions. It is based on the survey questions that a particular barrier to a specific energy efficiency group is classified. The considerations include where stakeholders typically associate the barrier, and how frequently the barrier is referenced in comparable materials.

Experts have long acknowledged that a lack of commercial financing is a major impediment to implementing energy efficiency projects. Energy efficiency projects are generally ranked low on the priority lists of high-level private sector managers or investors when competing for financing. In the utility business, a common obstacle is the belief that energy saving measures will diminish revenue. In some circumstances, energy efficiency programs can assist electricity companies better manage peak demand and avoid the need to invest in new power infrastructure, and so can be very profitable for electricity companies.

5 The reasons for improving energy efficiency

In this chapter the second research question will be answered. The second research question being:

To what extent, and why do SMEs do look for ways to improve energy efficiency, particular in the Dutch province of Fryslân?

5.1 Outcome survey

The results of the survey are divided into general questions relating to the company; the results of the questions for companies that are not working on improving energy efficiency; and the results of the questions for companies working on improving energy efficiency. In total, the survey yielded 32 respondents.

5.1.1 General

The general questions give a picture of the companies surveyed in terms of number of employees, turnover and in which sector they operate.

Figure 5.1 Fte surveyed companies

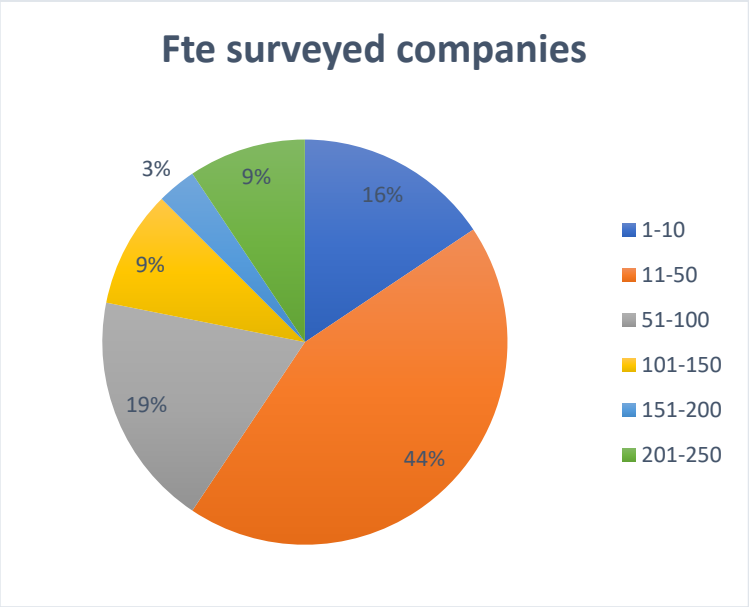


Figure 5.1 shows the amount of fte of the companies that responded to the survey.

The vast majority of companies that responded (44%) have an fte of between 11 and 50.

It is noticeable that only 16% of the companies that responded have 1 to 10 fte. This despite the fact that, according to MKB Nederland, there are approximately ten times more companies with 1 to 10 fte (495.00 companies) than companies with 11 to 49 fte (56.000 companies) (De Zaak, 2014).

This may have to do with the possibility that these companies have responded more to the survey because slightly larger companies might employ a dedicated member of staff for this. It is most likely that most of the companies that have been contacted are between 11 and 50 fte's because they are often easier to find than smaller companies.

Figure 5.2 shows the turnover in millions of the surveyed companies. Most companies fall in the turnover range of 0 to 1.9 million euros (22%), 2 to 5.9 million euros (22%) or 6 to 10.9 million euros (26%).

Figure 5.2: Turnover surveyed companies in millions

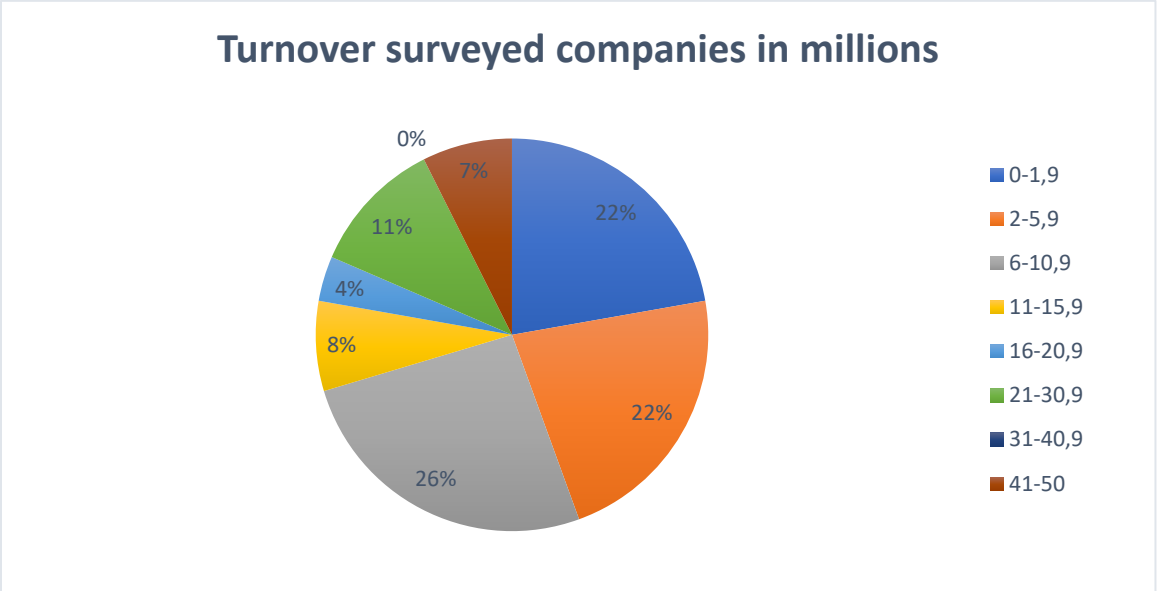
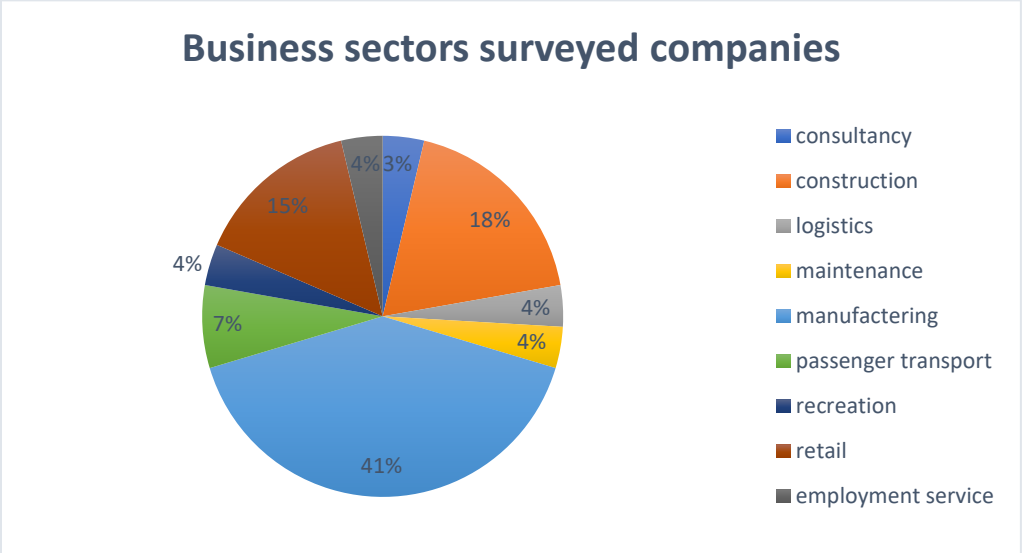


Figure 5.3 shows the sectors in which the companies that responded to the survey are operating. Most of the companies, 41%, that responded are part of the manufacturing sector. This sector also includes the most energy-intensive companies (Bruyn, 2014).

Figure 5.3 shows the sectors in which the surveyed companies are operating.

Figure 5.3: Business sectors surveyed companies



5.1.2 Companies that do not look for ways to improve energy efficiency

Of the 32 companies that ultimately filled out the survey, two are not working on improving energy efficiency. The reasons these companies give for not doing so are:

- We don't have time for that (metalworking);
- we don't see the benefits (metalworking);
- we haven't looked into it yet (clothing retailer).

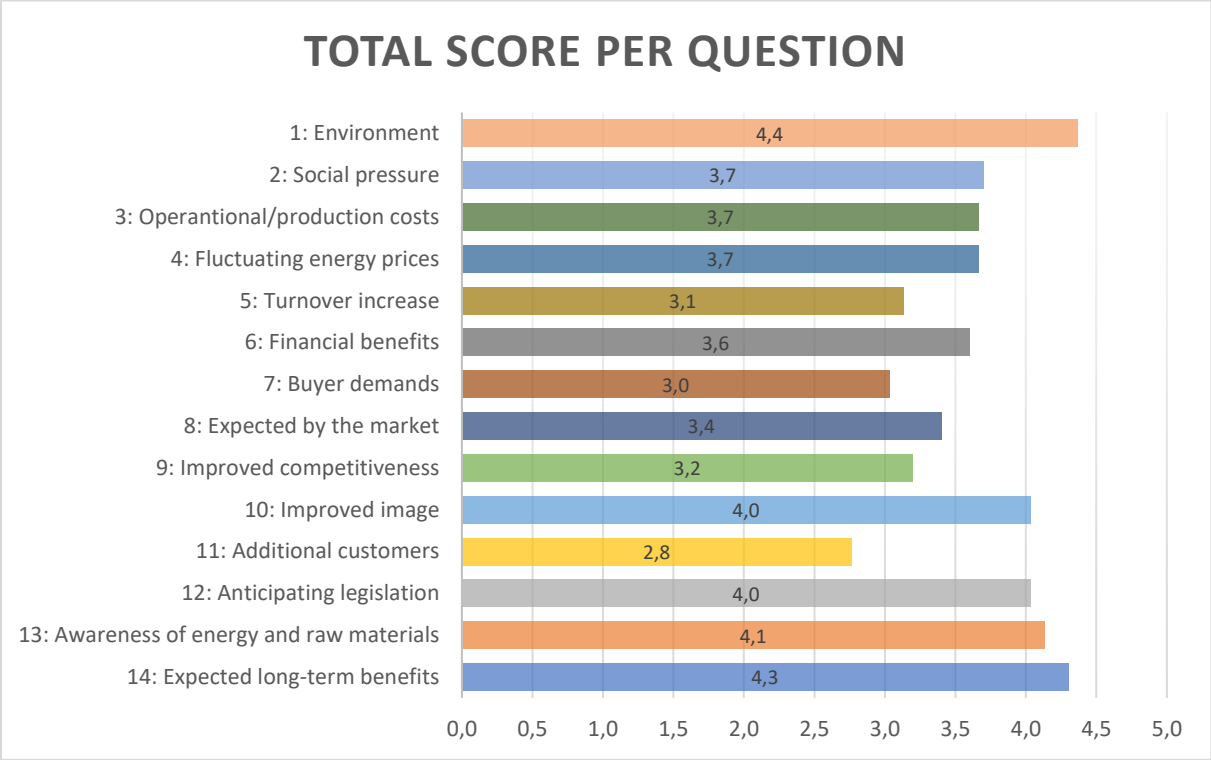
The companies that are not engaged in improving energy efficiency are a metalworking company and a clothing retailer.

5.1.3 Companies that do look for ways to improve energy efficiency

A total of 30 companies filled in the questions about what they see as the reasons for improving energy efficiency.

The chart below (figure 5.4) shows the average answer per question. The questions have been answered with a score from one to five, where one corresponds the least to the situation at the company and five corresponds the most to their situation.

Figure 5.4: Total score per question



On average, the environment is seen as the main reason for improving the company's energy efficiency. Other reasons that are seen as important for improving energy efficiency are expected long-term benefits, awareness of energy and raw materials, anticipation on legislation and an improved image of the company.

It is noticeable that many companies expect that legislation will oblige them to use energy more efficiently and that companies are already taking this into account in their business operations.

Extra customers, buyer demands and an increase in turnover score relatively low compared to the other reasons.

If improved energy efficiency does not attract additional customers, it seems logical that this will not increase turnover. The fact that buyers take little or no account of how a company deals with energy is once again confirmed by the fact that companies do not see this reflected in buyer demands.

5.2 Remarks

The survey carried out is a sample. This means that the outcome is only an approximation of reality.

In total there are 51.260 SMEs in Fryslân (Provinsje Fryslân 2018). Since this study concerns all SMEs in Fryslân, this means that the population is 51.260. In total, the survey yielded 32 respondents. The sample is thus 32. A population of 51.260 with 32 respondents and a reliability level ultimately resulted in a sample with an error margin of 17,32%.

Small and medium-sized enterprises (SMEs) and businesses that are willing to invest in renewable energy in the Netherlands are in an environment where there is a lot of knowledge available and other companies working in this field. Dutch energy companies have world-class research and development (R&D) facilities and excellent incentive schemes that encourage and promote innovation. International energy companies wishing to move or expand in Europe can benefit from the Netherlands' workforce, abundance of natural resources, commitment to sustainability, and innovative options (NFIA, 2021). Some of the world's best experts in the business have flocked to the Netherlands because of its progressive regulations and love for innovation. TKI Wind op Zee, the Energy Research Center of the Netherlands (ECN) and Delft University of Technology are among the notable organizations. Orsted, Siemens Gamesa, and DNV (former DNV GL) are some of the international energy businesses that are innovating in the Netherlands' energy environment. In the Netherlands, Air Liquide has also invested in renewable energy. Orsted Borssele I and 2 and Vattenfall Hollandse Kust Zuid are two big international offshore wind energy projects in the Netherlands. The Gemini Offshore Wind Park, one of the world's largest offshore wind parks, is being built in the north by a partnership of firms including Northland Power and Siemens. Eneco's Sunport Delfzijl is the Netherlands' largest solar park and produces a third of the country's electricity. In addition to wind farms, hydroelectric power plants, and solar energy parks, the region serves as an essential European link for renewable energy sources. Eemshaven, IJmuiden, and Vlissingen are among the best ports for installing and maintaining offshore wind parks. Europe's first Offshore Center for Wind Energy has been built by the Port of Rotterdam and its man-made expansion, Maasvlakte 2, in the offshore and maritime industry.

For example, Dutch companies and research institutes collaborate with foreign companies to develop food production based on plants rather than animals, photonic IT (information technology) solutions that reduce power consumption and synthetic fuel and EV (electric vehicle) charging infrastructure for the transportation sector, among other new energy technologies. Technologies that significantly improve the efficiency of industrial processes, infrastructure, and buildings are also being developed.

There are rules in the Netherlands aimed at ensuring that small and medium-sized enterprises (SMEs) and other firms implement energy-efficiency measures. From 2017 to 2018, the Netherlands has taken several efforts towards achieving its 2015 Paris Climate Change Conference goals (CMS, 2020). An ambitious energy program was announced by the Dutch government in October 2017 targeted at cutting greenhouse gas emissions by 49 percent by 2030 and 95-100 percent by 2050. The Netherlands became the seventh country in the world to enact a Climate Act on September 1, 2019. Dutch Climate Agreement was released in June 2019 which outlined the Netherlands' plans to meet its CO2 emission reduction goals in great detail. More than a hundred organizations, industries, and governmental agencies were involved in the preparation of the Climate Agreement, which

included governmental action in five distinct areas: electricity, transportation, agriculture, industry, and the built environment (CMS, 2020).

Legislative proposals to introduce a minimum price for CO2 were among the measures. The legislation was scheduled to take effect January 1, 2020. However, the process has been pushed back and the Dutch Parliament is still debating the proposal. Also in May 2020, a legislative proposal to charge industrial businesses for CO2 emissions was put up for public comment. Although there are many parallels between the two plans, a minimum price for electricity generators is only applicable. The country has made significant progress toward eliminating fossil fuels (CMS, 2020). The first coal-fired power plant shut down on January 1, 2020, as a result of a new law restricting the use of coal in the production of electricity that went into effect on December 11, 2019. Final four coal-fired plants in the Netherlands will be phased out by 2030. In March 2018, the Dutch government declared that gas extraction from the Groningen field, Europe's largest gas field, will be phased out by 2030 at the earliest, according to a statement. The Dutch government plans to phase out residential natural gas use and has passed legislation removing the TSO's (Transmission System Operator) obligation to link newly constructed dwellings to the gas grid as of July 1, 2018. According to CMS (2020), Dutch authorities predict that by 2021, 75 percent of new homes will not be linked to the gas grid, and that by 2050, households in the Netherlands would stop using natural gas. Energy-efficient initiatives will be more widely adopted and implemented in the Netherlands thanks to the Dutch government's policies, directives, and projects.

5.3 Conclusion

“To what extent, and why do SMEs do look for ways to improve energy efficiency, particular in the Dutch province of Fryslân?”

To what extent do SMEs look for ways to improve energy efficiency? A total of 30 of 32, almost 94%, companies surveyed indicated that they are engaging in improving energy efficiency. Despite the 17.32% margin of error in the sample, this indicates that a considerable part of the companies are in the process of improving energy efficiency.

Why do SMEs look for ways to improve energy efficiency? The main reasons to improve energy efficiency are: importance of the earth and environment; expected long-term benefits; awareness of energy and raw materials; anticipation on expected legislation; and an improved image of the company.

6 Influence from measures to improve energy efficiency on business operations

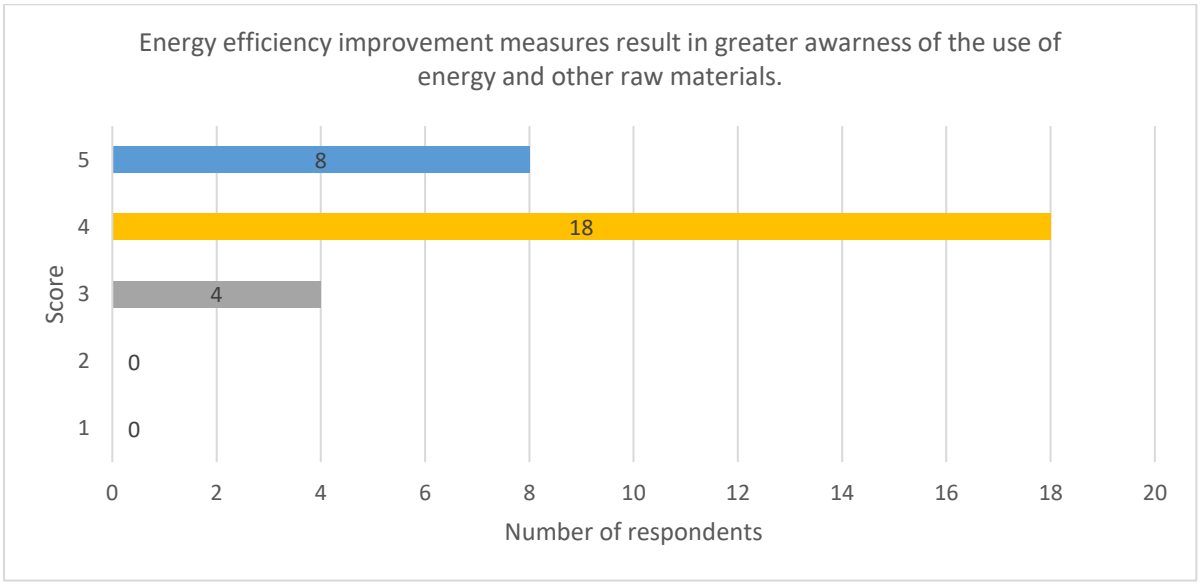
In this chapter the third and last research question will be answered. The third research question being:

Do measures to improve energy efficiency influence their business operations, and how is this related to their motives to look for improving energy efficiency?

6.1 Outcome survey

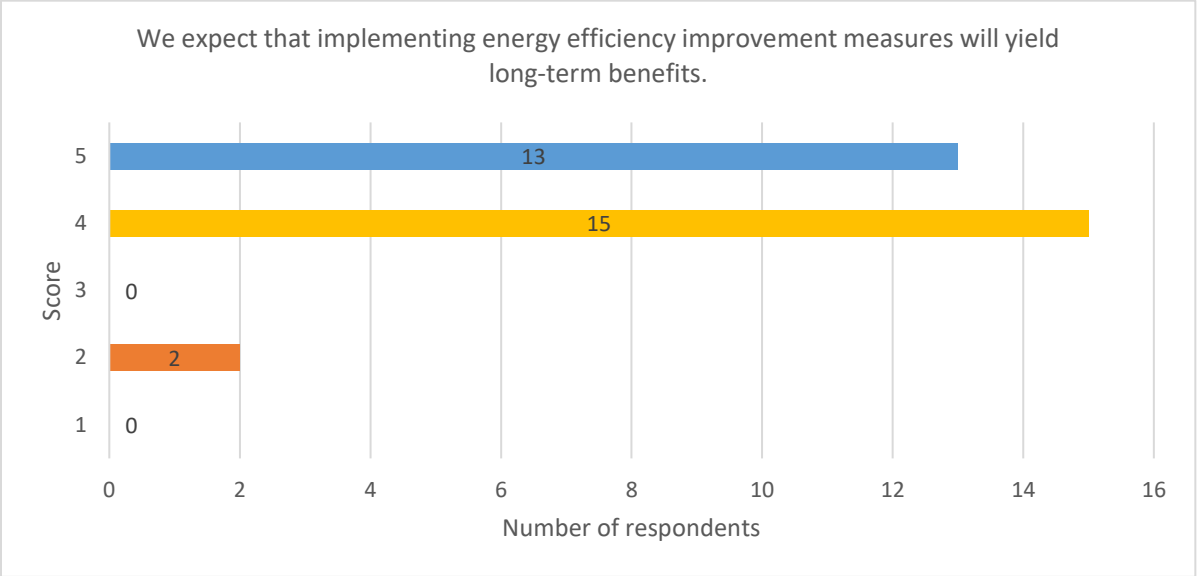
The survey also included a section of questions focused on what influence improving energy efficiency has on business operations. The statement: “Energy efficiency improvement measures result in greater awareness of the use of energy and other raw materials”, yielded an average score of 4.13 on a scale of 1 to 5. This means that just being involved in improving energy efficiency in many companies improves the use of energy and other materials because people are more aware of their use. The distribution in Figure 6.1 shows that there is little variation in the score given by the various companies. Where the lowest score is a 3 and the highest a 5. Zero respondents answered the question with a score 1 or 2.

Figure 6.1: Energy efficiency improvement measures result in greater awareness of the use of energy and other raw materials.



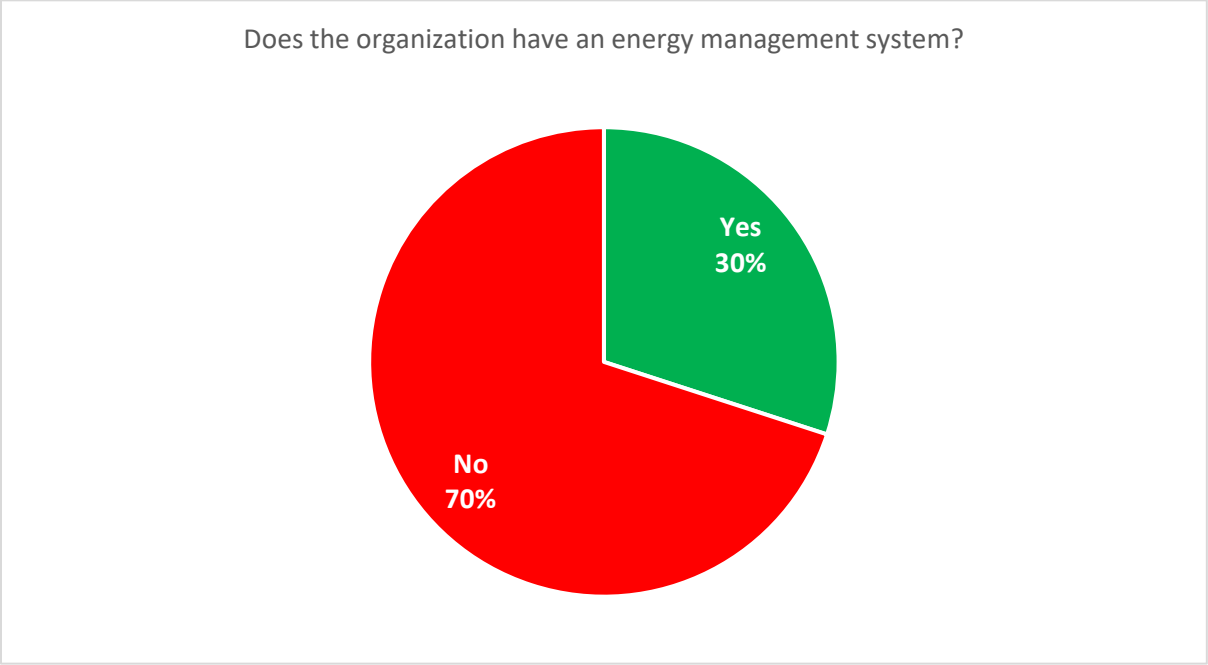
The statement: “We expect that implementing energy efficiency improvement measures will yield long-term benefits”, gave an average score of 4.3 on a scale of 1 to 5. On average, companies expect high benefits from implementing energy efficiency measures. It is remarkable that when looking at the distribution in Figure 6.2, two companies gave a score of 2 and therefore have this expectation relatively little, but the rest of the companies that were surveyed gave a score of 4 or 5 and have this expectation relatively strong.

Figure 6.2: We expect that implementing energy efficiency improvement measures will yield long-term benefits.



Of the surveyed companies, 30% have an energy management system (Figure 6.3). These energy management systems can be very different in their final operation and in the extent to which they help to make business processes more energy efficient. But it does indicate that these companies are already serious about the subject of energy efficiency. The degree of implementation of the energy management system in the business processes will ultimately determine the influence of this system on these processes.

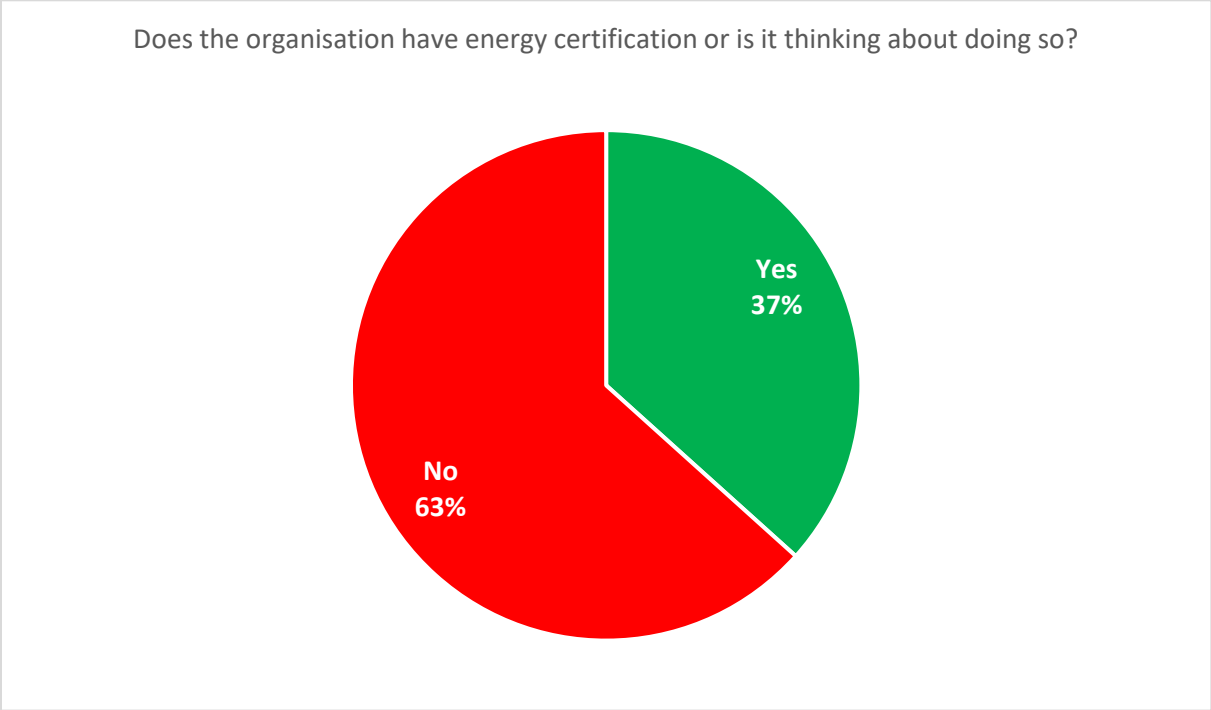
Figure 6.3: Does the organization have an energy management system?



Of the companies surveyed, 37% reported that they have an energy certificate or intend to acquire such a certification (figure 6.4). An energy certificate can be a requirement of certain customers. Particularly in the case of tenders by government agencies, requirements are increasingly being set for the use of energy. As a result, you would expect more companies to try to obtain an energy certificate, because this can generate more turnover. An energy certificate means that as a company

you have to adhere to certain requirements in the field of energy. This can mean more effort for companies. This can be a reason not to do it in the end. Moreover, a certificate itself will usually also cost money.

Figure 6.4: Does the organization have energy certification or is it thinking about doing so?



6.2 Conclusion

"Do measures to improve energy efficiency influence their business operations, and how is this related to their motives to look for improving energy efficiency?"

Measures to improve energy efficiency create significant greater awareness on the use of energy and raw materials. People become more aware of the consumption of different resources by the business processes. This makes it more likely that they adapt business processes in such a way that less energy is consumed. In addition, it helps companies develop a more long-term vision, as a significant proportion of companies believe it will deliver long-term benefits.

Some of the companies also have an energy management system. This energy management system can influence certain choices that affect energy consumption. It is difficult to say exactly to what extent this affects the business processes, but it can be said with reasonable certainty that it does have an impact.

There are also companies that have an energy certificate. Because in order to obtain an energy certificate, a company has to meet certain requirements, this has a direct impact on business processes.

It can therefore be concluded that there are several energy efficiency related factors that influence business processes in a number of companies. Taking measures to improve energy efficiency or opting for an energy system or energy certificate can be directly related to companies' motives to improve energy efficiency.

7 Conclusion

Answering the three sub questions results in acquiring the research objective, which is “to find out why SMEs in Fryslân do energy audits and what influence do the energy audits have on business operations of these SMEs.”

Sub question one identifies different categories of drivers and barriers in literature. The identified types of drivers and barriers are: environmental, economic, social, regulational, behavioral and business operations (organizational).

The relevance for different types of SMEs can be divided in SME size, energy intensity of the SME and different types of sectors. The perceived importance of barriers for small, medium and medium-large enterprises are as good as similar. For companies that are energy intensive, the possible barriers to energy efficiency are less important than for companies that are non-energy intensive.

Moreover, literature research shows that there is a variation between different sectors. Business sectors with a good competitive position are likely to see barriers to energy efficiency as less significant than sectors that are less competitive.

The drivers and barriers found in sub question one are not specific to Fryslân. However, it can be stated with some certainty that the drivers and barriers that apply in other regions will also contribute to Fryslân. The barriers and drivers found also form the basis for the survey that is used to answer sub-questions two and three.

In answering sub question two it comes to light that about 94 percent of companies surveyed are engaged in improving energy efficiency. Despite the 17.32% margin of error in the sample, this indicates that a considerable part of the companies are in the process of improving energy efficiency.

The main reasons for companies in Fryslân to improve energy efficiency are: companies consider the earth/environment important; they expect long-term benefits; their awareness of energy and raw materials; their anticipation on legislation; and/or they pursue an improved image of the company.

Sub question three shows that measures to improve energy efficiency create significant greater awareness on the use of energy and raw materials. People become more aware of the consumption of different resources by the business processes. This makes it more likely that they adapt business processes in such a way that less energy is consumed. In addition, it helps companies develop a more long-term vision, as a significant proportion of companies believe it will deliver long-term benefits.

Some of the companies also have an energy management system. This energy management system can influence certain choices that affect energy consumption. It is difficult to say exactly to what extent this affects the business processes, but it can be said with reasonable certainty that it does have an impact.

There are also companies that have an energy certificate. Because in order to obtain an energy certificate, a company has to meet certain requirements, and this has a direct impact on business processes.

It can therefore be concluded that there are several energy efficiency related factors that influence business processes in companies in Fryslân. Companies that are already working on measures to improve energy efficiency can be directly linked to their motives to improve energy efficiency even more. Some companies are also opting for an energy system or energy certificate, and this may be directly related to companies' motives to improve energy efficiency.

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