ENERGIEPARTNERS

Master's Thesis – master Energy Science

The effect of intervention strategies on the energy consumption of SMEs

A case study on SMEs in the Netherlands

Author: Mans Sopers
Student №: 3507807
Email: mans@sopers.nl
Intern company: Energiepartners
Intern supervisor: Lars Janssen (l.janssen@energiepartners.com)
University supervisor: Robert Harmsen

09-10-2020

Abbreviations

ECN	*Energy research centre Netherlands*
EML	*Recognised Energy Efficiency Measures List*
kWh	*Kilowatt hours*
m^2	*Square meters*
m^3	*Cubic meters*
MJ	*Megajoule*
ODWH	*Environmental service of West-Holland*
OFGV	*Environmental service of Flevoland, Gooi and Vechtstreek*
PBP	*Payback period*
RVO	*Netherlands Enterprise Agency*
SMEs	*Small and medium enterprises*
Wm-institution	*Environmental Law institution*

Abstract

Recently, the environmental performance of small and medium enterprises (SMEs) has gained more interest. In the Dutch climate agreement, policies are proposed on energy saving measures for SMEs. These measures are subject to an intervention strategy which should provide maximum effectivity and minimal administrative burdens for both the companies and institutions, and competent authorities. This research tried to provide insights in the Dutch intervention strategy by answering the question what the effect is of enforcement and stimulation interventions on the energy consumption of SMEs in the Netherlands? This was done by doing a quantitative analysis based on a dataset provided by Energiepartners. Data from an enforcement project in Utrecht was compared to a stimulation project in the province of South-Holland on the parameters energy savings, amount of energy saving measures and completion of the data. The data showed positive results for both strategies, however the stimulation strategy had better results on all three parameters. Furthermore, it was shown through an extensive discussion that the results are not reliable. The most important conclusion from this research are that there is insufficient data available to be able to evaluate these intervention strategies. Therefore, this research suggests to investigate into ways to get a more complete and reliable dataset. Further research could also be done on a new pilot project by the environmental service of Flevoland, Gooi and Vechtstreek (OFGV). This project is a combination of both strategies and shows possibilities to obtain a more reliable and complete dataset.

Preface

Before you lies the master's thesis "The effect of intervention strategies on the energy consumption of SMEs: A case study on SMEs in the Netherlands.", which is a case study based on datasets provided by Energiepartners. It has been written for the master programme Energy Science at the Utrecht University as the final step to fulfil the graduation requirements. I have been engaged in performing this research from March to September 2020 on a 32 hour basis.

The project was undertaken at Energiepartners in the form of an internship. The goal was to explore what intervention strategy would have more impact on SMEs in the Netherlands, as Energiepartners performs both strategies. This research has provided me with new challenges, even at the end of my career at the Utrecht University. The biggest challenge was to write a thesis while quite soon knowing that I would not be able to give an answer to my research question as I had hypothesized. Thanks to the support of my supervisor Robert Harmsen, who convinced me that the results still mattered, I was able to finish this thesis. I would also like to thank him for giving me feedback on my work in an extensive way.

I would like to further thank my supervisor Lars Janssen and Leonard Tersteeg for helping getting all the data out of Energiepartners' software. Furthermore I would like to thank Ruben van Brenk for providing me with the necessary information from the municipality of Utrecht.

I hope you enjoy reading.

Mans Sopers

Utrecht, September 18, 2020

Table of contents

1. Introduction

In 2019 the Dutch government signed a climate agreement to reduce greenhouse gas emissions by 49 percent by 2030 compared to 1990 levels. This agreement will have a significant impact on all levels of society (Dutch Government, 2019). It was developed by over 100 stakeholders, representing five main sectors: the built environment, mobility, industry, agriculture and land use, and electricity (Dutch Government, 2019). The industry sector is by far the largest sector in terms of primary energy consumption, as shown in figure 1.

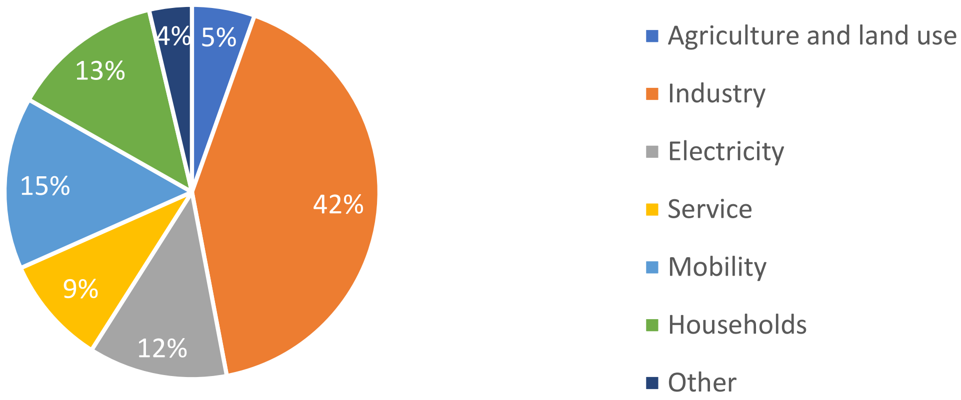

Figure 1: *Share of energy consumption by different sectors in the Netherlands in 2018 (CBS, 2019).*

The industry sector consists of around 60.000 companies, of which over 99 percent of the companies are SMEs (ECN, 2016). SMEs have often been overlooked when it comes to corporate social responsibility (Morsing & Perrini, 2009), despite being of considerable size when treating SMEs as one group. In the case of Dutch energy consumption, this is also shown in some of the numbers. The industry sector is responsible for 24 percent of the potential greenhouse gas emission reduction (Hekkenberg et al., 2019) and for 66 percent of the energy consumption of all companies in the Netherlands (ECN, 2016). Although it is not clear what the share of SMEs is in terms of energy consumption in the industry sector, the amount of companies that are SMEs in the industry sector show they should not be overlooked.

Recently, the environmental performance of SMEs has gained more attention (Blundel et al., 2013). In the Dutch climate agreement, policies are proposed on energy saving measures for SMEs. These measures are subject to an intervention strategy which should provide maximum effectivity and minimal administrative burdens for both the companies and institutions, and competent authorities (Dutch Government, 2019). However, what this intervention strategy should look like is left to regional and local authorities. The main strategy in the Netherlands is to enforce (InfoMil, n.d.-a), but some authorities choose a stimulation strategy (ODWH, n.d.).

It is yet unclear what the most effective strategy is. There has been research done towards climate mitigation policies and energy saving measures for SMEs. Blundel et al. (2013) reviewed the main types of environmental policy regarding SMEs implemented in the last 20 years. They did this by analysing four case studies in different European countries. Kalantzis and Revoltella (2019) researched the effectiveness of energy audits to help SMEs realize energy-efficiency opportunities. They show that an energy audit does support SMEs in breaking barriers such as the information barrier. Parker et al. (2009) reviewed different intervention strategies that are used to stimulate SMEs to improve environmental performance, and categorised SMEs based on different levels of environmental commitment. They proposed a holistic approach for implementing intervention strategies for SMEs with different levels of environmental commitment. Both Parker et al. (2009) and Blundel et al. (2013) concluded that more research on this topic is needed. Parker et al. (2009) also indicated that quantitative research is needed to support the theory they have developed. Andersson et al. (2018) did a study to the Swedish energy audit program by looking at industrial SMEs. Their main conclusions are that the program does not provide enough viable data to provide generalizing results. Kube et al. (2019) did a case study to research the impact of voluntary environmental programs, such as the stimulation program here. They find that there is no impact on CO_2 emissions and energy intensity. Finally, Fleiter et al. (2012) did an empirical analysis on de adoption of energy saving measures in SMEs in Germany based on audit data. They did a regression analysis to investigate the effects of multiple factors that could influence this adoption. Their study showed that the financing of especially high costs investments was a barrier, as well as the quality of the energy audits (Fleiter et al., 2012).

To add to the body of literature on this topic, both the enforcement and stimulation intervention strategies have been investigated and compared by means of a unique dataset. Furthermore, the aim of this research is to provide insights into the current Dutch intervention strategy. The research question was as follows:

What is the effect of enforcement and stimulation interventions on the energy consumption of SMEs in the Netherlands?

By answering the research question, the body of literature on intervention strategies for climate mitigation in SMEs is further expanded by adding quantitative results of the effect of different intervention strategies. Furthermore, the dataset that was used in this research is unique and not publicly available. Having done research with this dataset, the results can later on be compared with other case studies to create general theories. The results also have a social relevance, as they give information on the effectiveness of climate policies in the Netherlands regarding to SMEs. As stated earlier, different strategies are applied at this moment. This research can help working towards a single strategy that has the largest impact on climate mitigation of SMEs in the Netherlands.

In the past years, the municipality of Utrecht has already used regulation with enforcement in order to reduce energy consumption in SMEs. Furthermore, in the province of South-Holland a project took place that used stimulation in order to reduce energy consumption in SMEs. These projects have been executed by, amongst others, Energiepartners. This company also gave advice to SMEs to reduce energy. From both strategies, they have data available the can further expand the knowledge on the effectivity of intervention strategies. Since the municipality of Utrecht has SMEs in all subsectors (CBS, 2020), it is representative for the Netherlands.

This research continues by giving some background information on the current regulation in the Netherlands regarding climate mitigation for SMEs in chapter 2. This chapter also discusses the different intervention strategies that are currently applied and ends with a conceptual model. In chapter 3 the methods that were used are explained. The main parts will be on the data preparation, processing and analysis. Chapter 4 presents the results that were found. The results are discussed for both intervention strategies separately and they are also compared with each other. This chapter is also used to discuss the results. Finally, chapter 5 provides the conclusion and recommendations of this research.

2. Background

2.1 Dutch Environmental Law

Current legislation on climate mitigation for Dutch companies is based on the Environmental Law (RVO, n.d.-a). This is the most important environmental law in the Netherlands, as it determines what legal tools can be used to protect the environment. These tools consist of instruments such as permits, environmental quality demands and regulations (Rijkswaterstaat, n.d.). In addition to the Environmental Law, the Environmental Management Activities Decree dictates other environmental laws that mostly apply to companies (InfoMil, n.d.-c).

An important part of the legislation is the concept 'Environmental Law institution' (Wm-institution). Most of the legislations from the Environmental Law and the Environmental Management Activities Decree are only applied to Wm-institutions. According to the Environmental Law, something is a Wm-institution when; (1) it is a company or something that has the extent of a company; (2) the activities take place on one location, not multiple locations; (3) the activities take place during a timeframe of at least six month or is reoccurring at the same place on a regular basis; and (4) the activities are described in Appendix 1 of the Environmental Decree (InfoMil, n.d.-c).

2.2 Recognised measures and the notification obligation

The Environmental Management Activities Decree and the Environmental Law dictate that companies have an energy efficiency obligation. This applies to all Wm-institutions that use more than 50.000 kWh or 25.000 m^3 of natural gas annually. The energy efficiency obligation requires these companies to take energy efficiency measures with a payback period (PBP) of five years or less (RVO, n.d.-a).

These energy efficiency measures are predetermined in Appendix 10 of the Environmental Management Activities Decree (RVO, n.d.-a) and are divided into nineteen lists for different subsectors, such as office buildings or restaurants ("Regeling van de Minister", 2019). These lists are referred to as a 'Recognised Energy Efficiency Measures List' (EML) (RVO, n.d.-a) and have been constructed by the government in co-operation with trade associations ("Regeling van de Minister", 2019). An example of an EML for office buildings is presented in Appendix A.

In order to determine which measures of the EML have to be taken, all Wm-institutions with an energy efficiency obligation also have an energy efficiency notification obligation. In this notification companies show what energy-saving measures already have been implemented (RVO, n.d.-b). Furthermore, the companies have to give their energy consumption in the year 2017 or 2018.

2.3 Intervention methods

In order to determine whether a company has complied to the energy efficiency obligation, the competent authority uses interventions (RVO, n.d.-b). The authorities that are responsible for performing these interventions are municipalities and environmental services ("Regeling van de Minister", 2019). In general, the strategy for these interventions is to perform enforcement. When the information provided in the energy efficiency notification raises questions, the authorities might perform an inspection. If companies do not report in time, or measures or not implemented in time, enforcement actions may be taken. This could finally lead to financial consequences in the form of a non-compliance penalty payment (RVO, n.d.-b).

Some of the competent authorities choose for a different intervention strategy however. This strategy is to stimulate companies to save energy rather than enforcing them. The interpretation of this strategy is determined by the authorities themselves, which could lead to some variations in the approaches of different authorities. The Environmental Service of West-Holland (ODWH) is such authority. By providing a free energy efficiency audit including monitoring and supervision for a period of time, and the fulfilment of the energy efficiency notification obligation, the ODWH wants to stimulate companies to save energy (ODWH, n.d.). The same energy efficiency obligations apply to companies that are stimulated, but they have a longer period of time to realise these measures. In this case the ODWH provides stimulation for companies during a two year trajectory (ODWH, n.d.).

In order to determine which intervention strategy is more effective, it is important to investigate how they differ from each other. Since the aim of this research was to add to the current body of literature in a quantitative manner, social or political aspects were not considered. For example, there can be different reasons not to implement certain measures. These reasons can vary from economic reasons such as a long payback period to social or political reasons such as not believing in climate change. The two intervention strategies could deal with such aspects in different ways. The aspects that could be compared are the energy saving measures considered in the strategies and the time spent on each strategy.

2.3.1 Energy saving measures

As mentioned in section 2.2, the energy efficiency obligation states that companies have to comply to the EML. For the enforcement strategy, this is as far as the energy saving measures go. When a company has taken all applicable measures that are described in the EML, they have completed their energy efficiency obligation (RVO, n.d.-a).

The stimulation strategy goes beyond the EML. During the time period of the stimulation project, the energy use of the companies is being monitored and analysed. This leads to savings in their energy use behaviour. Furthermore, energy saving measures related to the building are assessed. This includes the assessment of renewable energy sources such as solar power (ODWH, n.d.).

2.3.2 Enforcement strategy

The general Dutch strategy is the enforcement strategy, which emphasizes more on the obligation to save energy. The steps taken with this strategy are shown in figure 2. The first step for companies is to comply to the notification obligation. This gives the authorities insight in which measures are implemented and which are not (InfoMil, n.d.-a). Two types of measures are distinguished; independent and natural moment measures. Independent moment measures have a PBP shorter than five years and have to be implemented as soon as possible. Natural moment measures have a longer PBP than five years and have to be taken when a natural replacement occurs, for example when a device is broken. The deadline for the notification obligation was July 1st 2019 (InfoMil, n.d.-a; InfoMil, n.d.-d).

The second step is the enforcement. Based on information from the notification obligation, authorities can choose to do a visual inspection. A representative of the authorities will go to the company to check the progress of implementing the energy saving measures. Based on their findings, a deadline will be set of a maximum of six months to implement the independent moment measures that are not yet implemented (InfoMil, n.d.-a).

The final step is the evaluation of the enforcement. When the deadline for implementing the remaining measures is expired, the company has to show proof of the measures that have been implemented. If everything is in order, the company has fulfilled its energy saving obligation. If not, a penalty payment can be used to force the company to take the remaining measures. The height of this penalty payment depends on the magnitude of the violation. Besides the penalty payment, the company is given a new deadline to implement the measures. This loop continues until the company has implemented all measures (InfoMil, n.d.-a).

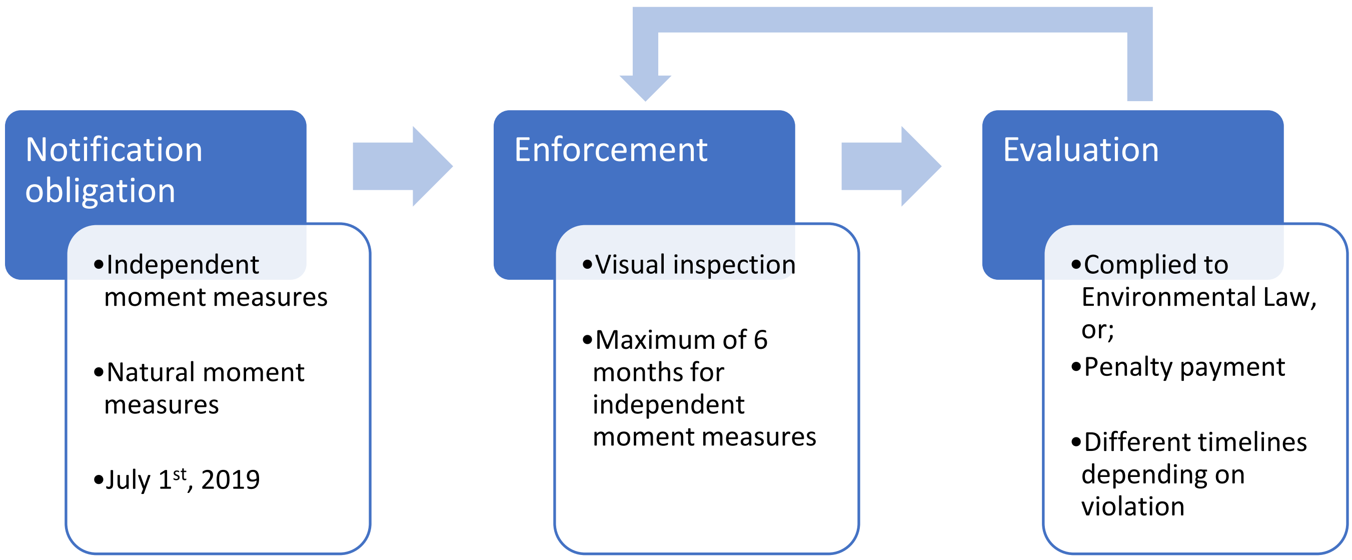

Figure 2: *Pathway of enforcement strategy, based on Dutch national policy (InfoMil, n.d.-a; InfoMil, n.d.-d).*

2.3.3 Stimulation strategy

The steps taken with the stimulation strategy are shown in figure 3. The first step of this strategy is to do a visual inspection of the building, which will be further referred to as the energy audit. Contrary to the enforcement strategy, this audit is focused on opportunities rather than to check if the company has implemented all recognized measures. Furthermore, smart electricity and, if possible, gas meters are installed to make analysis of the energy usage possible (ODWH, n.d.).

The next step is to do an analysis of the company. Based on the audit, energy saving measures can be suggested as well as renewable energy sources such as solar panels. Furthermore, the energy use patterns are analysed when the data is available. Together this forms an energy savings advice which the company can implement (ODWH, n.d.).

The final step is to implement the measures and to evaluate. This is an ongoing process during the time period of the stimulation. Companies are free to choose when the measures are implemented. The evaluation takes place in a frequent manner, for example each year. During the evaluation the progress is discussed and the energy use patterns are analysed again (ODWH, n.d.).

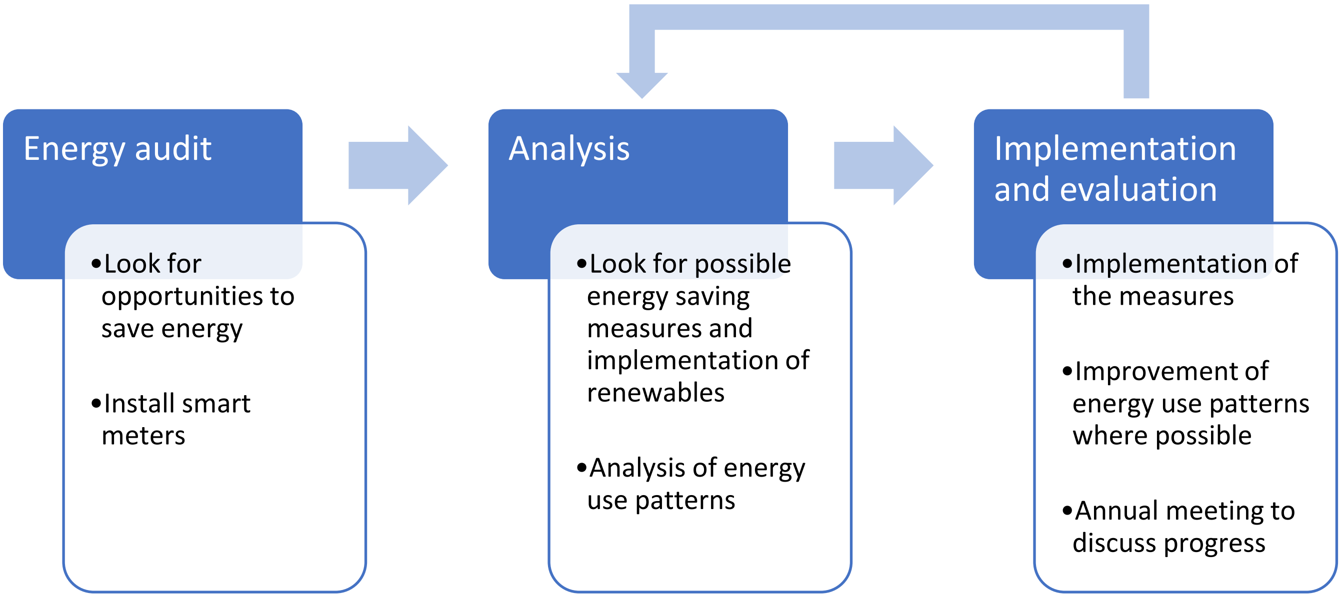

Figure 3: *Pathway of the stimulation strategy, based on Dutch regional policy (ODWH, n.d.).*

2.4 Conceptual model

Policy instruments can be judged based on their effectiveness (Blok & Nieuwlaar, 2016). The effectiveness determines how the policy instrument has added to the goal, in this case energy savings. The effectiveness of the policies in this research was tested by comparing the energy savings. To show how this was investigated, a conceptual model was built.

The conceptual model shown in figure 4 is divided into three steps; the start, evaluation and comparison of the strategies. In step 1 the starting conditions of both strategies were determined for the companies. These conditions are part of the notification obligation and energy audit. This step is also the part where most data was gathered and prepared for the analysis. Step 2 is the part where the strategies were executed. This step was used to evaluate both strategies. Information on the measures that were implemented was used to determine the potential energy savings of the companies. Furthermore, at the end of step 2 the information on the actual energy savings was used to evaluate the success of the intervention for each company. In the final step, the strategies were compared to each other.

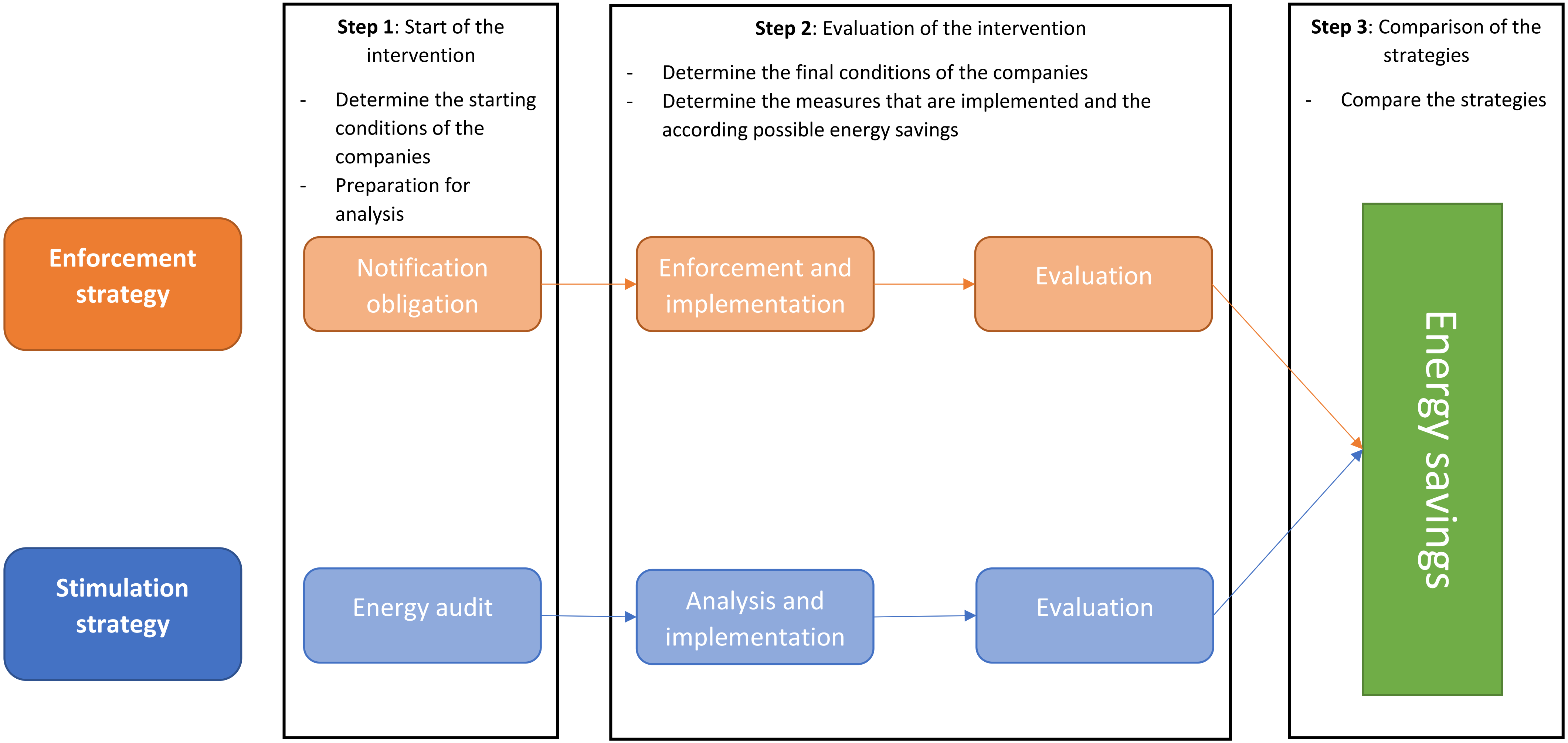

Figure 4: *Conceptual model.*

3. Methods

3.1 Data collection and preparation

Step 1 of the conceptual model was about retrieving all information on the companies and preparing it. The starting values for companies, such as energy consumption before the intervention, were determined and prepared in a way that makes it usable for step 2.

3.1.1 Data collection

Energiepartners had data available for both the enforcement strategy and the stimulation strategy from 2016 to 2018. The data for the enforcement strategy came from the inspections commissioned by the municipality of Utrecht. It showed for every enforced company what measures from the EML are already taken, what measures still have to be taken and their annual energy consumption before the intervention. The same sort of data was available for the project in South-Holland with the stimulation strategy, but for these companies all possible energy saving measures are based on what is suited for the company rather than following a general set of measures, such as the EML. This data was used to determine the energy saving potential of each strategy.

To determine the actual energy change, the energy consumption after the intervention was needed. For the stimulation strategy, this was also available at Energiepartners. The actual energy consumption is monitored during the stimulation period. As for the enforcement strategy, this data was available at the municipality of Utrecht as a part of the notification obligation. This data was from either 2017 or 2018, while the start of the interventions executed by Energiepartners started before 2016. Therefore, this data was suitable to determine the energy consumption after the intervention. It was requested from the municipality of Utrecht.

To compare the energy saving potential to the actual energy savings, data was needed on the energy saving potential of the energy saving measures. For all the measures described in the EML, the average energy savings that are presented by Stimular were used. Stimular is a foundation that helps companies and organisations to become more sustainable (Stimular, n.d.). They have worked out all measures to a detailed level, including numbers on possible energy and financial savings. These are the numbers that were used by the government to determine the payback period of the recognized measures. For the measures in the stimulation strategy calculations were used from Energiepartners.

In order to do an estimation of how much energy is saved by every measure, data was needed on how much energy every function of a company uses. To determine this, the subsector energy use per function was used. These figures were found in a research by Meijer & Verweij (2009), which was commissioned by RVO. Furthermore, subsector key figures were used combined with the total surfaces of the companies to determine the energy intensity of a company. This information was found in a research by ECN (Sipma & Rietkerk, 2016). The amount of degree days, which were used to correct the numbers for space heating, were found at Eurostat.

Finally, all other information was retrieved from scientific and grey literature. The information regarding to legislation came mostly from RVO and InfoMil. Data on energy consumption was searched for in subsector averages. An overview of all sources is presented in table 1.

Table 1: *Overview of data sources.*

Required data	Source
Applied energy saving measures	Energiepartners
Energy consumption	Energiepartners / Municipality of Utrecht
Calculations for energy saving measures	Stimular / Energiepartners
Energy use per function	Meijer & Verweij (2009)
Total surface of companies	Energiepartners
Key figures for subsectors	Sipma & Rietkerk (2016)
Information on legislation	RVO / InfoMil
Degree days	Eurostat
Other information	Scientific / Grey literature

3.2.2 Data preparation

The enforcement strategy data was reported in a uniform style in order to be able to analyse it later on. However, each company had its own Excel file. Because all the files were built in the same way, it was possible to gather all the data into a single file, making it easier to do an analysis. In order to get all the files together, a tool called *ASAP Utilities* was used. This is an extension for Excel that, amongst others, can import parts of other Excel files. With this tool it was thus possible to get all information needed in a single file for each strategy. In order to prevent a possible time loss, five random companies were prepared first to see if there are possible flaws in the method or execution of the method.

Due to limited data, not all subsectors were investigated. Only the subsectors that have data of at least 10 companies for both intervention strategies were taken into account. This was done to increase the validation of this research. Each subsector has its own measures list, since the EML for each sector differs from the others. Therefore, two Excel files were made, one for each subsector. These subsectors were *offices* and *hotels & restaurants*, which will be further referred to as *restaurants*. To complete the data, two additions were made. Both the current energy consumption and size of the companies were not in the files. However, this data was available at Energiepartners and added to the analysis.

For the stimulation strategy an extra step was needed. This data was not yet in a uniform format available, thus such format needed to be created first. After that, all companies that were investigated were processed into the uniform file and further prepared in the same manner as the enforcement strategy data.

3.2.3 Dataset

Once the data was prepared, two single Excel files remained; one for the enforcement strategy and one for the stimulation strategy. Each file consisted of a list energy saving measures for every company in each of the subsectors, their annual energy consumption, amount of energy saving measures and surface. An overview of the dataset is found in Appendix B. Some findings that were obtained during the data collection and preparation are discussed below.

Part of the data preparation was to filter out incomplete results. The datasets started with 69 files for the stimulation strategy and 248 files for the enforcement strategy, with each file containing information on one company or building. In order to take the files into account, the files should at least contain the starting energy for gas and electricity and contain a complete list of energy saving measures. The complete list of energy saving measures is only applicable to the enforcement strategy, as these lists were manually filled out by the enforcer. Furthermore, the energy consumption levels after executing the recognized energy saving measures were gathered from the municipality of Utrecht for the enforcement strategy. This was a different dataset and had a lot of mismatches with the dataset used for this research. After filtering out the files that had incomplete data, 47 files remained for the stimulation strategy and 54 for the enforcement strategy. That is a total loss of 68 percent, of which most of the data is lost at the enforcement strategy.

3.3 Data processing

To prepare for the data analysis, the calculations for both strategies were executed. This is what happened in step 2 of the conceptual model. Both Excel files then consisted of a list of all potential measures for each company, including their energy consumption at the starting point and their total surface. The main goal of this part of the research was to determine the potential energy savings, so it could be compared to the actual energy savings. To calculate these potential energy savings, several steps were taken. These steps are presented in figure 5. The steps were taken for both intervention strategies. There were some minor differences, which are discussed below.

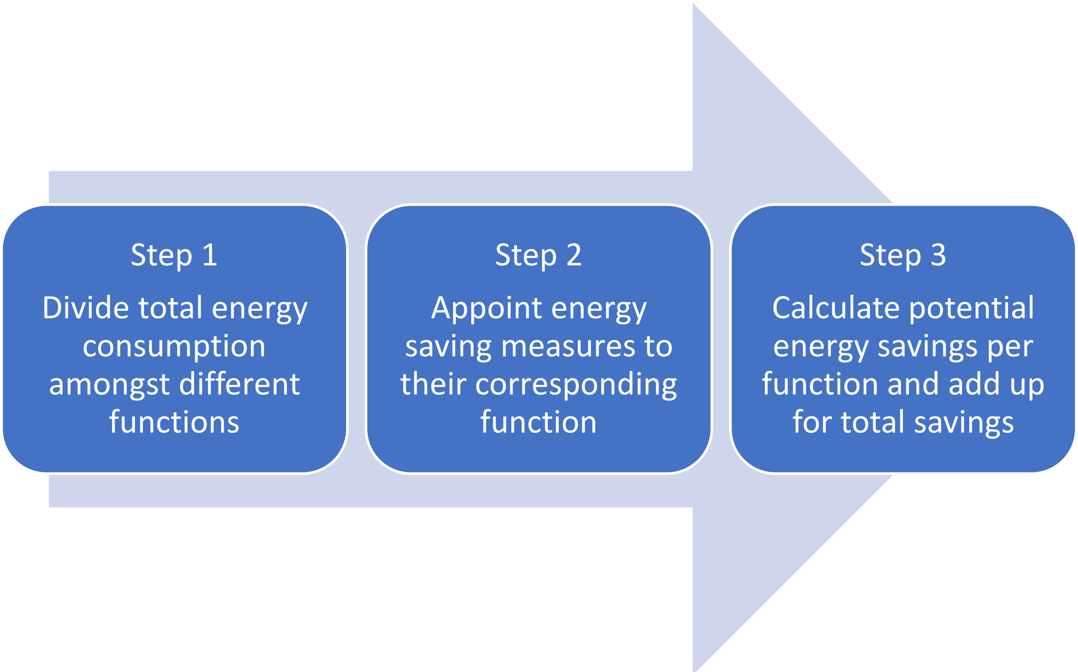

Figure 5: *Processing of the data visualised. This process is executed in step 2 of the conceptual model and is divided into three sub steps.*

The first step was to add the energy use per function to each subsector. This divided their total energy use amongst different functions, which made it easier to determine the energy savings of the possible measures that are taken. The figures from Meijer & Verweij (as mentioned in section 3.1) were presented in MJ/m^2. Since the initial energy consumption is already known, these numbers were first rewritten as percentages. An example of the energy use per function is presented in table 2. With these numbers, the energy consumption of every function for each company was calculated.

Table 2: *Energy consumption for each function in office buildings, in percentages of total energy consumption (Meijer & Verweij, 2009).*

Function	**Electricity consumption (%)**	**Gas consumption (%)**
Space heating	0	99.72
Cooling	9.41	0.14
Hot tap water	0.73	0.12
Humidification	0.26	0.02
Miscellaneous	3.39	0
Catering	6.79	0
ICT (centralised)	20.36	0
ICT (decentralised)	12.22	0
Pumps	2.04	0
Product preparation	0	0
Product cooling	0	0
Transport	2.04	0
Ventilation	5.43	0
Lighting (inside)	35.30	0
Lighting (outside)	1.36	0
Lighting (emergency)	0.68	0
Total	100	100

Furthermore, space heating is affected by the outside temperature and was thus corrected by using degree days. This was done for both the starting energy consumption as the energy consumption after the measures had been taken. The share of energy that was used for space heating is determined by using the key figures for subsectors. The calculations were done by using the formula 1, which is a ratio equation. Space cooling was not corrected for cooling degree days, as the share of energy consumption for space cooling could only be estimated. This could have led to a larger error margin as a consequence.

(1) $$Q_{t,a} = Q_t * c * \frac{HDD_a}{HDD_t}$$

$Q_{t,a}$ = corrected amount of gas equivalent consumption at year t
Q_t = amount of gas equivalent consumption at year *t*
c = percentage of gas equivalent used for space heating
HDD_t = number of degree days at year *t*
HDD_a = average number of degree days

The next step was to appoint the energy saving measures to their corresponding function. The EML was already divided into measures for different functions of a building or company processes. For example, measures GD1 and GD2 for office buildings are related to space heating (Appendix A; InfoMil, n.d.-b). It is possible that multiple measures are related to a single function. For the stimulation measures the division was made for all measures individually. However, there was an exception for renewable energy measures. These were not linked to a specific function, but to the company's total energy use. Therefore, it was possible to get energy savings of over 100 percent.

The final step was to calculate the possible energy savings for each function and adding them together to get the total possible energy savings for each company. This was done by using the saving percentages that were provided by Stimular. When a range of possible energy savings was provided, for example 10 to 20 percent savings on ventilation, the average number was used. There were many factors that could determine if the savings are higher or lower, but these factors were not investigated in this research. This could have affected the potential energy savings, but since the actual energy savings were also calculated this was taken in to account.

When there were multiple measures related to a single function, the savings were calculated in different steps. This was done by using formula 2. After all energy savings for each function were calculated, they were summed up to get the total energy savings for each company.

(2) $$E_{tot,x} = E_x * \alpha + (E_x * \alpha) * \beta + (E_x * \alpha * \beta) * \gamma + \cdots$$

$E_{tot,x}$ = total energy savings for function *x*
E_x = energy consumption of function *x*
α = possible energy saving for measure A in %
β = possible energy saving for measure B in %
γ = possible energy saving for measure C in %

3.4 Data analysis

The final step of the conceptual model was where the two strategies are compared. As mentioned in section 2.4, policy instruments could be measured by looking at the effectiveness. The effectiveness could be calculated with the saved energy and total surface used. This was done by using formula 3. Note that the effectiveness also could be calculated for each building individually.

(3) $$E_{efficiency,i} = \frac{E_{saved,i}}{S_{total,i}}$$

$E_{effectiveness,I}$ = effectiveness of policy measure *i* in kWh/m^2 or m^3 natural gas/m^2
$E_{saved,I}$ = total energy saved by policy measure *i* in kWh or m^3 natural gas
$S_{total,I}$ = total surface of the buildings in policy measure *i*

The results from both strategies were first analysed separately. In this part, the aggregated results for both subsectors were analysed by looking at the potential energy savings and change in actual energy consumption at different levels[1]. The different levels are parameters such as energy savings per building or per square meter. Furthermore, the results per building were analysed in the same manner and by looking at the effect individual buildings had on the aggregated results. After the analysis of the

[1] The change in actual energy consumption is in this case the observed change when comparing the energy consumption levels before and after implementing energy saving measures and is further referred to as *actual energy change*. A positive number for the actual energy change means energy savings, while a negative number means more energy is used than before.

results per building, the intermediate results were discussed. Since this research followed several steps to do the analysis, some insights were gained while doing the analysis. This part focused mostly on possible explanations for the results found in the first part. This was mainly done by analysing the data in terms of quality, suitability and availability. The final step was to compare both strategies. This was done by analysing the results of the first two parts in light of each other. This is done by looking at the average energy savings, average amount of energy saving measures and data completion.

By comparing the average energy savings, a perspective is provided on the effects both strategies have on SMEs in the Netherlands. This gives insights for both strategies in the potential to save energy and how much of that potential is actually realised in respect to each other. Comparing the average amount of energy saving measures provides insights in the potential to save energy for both strategies. This gives an indication of the added value in terms of possible energy savings for the stimulation strategy. Finally, comparing the data completion gives an indication of the accuracy and availability of the data for both strategies. Since this research aims to determine the effect of both strategies on energy savings for SMEs in the Netherlands by using this data, the availability and completion of the data show how representative the data is and how well the data can be used for an analysis such as this.

4. Results & Discussion

The results & discussion chapter is divided into four sections. The first two sections provide the overall results for the enforcement and stimulation strategy. The third section discusses the results by zooming in on the different steps made during the analysis and by discussing the intermediate results and other insights gained during the analysis. This is done to support the findings in the first two sections, as not all findings could be explained there. The chapter finishes by comparing both strategies in the fourth section.

4.1 Enforcement strategy

4.1.1 Office buildings

Aggregated results

The offices have on average 3 energy saving measures per building and the amount of energy saving measures vary from 0 to 9 measures per building. The potential energy savings and actual energy changes of all buildings are presented in table 3. The actual electricity change is 51 percent higher than the potential savings predict, while for gas an increase in consumption is found. For both the actual electricity as gas change, it appears that these deviations from the potential savings are caused by extremes[2] in the individual results. The range of energy use for buildings shows that the most positive individual actual electricity change is already more than the sum of potential savings. For gas a similar trend is visible, although for gas the building with the most negative actual gas change is almost equal to the total actual gas change.

Table 3: *Potential energy savings and actual energy change of office buildings with an enforcement strategy. * The amount of office buildings for enforcement are 31. One building lacks data on the actual electricity change, four lack data on the actual gas change. One building does not use gas.*

	Amount	Range*	Unit
Total potential electricity savings	754,016.88		kWh / year
Total actual electricity change	1,138,845.00		kWh / year
Total potential gas savings	59,658.68		m^3 gas eq. / year
Total actual gas change	-64,130.28		m^3 gas eq. / year
Average potential electricity savings per building	24,323.13	225,734.89 ↔ 0.00	kWh / building / year
Average actual electricity change per building	36,736.94	759,210.00 ↔ -150,754.00	kWh / building / year
Average potential gas savings per building	1,988.62	18,176.40 ↔ 0.00	m^3 gas eq. / building / year
Average actual gas change per building	-2,137.68	21,266.33 ↔ -61,437.38	m^3 gas eq. / building / year
Average potential electricity savings per m^2	6.66	44.12 ↔ 0	kWh / m^2 / year
Average actual electricity change per m^2	10.06	269.50 ↔ -32.10	kWh / m^2 / year

[2] A result is considered an extreme when it is at least two times as high or low as the average savings or change.

Average potential gas savings per m^2	0.53	5.40 ↔ 0	m^3 gas eq. / m^2 / year
Average actual gas change per m^2	-0.57	13.95 ↔ -66.06	m^3 gas eq. / m^2 / year

The presence of extremes in the data is also shown when comparing the range with the averages. In all cases it is shown that the upper and lower bound values of the range are multiple times larger than the averages. This is both the case for the actual energy changes as for the potential savings and also for both the averages per building as the averages per square meter. Furthermore, the edge cases of the range for the potential energy savings and actual energy changes are far away from each other. It is possible that building size also has an influence on these results, as the company sizes also show a range with wide edge cases. To find possible explanations for these results, the next part looks at the results per building.

Results per office

The potential electricity saving and actual electricity change per building are presented in figure 6. It shows that 12 out of 31 offices had no possible electricity saving measures based on the EML. The possible reasons for this are further discussed when also looking at the gas savings. These offices without savings could be a reason to why the actual electricity change is 51 percent higher than the potential electricity savings, as the buildings could have had additional electricity saving measures beyond the EML. The figure further shows that 15 out of 31 offices have a negative actual electricity change. The numbers presented here cannot explain this, but this is further discussed in section 4.3.

Furthermore, there are 6 out of 19 offices in which energy saving measures have been implemented and actually saved electricity. Two of those had higher savings than estimated, which are office building 13 and 14. The data does not provide any possible explanations on why these buildings show higher actual electricity changes than estimated. Buildings 13 and 14 show no extremes in their surface area and electricity consumption levels, but other possible explanations are further discussed in section 4.3.

Besides the many office buildings with negative actual electricity changes, there are also some extremes that show positive electricity changes that are multiple times higher than most other positive changes. Buildings 9, 13, 24, 2 and 28 all show actual electricity changes that are at least 4 times more than the average electricity change. The figure shows that out of these 5 extremes, only one had potential electricity savings. As mentioned before, this could indicate that other energy saving measures have been taken or that a change in the building's occupancy has occurred.

In the aggregated results section the role of a building's size was also discussed. A difference in size could influence the electricity change in multiple ways, such as the need for more advanced climate systems and extra facilities such as a cafeteria in larger buildings. However, the data shows no connection between the building size and the electricity changes. This is best illustrated by comparing buildings 2 and 28, who show an almost similar actual electricity change per square meter. Building 2 has a surface area of 18,464 m^2, while building 28 has a surface area of 924 m^2. Similar results can be found when looking at office buildings with negative actual electricity changes. There are also no connections found between building sizes when looking at the potential electricity savings.

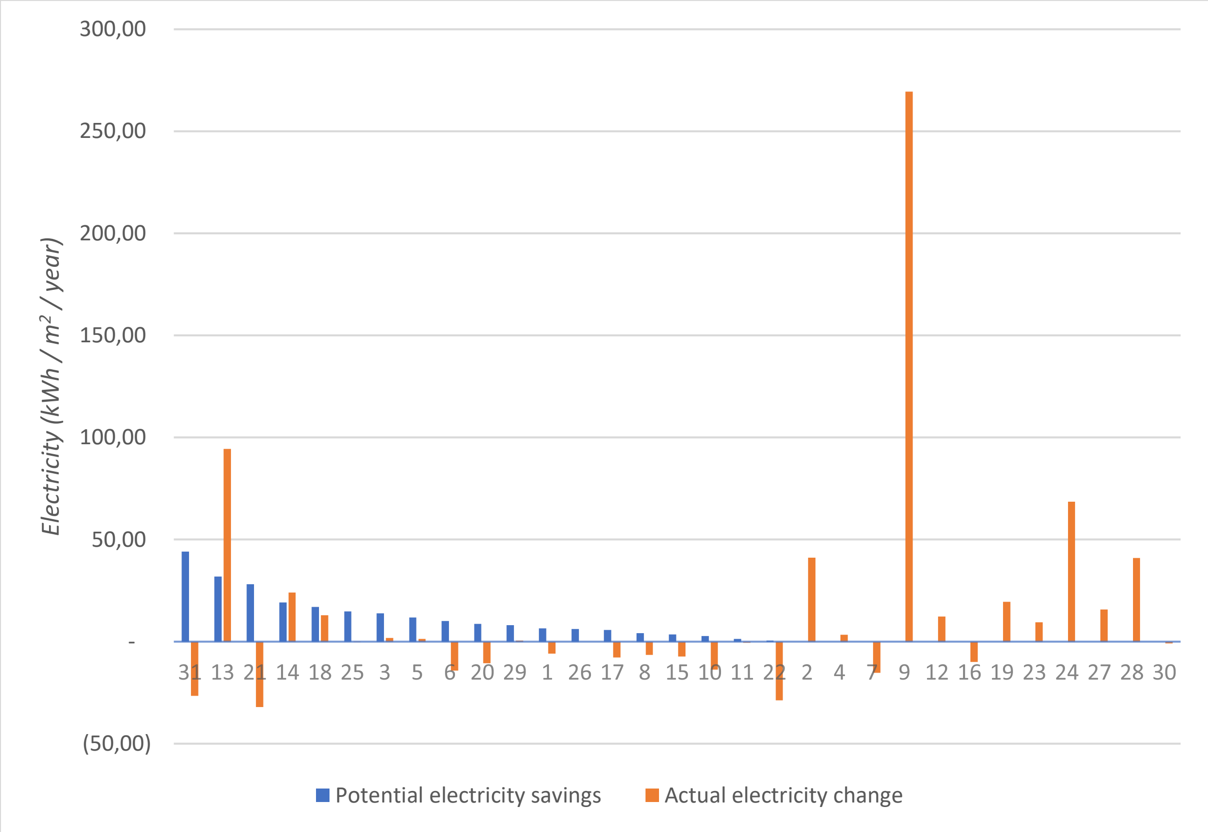

Figure 6: *Potential electricity savings and actual electricity change of office buildings in the enforcement strategy.*

The potential gas savings and actual gas change per building are presented in figure 7. It shows that 17 out of 31 offices had no gas saving measures based on the EML. 9 out of these 17 buildings also had no potential electricity savings. There could be two explanations for that. These are that these 9 buildings had already complied to the Environmental Law, or the energy saving measures were not documented or inventoried correctly. It is however not possible to indicate which situation applies, as both scenarios could still show positive actual gas or electricity savings by either taking energy saving measures beyond the EML or by taking measures of the EML that have not been documented or inventoried correctly.

The figure further shows that 14 offices have a negative gas change. Contrary to the previous paragraph, there seems to be no clear connection between gas and electricity as only 5 buildings have a negative change for both gas and electricity. Out of the 14 offices that have implemented energy saving measures, 6 offices actually have gas savings. Two of those have more savings than the potential savings estimated, which are offices 11 and 18. As the data has been corrected for degree days, a difference in temperature of the compared years would not explain these results. Similar to the case with electricity, the data does not provide a reason why these offices have more savings than estimated.

When looking at figure 7, the first extreme to notice is building 27. It has a negative actual gas change which almost compensates for all positive actual gas changes together. While building 27 has the highest impact in terms of actual gas changes, building 9, 10 and 22 can also be considered as extreme results for positive actual gas changes, as well as building 31, 14, 13 and 21 for negative actual gas changes. All of these have an impact on the actual gas change which is at least 6 times as high as the average impact. Similar to the case with electricity, this too is not explained by looking at the results that are presented in this research.

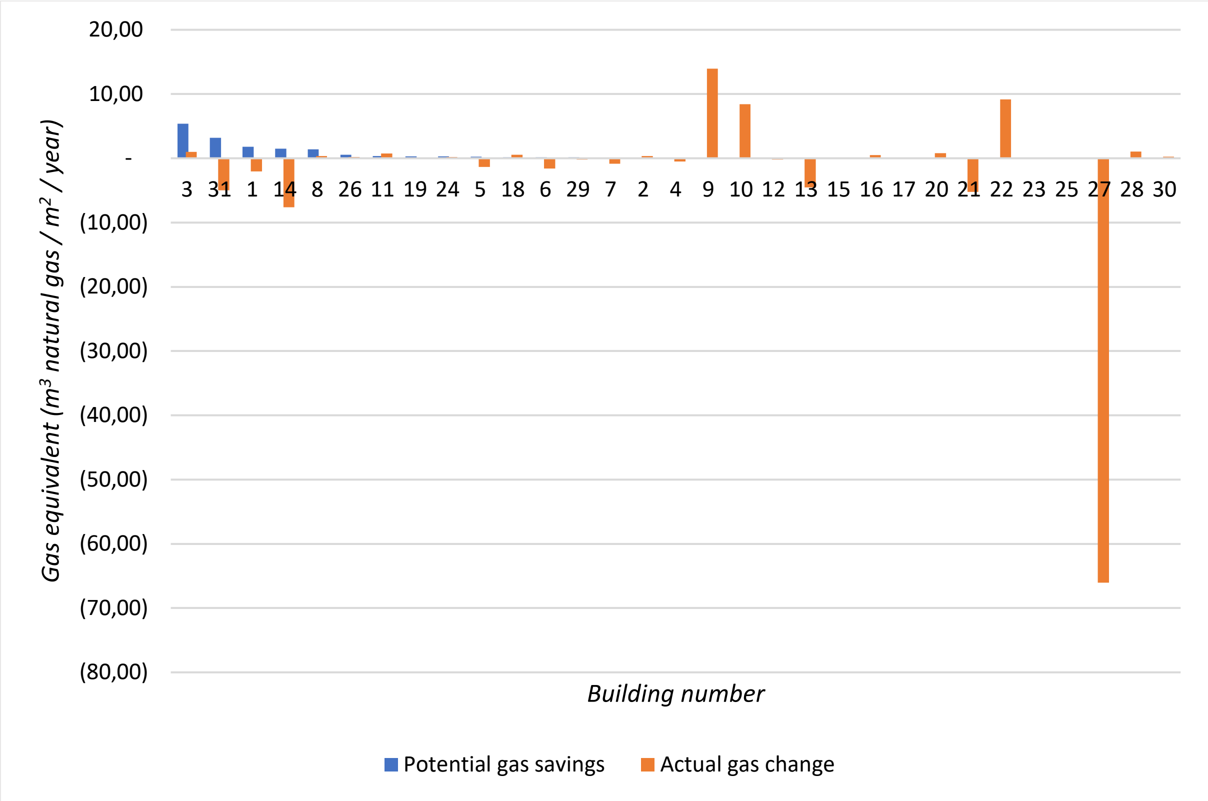

Figure 7: *Potential gas savings and actual gas change of office buildings in the enforcement strategy.*

4.1.2. Restaurants

Aggregated results

The restaurants have 5 energy saving measures on average per building and the amount of energy saving measures vary from 0 to 9 measures per building. The potential energy savings and actual energy changes are presented in table 4. Contrary to the office buildings, for restaurants actual electricity changes show an increase of consumption, while the actual gas changes show a 455 percent higher decrease in gas consumption than the potential savings estimated. Similar to the office buildings, it appears that extremes in the results are the main cause of the difference between potential energy savings and actual energy change. The negative edge case for the actual electricity change gives an even greater increase in electricity consumption than all the restaurants combined, while the positive edge case for gas shows almost as much savings as the restaurants combined.

*__Table 4:__ Potential energy savings and actual energy changes of restaurants with an enforcement strategy. * The amount of restaurants for the enforcement strategy are 22. 3 restaurants had no data on actual gas change, while 2 restaurants do not use gas.*

	Amount	Range*	Unit
Total potential electricity savings	231,751.34		kWh / year
Total actual electricity change	-53,238.00		kWh / year
Total potential gas savings	7,457.63		m³ gas eq. / year
Total actual gas change	41,406.42		m³ gas eq. / year
Average potential electricity savings per building	10,076.15	124,271.19 ↔ 0	kWh / building / year
Average actual electricity change per building	-2,314.70	57,600.00 ↔ -136,580.00	kWh / building / year
Average potential gas savings per building	324.24	13,751.76 ↔ 0	m³ gas eq. / building / year
Average actual gas change per building	1,800.28	39,070.73 ↔ -8,371.70	m³ gas eq. / building / year
Average potential electricity savings per m²	8.95	64.88 ↔ 0	kWh / m² / year
Average actual electricity change per m²	-2.06	89.50 ↔ -390.23	kWh / m² / year
Average potential gas savings per m²	0.29	4.44 ↔ 0	m³ gas eq. / m² / year
Average actual gas change per m²	1.60	41.76 ↔ -38.36	m³ gas eq. / m² / year

When comparing the ranges with the averages for buildings and per square meter, it also indicates the presence of extremes in the results. The edge cases have a deviation from the averages of at least 700 percent. Furthermore, when looking at the ranges for gas per square meter, it is shown that the potential gas savings are significantly lower than the actual gas change. In order to find an explanation for these results, the next section looks at the results per building.

Results per restaurant

The potential electricity savings and actual electricity changes are presented in figure 8.This shows that 12 out 23 restaurants had no potential electricity savings based on the EML. While for office buildings it was suggested that this was a possible explanation for the higher actual electricity changes, for restaurants the actual electricity change is negative. This does not make the conclusion in the previous section wrong, but it is likely that there is at least another factor that has influence on the actual electricity change. A possible explanation was also suggested in the previous section. It showed that a lot of buildings had no potential energy savings for both gas and electricity. In this case however, this is only seen at three buildings. Since more than 50 percent of the restaurants have no potential electricity savings, this could be a coincidence. Nevertheless it is noteworthy that more than 50 percent of the restaurants had no potential electricity savings. As the results for electricity do not give an alternative explanation, this is further discussed in section 4.3.

Based on figure 8, there are 5 extremes in the results in terms of actual electricity change with restaurants 13 and 9 as the respective positive and negative edge cases. It should be noted however that restaurant 13 also has the highest potential electricity savings. These restaurants all have a surface area between 282 and 450 square meters. With an average of 1,126 square meters these restaurants are considered small of size. However, when looking at all the results it does not show that there is a connection in building size and actual electricity change for restaurants. The same is found when looking at the potential electricity savings and building size.

Finally, the results show that out of the 8 restaurants with a negative actual electricity change, only two had potential electricity savings. This could indicate that the restaurants have already implemented all measures from the EML and possibly more. Therefore, it would not be less likely to that these restaurants are able to implement other energy saving measures, making it less like likely to save electricity. In that case, other factors such as an increase in production could explain the negative actual electricity change. This is also further discussed in section 4.3.

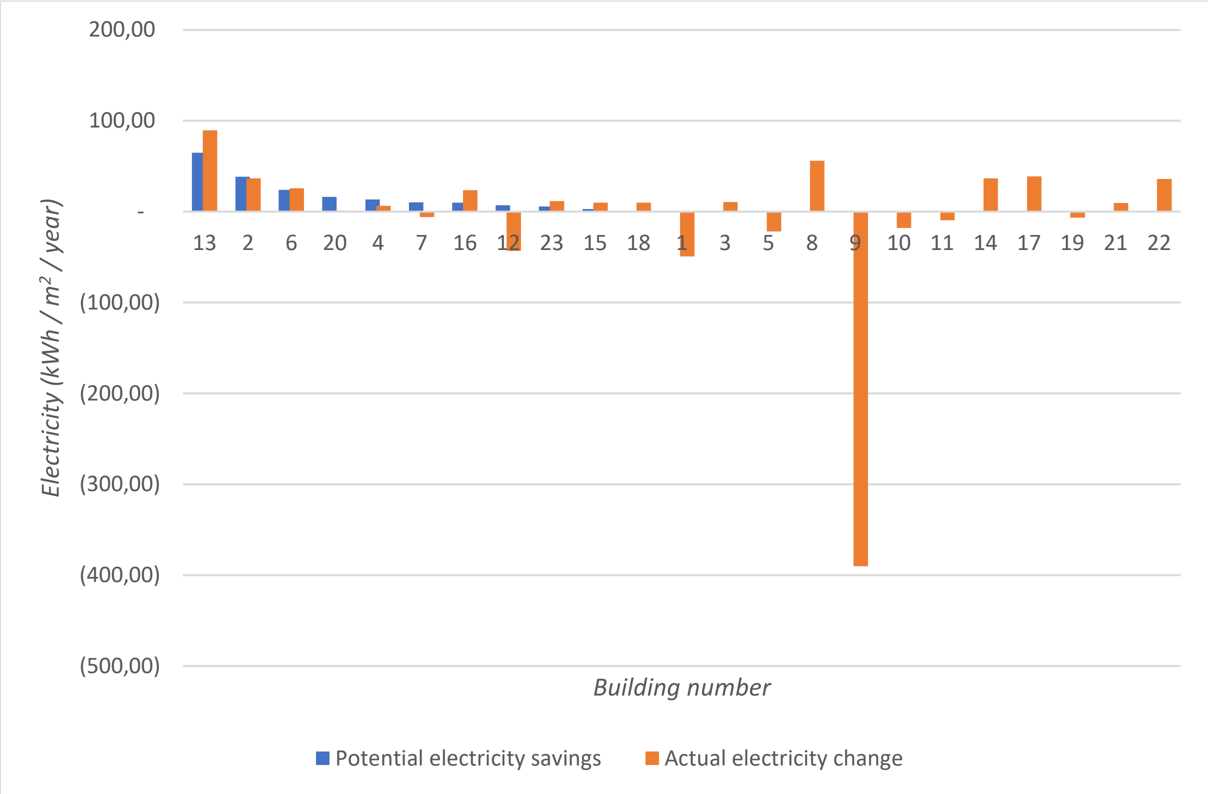

Figure 8: *Potential electricity savings and actual electricity change of restaurants in the enforcement strategy.*

The potential gas savings and actual gas change of the buildings individually are presented in figure 9. While for the actual electricity change the extremes were mostly limited to restaurant 9, for the actual gas change more extremes are found. There are 6 negative extremes and 3 positive ones. There are no explanations found in the results to explain these numbers, but on restaurant stands out. Restaurant 9 had the most extreme result for electricity, as it showed a large increase in electricity consumption. For gas it shows the opposite, which is a decrease in gas consumption. The input data shows that the gas consumption after the enforcement was 0, which means they switched to electrical heating. This explains the extremes, but this is not a part of the EML. The other 4 restaurants that show a large positive actual gas change, restaurants 18, 17, 20 and 6, all have positive actual electricity changes too.

Figure 9 further shows 8 negative actual gas changes. Where the previous sections could not find a connection between the building size and actual energy change, these restaurants are all relatively small. All 8 are below the average of 1,126 square meters and 7 out of 8 are smaller than 300 square meters. To compare, in the other 15 results only 3 restaurants have a surface area of less than 300 square meters.

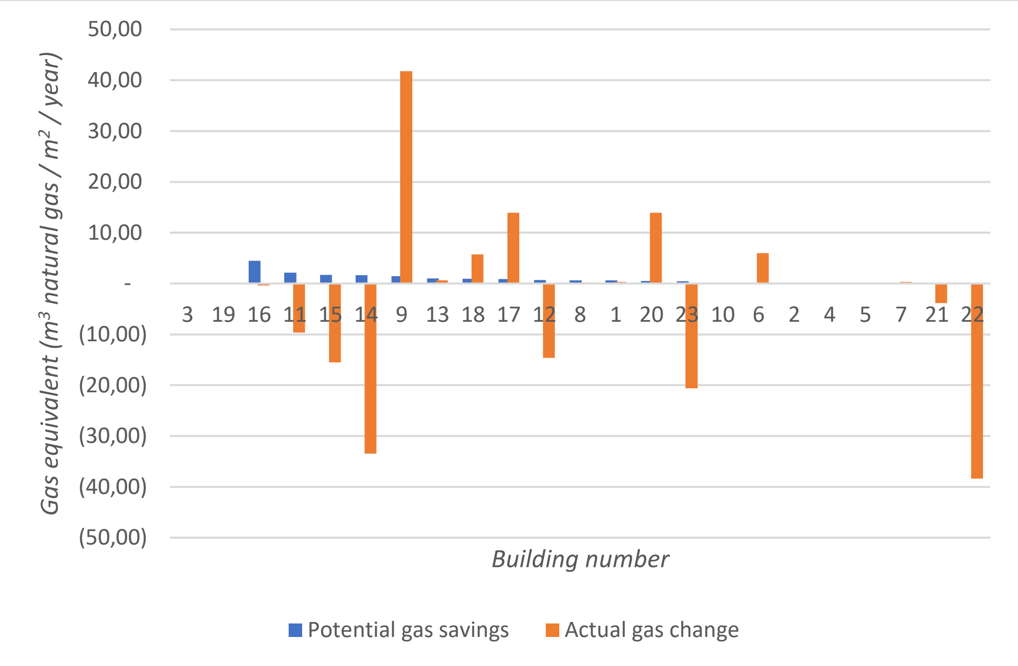

Figure 9: *Potential gas savings and actual gas change of restaurants in the enforcement strategy.*

4.2 Stimulation

4.2.1 Office buildings

Aggregated results

The potential energy savings and actual energy changes are presented in table 5 and have 10 energy savings measures on average per building. The amount of energy saving measures varies from 4 to 22. This shows that for every building it is possible to save energy, whereas the previous section showed a lot of buildings without energy saving measures.

Table 5: *Potential energy savings and actual energy changes of office buildings with a stimulation strategy. * The amount of office buildings for the stimulation strategy is 31. There are 3 buildings that have electrical heating and 9 more that have no data on the actual gas change.*

	Amount	Range*	Unit
Total potential electricity savings	900,832.00		kWh / year
Total actual electricity change	-775,148.09		kWh / year
Total potential gas savings	93,653.00		m^3 gas eq. / year
Total actual gas change	163,064.80		m^3 gas eq. / year
Average potential electricity savings per building	29,059.10	317,610.00 ↔ 3,220.00	kWh / building / year

Average actual electricity change per building	-25,004.78	152,206.95 ↔ -946,133.42	kWh / building / year
Average potential gas savings per building	3,229.41	12,451.00 ↔ 0	m^3 gas eq. / building / year
Average actual gas change per building	5,622.92	47,708.31 ↔ -757.99	m^3 gas eq. / building / year
Average potential electricity savings per m^2	15.40	254.09 ↔ 0.93	kWh / m^2 / year
Average actual electricity change per m^2	-13.25	55.98 ↔ -228.66	kWh / m^2 / year
Average potential gas savings per m^2	1.60	20.75 ↔ 0	m^3 gas eq. / m^2 / year
Average actual gas change per m^2	2.79	38.17 ↔ -3.03	m^3 gas eq. / m^2 / year

The actual electricity change shows an increase in consumption, while for gas the actual changes are 74 percent higher than the potential gas savings had estimated. Similar to earlier findings, the ranges indicate the presence of extremes in the results. The negative edge case for the actual electricity change uses almost 175,000 kWh more per year than all buildings combined. That difference alone is 7 times as much as the average actual electricity change per building.

When only looking at the positive edge cases for electricity per square meter, this is the only case in which the potential savings are higher than the actual savings. This could indicate that while most results show extremes in the actual energy changes, this case could also show extremes in the potential electricity savings. This and the other findings are further explored by investigating the results per building in the next section.

Results per office

The results of the potential electricity saving and actual electricity change of the buildings are presented in figure 10 and shows that every office has potential electricity savings. This is probably due to the stimulation strategy, as it seeks to provide as much savings potential as possible. Only when a company has a perfect energy household, no more energy saving measures would be added.

The figure shows that 6 out of 31 offices have negative actual changes, of which 2 are extremes. These are buildings 14 and 5. These two buildings do not show any noteworthy results that could explain why they show such negative actual electricity change, however building 14 does show the highest potential electricity savings. This finding cannot be explained by these results, therefore it is discussed in section 4.3.

The other 25 offices all saved electricity. Furthermore, 5 out of these 25 offices show higher actual changes than the potential savings estimated. However, the figure clearly shows that even without the two negative extremes, the potential electricity savings would be higher than the actual electricity change. This could be caused by a wrong estimation of the potential savings by the advisor, or because the measures were not executed as the stimulation strategy was voluntary in this case. There are also other possible explanations, which are discussed in section 4.3.

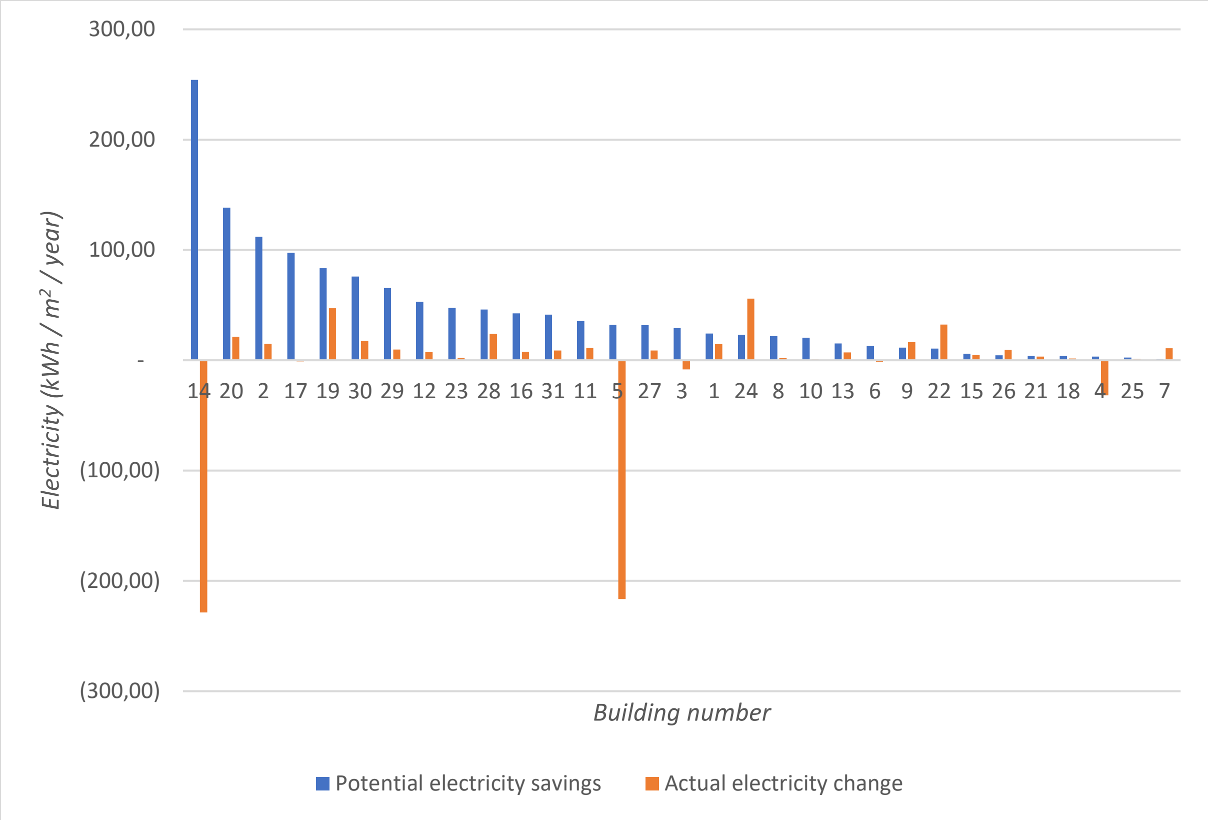

Figure 10: *Potential electricity savings and actual electricity changes of office buildings in the stimulation strategy.*

The potential gas savings and actual gas change of the buildings are presented in figure 11, which shows that 3 of the offices have a negative actual gas change. The data however shows nothing that could indicate why the actual gas change is negative for these buildings. What is more noteworthy is that 9 out of the 26 offices that use gas have no gas data, since the data analysis is an important aspect of the stimulation strategy. This could be caused due to technical reasons or costumers that are unwilling to invest in a smart gas meter.

While there are hardly any negative actual gas changes, there are some extremes for positive actual gas changes. The highest of these extremes is building 14, which also had the most extreme result for electricity. Similar to the case seen in the restaurants part of section 4.1, this can be explained by the building being removed from the gas grid. The large amount of positive actual gas change and negative actual electricity change are explained by this. Building 3 and 11 also showed large positive actual gas changes without much gas savings potential. However, these cases could not be explained with these results. This is further discussed in section 4.3.

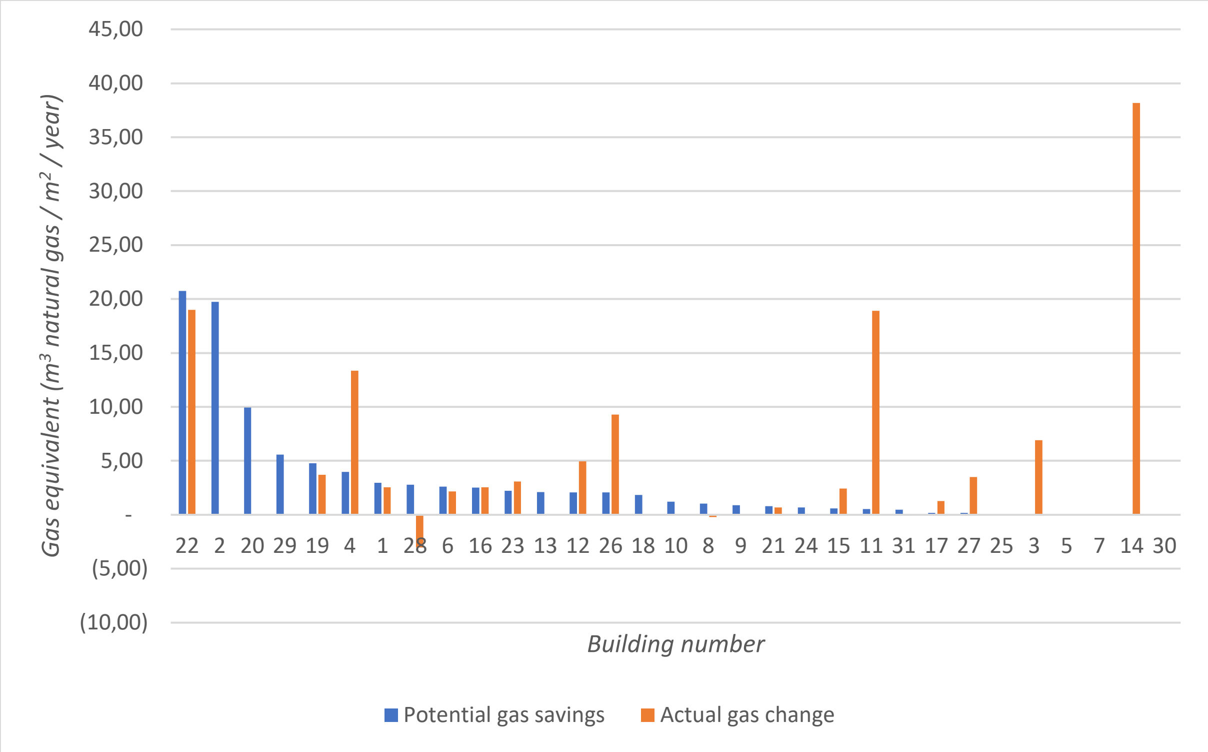

Figure 11: *Potential gas savings and actual gas change of office buildings in the stimulation strategy.*

4.2.2 Restaurants

Aggregated results

Similar to the offices, restaurants have the potential to save energy in all cases. They have 9 energy saving measures on average per building and the amount of energy saving measures vary from 5 to 22 measures per building. The potential energy savings and actual energy changes are presented in table 6.

Table 6: *Potential energy savings and actual energy changes of restaurants with a stimulation strategy. * The amount of restaurants for the stimulation strategy are 16. One of the restaurants uses electricity for cooking and heating, while 2 restaurants have no data on the actual gas change.*

Stimulation	Amount	Range*	Unit
Total potential electricity savings	141,480.00		kWh / year
Total actual electricity change	95,997.29		kWh / year
Total potential gas savings	26,153.00		m^3 gas eq. / year
Total actual gas change	46,954.86		m^3 gas eq. / year
Average potential electricity savings per building	8,842.50	113.280,00 ↔ 1,470.00	kWh / building / year
Average actual electricity change per building	5,999.83	37,851.71 ↔ -34,594.56	kWh / building / year
Average potential gas savings per building	1,743.53	8,737.00 ↔ 50.00	m^3 gas eq. / building / year

Average actual gas change per building	3,130.32	16,844.05 ↔ -182.08	m^3 gas eq. / building / year
Average potential electricity savings per m^2	9.77	119.94 ↔ 4.20	kWh / m^2 / year
Average actual electricity change per m^2	6.63	195.17 ↔ -128.13	kWh / m^2 / year
Average potential gas savings per m^2	1.81	32.36 ↔ 0.09	m^3 gas eq. / m^2 / year
Average actual gas change per m^2	3.24	20.84 ↔ -0.61	m^3 gas eq. / m^2 / year

From all 4 possible scenarios, this is the only one that has positive actual energy changes for both electricity and gas. For electricity the actual changes are 32 percent lower than the estimated potential savings, for gas the actual changes are 80 percent higher. Furthermore, this is also the only scenario that has possible savings for both gas and electricity for all restaurants.

While both actual energy changes are positive, the ranges still show the presence of extremes in the data. This is the case both when comparing the edge cases to the total savings and changes as well as when comparing them to the average savings and changes. This is further explored in the part below.

Results per restaurant

The potential electricity savings and actual electricity changes are presented in figure 12. The first thing to notice is that for the restaurants with 6 highest potential electricity savings, the corresponding actual electricity change is either negative or around 0 kWh per square meter per year. The only exception is restaurant 3, which shows a significantly higher actual electricity change compared to the potential electricity savings. The opposite can be said about the other 10 restaurants, where the actual electricity change and potential electricity savings are close to each other in absolute terms. Possible explanations could be that the possible electricity savings of measures with a relatively low impact are easier to estimate. For the cases that show actual electricity changes around 0 kWh per square meter per year, it could also be that the suggested energy saving measures had high costs, such as solar panels. These would also provide high possible electricity savings. Due to the high costs, the actors can choose not to implement those measures. These reasons however do not explain the negative actual electricity changes of restaurants 2 and 8. The explanations for these results are not found in the electricity data.

When looking at the extremes of the actual electricity changes, which are restaurants 2, 8 and 3, the size could play a role similar as seen in section 4.1 for restaurants. These restaurants vary in size from 69 to 270 square meters. Of the remaining 16 restaurants only 2 other buildings are smaller than 270 square meters, which are building 4 and 7. The average size of restaurants with a stimulation strategy is 905 square meters.

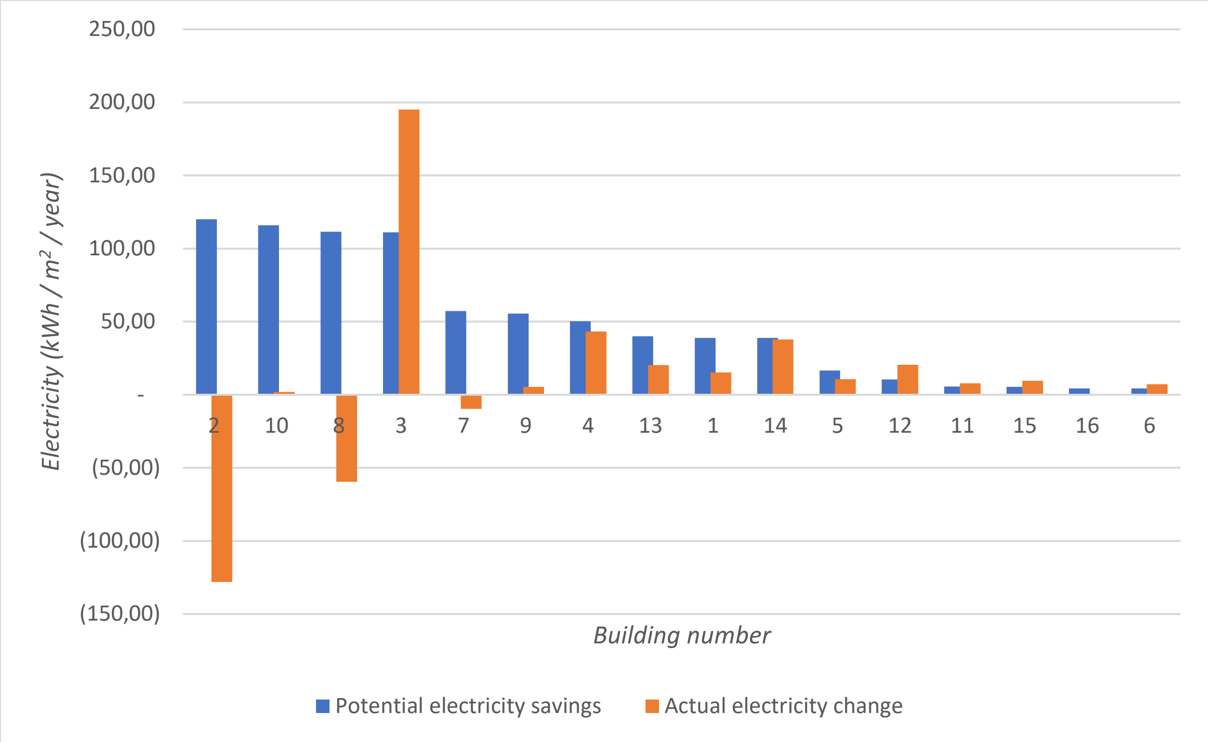

Figure 12: *Potential electricity savings and actual electricity changes of restaurants in the stimulation strategy.*

The potential gas savings and actual gas changes are presented in figure 13. The figure shows that most restaurants have higher actual gas changes than the potential gas savings had estimated, which is unlike other scenarios. As mentioned before, the gas data was corrected for degree days, which excludes that from the possible explanations. A possibility is that calculations for potential gas saving measures that are often applied are not correct.

When comparing the extremes for gas with those of electricity, it is shown that restaurants 2, 3 and 10 have extremes for both energy sources. However, restaurants 12 and 6 have no significant deviations for electricity. Furthermore, while for gas restaurants 2, 3 and 10 all show a high positive actual gas change, for electricity this is respectively a negative, positive and no effect on the actual electricity change. For restaurant 2 the case looks similar to earlier cases that show that gas is removed in favour of electrical heating.

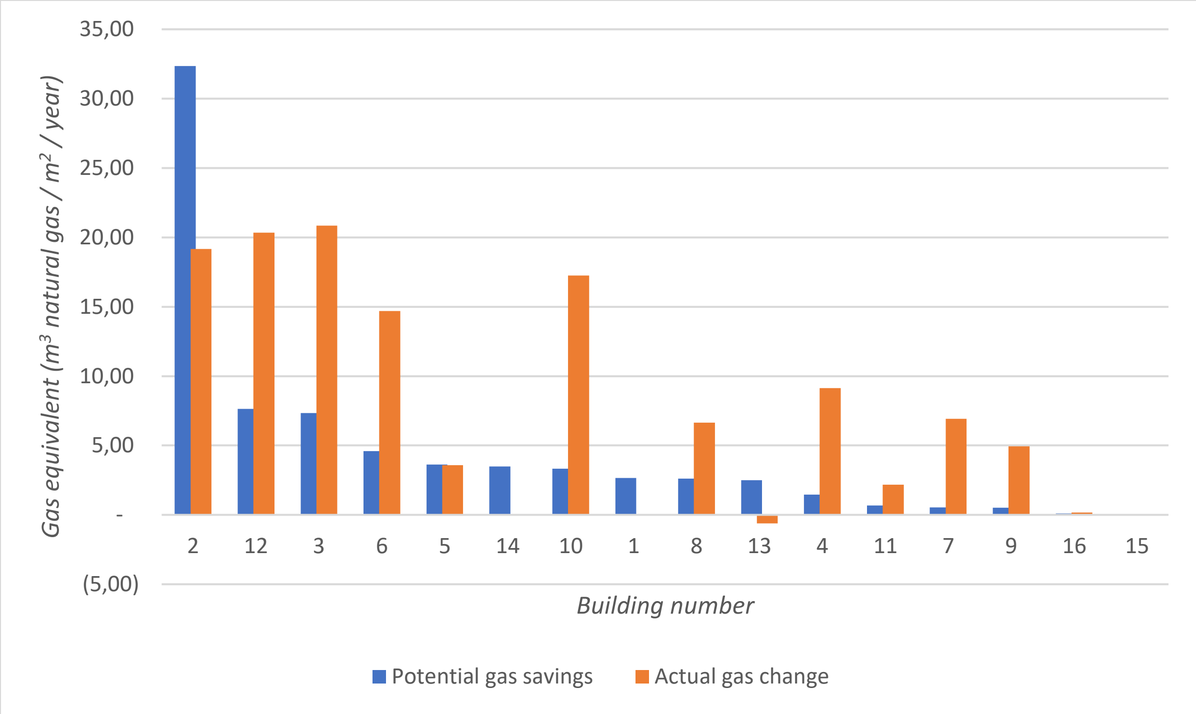

Figure 13: *Potential gas savings and actual gas changes for restaurants in the stimulation strategy.*

4.3 Discussion of the results

As indicated in the methods section, the analysis of the data was done in a few steps which gave some interesting intermediate results and gave some other insights that could support this research. The previous sections discussed the final results and showed large differences between the potential energy savings and actual energy changes, some extreme individual building results and negative actual energy changes. As mentioned in sections 4.1 and 4.2, some of these results could not be explained by the data presented in these sections. To identify possible explanations of the results within this research, this subsection discusses the data and insights gained during the different steps of the analysis. These steps are the data processing and data preparation. Finally, some results require an explanation that is beyond the scope of this research. These results are discussed in the final subsection.

4.3.1 Data processing

When filtering out the incomplete files, it was noted that a lot of the data was rounded off. While rounding off numbers may not cause major differences, it could also indicate that the number are estimates based on standard numbers.

For example, when looking at office building 22 with an enforcement strategy, the starting energy consumption is 122,175 kWh per year and 46,103 m^3 gas per year. The energy consumption after executing the recognized energy saving measures is 189,000 kWh per year and 24,000 m^3 gas per year. Looking at the results discussed above, office 22 had a potential electricity saving of 1,243.98 kWh per year and no potential gas savings, based on the EML. Instead, their electricity consumption increased by 66,825 kWh per year and their gas use declined by 22,103 m^3 per year. As shown in figures 6 and 7 office 22 is both in terms of absolute savings and difference in potential energy savings and actual energy change one of the more extreme results. It is likely that this is caused by wrong assumptions or estimates. This case is exemplary for other cases as well, such as restaurant 23 with an enforcement strategy and restaurant 12 with a stimulation strategy that both had rounded off initial energy consumptions.

Although this explains part of the earlier discussed results, for other results this is not the case. For example office 2, the most extreme case for offices with an enforcement strategy had no rounded of numbers, just like office 5 with a stimulation strategy. The same goes for other results.

4.3.2 Data preparation

While the data preparation for stimulation was mainly about getting all the files in place to be able to process them in the analysis, the data for enforcement needed more preparation. The energy saving measures and starting energy consumption needed to be sorted into the different categories as presented in table 2 in chapter 3 in order to determine how much energy would go to each function and thus how much could be saved. The energy savings were determined by looking at key figures that were also used by the government when creating the EML. Together, these steps provided the potential energy savings of the buildings. Within these steps, there are some factors that could be possible reasons for the extreme results and differences found in section 4.1.

A first explanation of the results can be found in the use of the key figures to determine how much of the total energy consumption is used by each function of an office. This distribution is shown in table 2 in chapter 3. These fall short at some points when they are used to analyse individual buildings.

- These key figures do not anticipate on buildings that are free of gas or district heating. They provide percentages on how much energy is used for each energy carrier. For space heating, this is 99.72 percent of the total gas consumption. They do not provide a percentage in the case space heating is done with electricity, which would affect all other percentages as shown in table 2 of chapter 3. This could lead to energy saving measures on space heating with zero potential gas savings, because the gas use is zero. Furthermore, this could lead to electricity savings that are higher than they should be, because the part of space heating is not subtracted from the total electricity consumption. Furthermore, in the case of electrical heating, part of the electricity consumption should be corrected for degree days, which could also no be done now.
- The key figures do not consider company size. The energy distribution for ventilation will be different for a small office with maybe a few handheld ventilators than for a large office with advanced climate control systems.

An example of this is restaurant 3 with an enforcement strategy. It has two recognized measures that are usually gas related. However, since this building is not connected to the gas grid and used electrical heating, it appears that there are no possible savings for these measures. Furthermore, part of the electricity consumption has not been corrected for degree days. This should result in a lower electricity consumption, which would make the gap between the potential electricity savings and actual electricity change smaller. Finally, it would provide some potential electricity savings, while it now appears as if there are no potential energy savings at all for this restaurant.

A second explanation of the results can be found in the use of key figures to determine what percentage is used to calculate the energy savings of a recognized measure. These percentages were provided by two sources; Stimular and Energiepartners. Both sources are also used by the government for the determination of the payback period of the recognized measures. The percentages are, like the key figures in the previous paragraph, not entirely suited to analyse individual buildings. This is mainly due to the fact that these percentages are based on standard conditions, for example that the lights are on during office hours. These conditions vary a lot between individual buildings, which makes these percentages less accurate in predicting the energy savings for the recognized measures.

It is not possible to illustrate this with an example from this research, which in itself is part of the problem described here. Because information on opening hours, amount of lights, type of lighting, occupancy of the different rooms and other information is unknown, it is not possible to make precise calculations on savings for replacing old lights with LED lights. While the standard calculations for example use a 50 hour workweek with 200 old TL lights in an office that is always fully occupied during opening hours could give an entirely different result than if one of the offices in this study has 80 hour workweeks with two empty floors and 150 old light bulbs, 300 old TL lights and 50 LED lights. Other than the size of the company, which can be used to make an estimation of the amount of lights, none of this information is known.

The final explanation of the results can be found in the way the recognized measures are formulated and has some overlap with the previous paragraph. Because not every recognized measure has a clear description of the original equipment as well as its replacement, it is for some measures not possible to give an accurate percentage for the energy savings. Furthermore, some of the recognized measures describe multiple starting scenarios which all have their own replacement equipment. An example of such recognized measure is GE6 (Appendix A). This recognized give multiple scenarios of what type of outside lighting is used, which should be replaced with LED lighting. However, both scenarios have different saving percentages, which affects the potential energy savings. The dataset however did not provide information on which scenario was applied, thus making it not possible to determine what savings percentage to use. Both this explanation as the one in the previous paragraph have an effect on almost every measure that includes lighting.

4.3.3 Other influences

The previous two subsections have tried to explain the results by discussing factors within this research. However, there are also some possible explanations found outside the scope of this research. Two of them have been briefly mentioned in sections 4.1 and 4.2. The first factor is mostly focussed on the enforcement result. Some of the differences between the potential energy savings and actual energy changes can be explained by energy saving measures that fall beyond the scope of the EML. This was for example possibly the case for offices 9, 13, 24, 2 and 28 with an enforcement strategy, as discussed in section 4.1.1. This could however also be the case for buildings with a stimulation strategy when an advise is not complete. This would mean not all potential energy savings are pointed out by the advisor, but the measures that are not pointed out can still be taken.

The second factor is the willingness of the actor that has to implement the measures. Especially in section 4.2 sometimes actual energy changes of around 0 were shown. This could be the result of measures that are too expensive or complicated, or just because the actor is not willing to invest in energy saving measures.

Another possibility for the extremes and mismatches in the data is suggested by literature by Blok and Nieuwlaar (2016). They suggest that the development of energy consumption is determined by three factors; energy efficiency, volume and structure. This research has focused on the energy efficiency effect, while the volume and structure effect were not discussed. The volume effect could have an effect on the results when a company for example has a change in production. The structure effect could influence the results when a restaurant for example had starts to cook on electricity rather than gas.

In order to take these effects into account, it would be necessary to obtain additional information. This information should be gathered before the start of the intervention and updated after the intervention is completed to understand the effects. Possible extra information that could be used for the structure effect could be obtained through a survey or by having an interview with the stakeholders of the business. An option to get extra information on the volume effect would be to get information on the revenue of a company, although this could be hard to obtain due to legislation and privacy issues. Further research on possibilities to make these effects suitable for a quantitative analysis would also help to investigate the effects of the different energy saving strategies.

An ideal dataset would thus consists of all the previous described information. This is the energy consumption before starting the intervention, the energy consumption after the intervention, surface area, a list of all appliances that use energy, information on the revenue, the occupation of the building and the opening hours. Furthermore, the energy saving measures should be clear and based on the building this is being subject to an intervention, so that the potential savings give an estimation that is as precise as possible without having to use key figures.

However, this would be nearly impossible due to reasons such as privacy, time and costs. A study that has this level of detail is possible for a case study, but is hard to generalise. Therefore, a less strict version of the above with an as large as possible dataset would be suggested as a possible middle ground. In that case, if the results make sense, it could be possible to make general theory. This version of the research should at least get the starting energy consumption and actual energy data from smart meters. This is already the case for the stimulation strategy, although not all smart meters were installed. Furthermore, the amount of surface that is in use should be roughly estimated periodically. This could at least show if there is a large difference in the volume effect. Ideally some extra information on the revenue of the company could give some information on the structure effect, but if that is not possible it should just be discussed with the actors in terms of an increase or decrease in production.

4.4 Comparison of the strategies

By comparing the effects of the enforcement and stimulation strategy, it is possible to highlight some of the effects that the two strategies have on the energy consumption of SMEs in the Netherlands. The strategies are compared on three aspects: average energy savings, average amount of energy saving measures and data completeness.

Average energy savings

The average energy savings are compared by looking at the savings per square meter of building surface. These results are presented in table 7. The results show that the stimulation strategy provides the highest average potential savings for both electricity and gas in both sectors. Furthermore, the stimulation strategy also has the highest average actual savings for electricity and gas in both sectors, except for the average actual savings of electricity for office buildings.

When looking at the actual savings versus the potential savings, the stimulation strategy has higher actual savings than potential savings for gas in both sectors. The electricity savings were lower than estimated by the potential energy saving measures in both sectors. For the enforcement strategy, 2 out of 4 actual energy savings were higher than the potential savings. These are the electricity savings for office buildings and gas savings for restaurants. This also shows that in 3 out of 4 cases, the potential savings for electricity are higher than the actual savings, while for gas the potential savings are lower than the actual savings in 3 out of 4 cases.

Table 7: *Average potential and actual energy savings per square meter for both sectors and strategies.*

	Office buildings		Restaurants	
	Stimulation	Enforcement	Stimulation	Enforcement
Average potential savings of electricity (kWh / m^2 / year)	15,40	6,66	9,77	8,95
Average potential savings gas equivalent (m^3 natural gas / m^2 / year)	1,60	0,53	1,81	0,29
Average actual savings electricity (kWh / m^2 / year)	-13,25	10,06	6,63	-2,06
Average actual savings gas equivalent (m^3 natural gas / m^2 / year)	2,79	-0,57	3,24	1,60

Energy savings measures

The potential energy saving measures for enforcement are limited to the EML such as presented in Appendix A, therefore it is expected that the enforcement strategy generally provides less energy saving measures than the stimulation strategy. This is also shown by the results presented in table 8. For office buildings the stimulation strategy has over three times as many potential energy saving measures than office buildings with an enforcement strategy, while for restaurants this is almost twice as many. Furthermore, it is shown that with the stimulation strategy all buildings in both sectors have at least one potential energy saving measure, while with the enforcement strategy in 19 and 4 percent of the cases for respectively offices and restaurants there are no possible energy savings measures.

Table 8: *Aggregated results on the amount of energy saving measure for offices and restaurants for both strategies.*

	Office buildings		Restaurants	
	Stimulation	Enforcement	Stimulation	Enforcement
Average amount of energy saving measures	10,10	3,29	9,00	4,78
Buildings without energy saving measures (%)	0%	19%	0%	4%

Data completeness

The data completeness of both strategies are presented in table 9. For both office buildings as restaurants, the data completion of the datasets is clearly higher for the stimulation strategy than for enforcement. For the stimulation strategy, the unavailability of gas and electricity data is the main reason for disregarding a part of the dataset. Without that data it is not possible to study the actual energy savings, making it impossible to determine the effect on the energy consumption of SMEs. For enforcement, besides the unavailability of gas and electricity data, there are also buildings disregarded because of the incompletion or absence of the filled out EML. Without that list, it is not possible to determine what measures have been taken to save energy, which makes it impossible to make statements on how that strategy has contributed to the energy savings of a building.

Table 9: Data completeness of the original datasets.

	Stimulation	Enforcement
Office buildings	61%	28%
Restaurants	89%	17%

Another difference between the two datasets was highlighted in section 4.3, which suggests that the energy savings by the different measures are more accurately determined for the stimulation strategy than the enforcement strategy. This is due to the use of key figures in order to determine the energy savings for the recognized energy saving measures. While for the stimulation strategy an advisor has been over the savings to correct them for company specific features, the potential savings for the enforcement strategy are now based on only their starting energy consumption and key figures.

Summary

Both strategies seem to have a positive effect on the energy consumption of SMEs in the Netherlands, both in terms of potential as actual energy savings. Although in some cases the result looks negative, such as the actual electricity consumption for offices with the stimulation strategy, this is caused by extremes such as buildings 5 and 14 for this case. This is also highlighted in the previous subsections. Although both strategies seem to have a positive effect, the stimulation strategy seems to have higher average energy savings in general than the enforcement strategy.

The amount of energy saving measures is higher for the stimulation strategy than the enforcement strategy. Although this was an expected result, the amount of measures are respectively 3 and 2 times higher for offices and restaurants. It is also shown that the stimulation strategy provides at least one energy saving measure for all buildings, while this is not the case for the enforcement strategy. This indicates that the enforcement strategy misses out on energy saving potential.

Finally, the datasets showed that the enforcement strategy had a lot of incomplete files, which caused over 75 percent of the dataset to be not usable for this analysis. For stimulation, these numbers are a lot lower. Because the completeness of the dataset for the enforcement strategy is mostly reliant on both the enforcer as the company that is enforced, the low completeness of the enforcement strategy dataset could indicate that the processing of these files has been done in an inaccurate way. This is also underlined by the amount of rounded off data found in the files as discussed in the previous subsection. Furthermore, it is suggested that the stimulation strategy offers more reliable potential energy savings due to the personalisation of the energy saving measures to a company rather than using key figures.

In total it seems that the simulation strategy has the highest impact on the energy consumption of SMEs in the Netherlands. In terms of energy savings and amount of energy saving measures, both strategies show positive results, but the stimulation strategy has significantly better results than the enforcement strategy. Furthermore, when looking at the data completeness, the data for stimulation was far more complete than the data for the enforcement strategy. This indicates that the results from the stimulation strategy are also more reliable.

5. Conclusion & Recommendations

5.1 Conclusion

This research aimed to answer the question what the effect is of enforcement and stimulation interventions on the energy consumption of SMEs in the Netherlands. The results show that both strategies have a positive effect by lowering the energy consumption of the SMEs. Furthermore, the stimulation strategy has a higher impact in terms of average energy savings, average amount of energy saving measures per building and data completeness. These results also show that even though the enforcement strategy has a positive effect, it misses out on a lot of potential any savings by being limited to the EML.

The results are based on a comparison on average energy savings, amount of energy saving measures and data completeness. It was possible to make a good comparison based on these parameters. However, the analysis and intermediate results gave enough reason to question the quality of these results. They show a lot of extreme individual outcomes as well as large differences between the potential energy savings and actual energy savings. A few possible explanations that have been discussed are the use of key figures that are not suited for the diversity of the SMEs researched, the quality of the data and the lack of complete data. Furthermore, there are other possible parameters that could be used to compare the strategies, for example by comparing the amount of time or money it costs to save energy.

As stated above, both strategies have a positive impact on the energy consumption of SMEs in the Netherlands, but that the stimulation strategy has a larger impact. Other research also show that SMEs are benefited by for example a more tailored approach (Meath et al., 2016) or a holistic approach that holds elements of multiple intervention strategies (Parker et al., 2009). Finally, Andersson et al. (2018) came to similar conclusions on the aspect of data completion. Their review of the Swedish audit program failed to provide generalizing results, due to the unavailability of quality data. Although the same applies to the results of this research, it does points out a lot of possibility for future research and improvement the current methods to evaluate the intervention methods being used to help SMEs through the energy transition.

5.2 Recommendations

In order to be able to answer the research question, more research is necessary. The first step would be to work out a method to collect the necessary data needed to make a quantitative analysis on this topic. The next step would be to create a larger dataset which is also possible to at least indicate if there are possible volume and structure effects in play. Finally, it would be possible to do another analysis on the energy consumption of SMEs. It would be best to start again with a case study, but of a larger proportion than this one in order to guarantee sufficient data.

Currently a pilot is running that is called stimulated enforcement, performed by the environmental service of Flevoland, Gooi and Vechtstreek (OFGV, n.d.). This pilot is basically a stimulation strategy that runs for 3 years, but has a few obligations such as the recognized measures that have to be executed and companies have to give access to detailed electricity and gas data. Furthermore, every year the company gets an update meeting in which progress is discussed with an energy expert. This approach could provide the best of both strategies while also tackling issues by getting access to the detailed data and being able to discuss possible unexpected outcomes that are being caused by for example the structure or volume effect. Therefore, it is recommended to gather detailed data on this pilot project, both quantitative and qualitative. The quantitative results could be used to do more research such as this but with more reliable data, while the qualitative results could help understand how possible mismatches in the data came to be.

5. References

Andersson, E., Karlsson, M., Thollander, P., & Paramonova, S. (2018). Energy end-use and efficiency potentials among Swedish industrial small and medium-sized enterprises–A dataset analysis from the national energy audit program. Renewable and Sustainable Energy Reviews, 93, 165-177.

Blok, K., & Nieuwlaar, E. (2016). *Introduction to energy analysis*. Taylor & Francis.

Blundel, R., Monaghan, A., & Thomas, C. (2013). SMEs and environmental responsibility: a policy perspective. Business Ethics: A European Review, 22(3), 246-262.

CBS. (2019). StatLine: Energiebalans, aanbod en verbruik; sector. Retrieved at 12-4-2020 from https://opendata.cbs.nl/statline/#/CBS/nl/dataset/83989NED/table?dl=21D0E

CBS. (2020). Statline: Vestigingen van bedrijven; grootte, rechtsvorm, bedrijfstak, regio. Retrieved at 13-4-2020 from https://opendata.cbs.nl/statline/#/CBS/nl/dataset/81644NED/table?ts=1586796437636

Dutch Government. (2019). Klimaatakkoord. Retrieved at 4-3-2020 from https://www.klimaatakkoord.nl/documenten/publicaties/2019/06/28/klimaatakkoord

ECN. (2016). EnergieTrends 2016. Retrieved at 4-3-2020 from https://energietrends.info/wp-content/uploads/2016/09/EnergieTrends2016.pdf

EEA. (2010). The European environment – state and outlook 2020. Retrieved at 4-3-2020 from https://www.eea.europa.eu/publications#c7=en&c14=&c12=&b_start=0&c13=SOER

EEA. (2019). How is climate change affecting total and peak energy demand for space heating and cooling across Europe? Retrieved at 13-4-2020 from https://www.eea.europa.eu/data-and-maps/indicators/heating-degree-days-2/assessment

Fleiter, T., Schleich, J., & Ravivanpong, P. (2012). Adoption of energy-efficiency measures in SMEs—An empirical analysis based on energy audit data from Germany. Energy Policy, 51, 863-875.

Hekkenberg, M., Koelemeijer, R., van den Born, G. J., Brink, C., Hilbers, H., Hoogervorst, N., ... & Dam, J. V. (2019). Effecten ontwerp Klimaatakkoord. Planbureau voor de Leefomgeving-Publicatie, 134.

InfoMil. (n.d.-a). Deel IV Handhaving energiebesparing. Retrieved at 12-3-2020 from https://www.infomil.nl/onderwerpen/duurzaamheid-energie/energiebesparing/informatieblad/deel-iv-handhaving/

InfoMil. (n.d.-b). Erkende maatregelenlijst kantoren. Retrieved at 2-4-2020 from https://www.infomil.nl/onderwerpen/duurzaamheid-energie/energiebesparing/erkende-maatregelen/

InfoMil. (n.d.-c). Korte uitleg systematiek milieuregelgeving. Retrieved at 5-3-2020 from https://www.infomil.nl/onderwerpen/integrale/activiteitenbesluit/activiteitenbesluit/eerste-kennismaking/uitleg-0/

InfoMil. (n.d.-d). Natuurlijke of zelfstandige momenten. Retrieved at 12-4-2020 from https://www.infomil.nl/onderwerpen/duurzaamheid-energie/energiebesparing/handreiking-erkende-maatregelen-energiebesparing/natuurlijke-zelfstandige-momenten/

Kalantzis, F., & Revoltella, D. (2019). Do energy audits help SMEs to realize energy-efficiency opportunities?. Energy Economics, 83, 229-239.

Kube, R., von Graevenitz, K., Löschel, A., & Massier, P. (2019). Do voluntary environmental programs reduce emissions? EMAS in the German manufacturing sector. Energy Economics, 84, 104558.

Meath, C., Linnenluecke, M., & Griffiths, A. (2016). Barriers and motivators to the adoption of energy savings measures for small-and medium-sized enterprises (SMEs): the case of the ClimateSmart Business Cluster program. Journal of Cleaner Production, 112, 3597-3604.

Meijer, I. P., & Verweij, I. R. (2009). Energieverbruik per functie voor SenterNovem.

Morsing, Mette & Perrini, Francesco. (2009). CSR in SMEs: do SMEs matter for the CSR agenda? Business Ethics: A European Review. 18.

ODWH. (n.d.). Energiescans organisaties. Retrieved at 10-3-2020 from https://www.odwh.nl/Bedrijven/Thema_s/Duurzaam_ondernemen/Energiescans_MKB_en_maatschappelijke_instellingen

OFGV. (n.d.). Stimulerend toezicht. Retrieved at 11-9-2020 from https://www.ofgv.nl/thema/energie/energie-besparen-0/stimulerend-toezicht/

Parker, Redmond & Simpson. (2009). 'A review of interventions to encourage SMEs to make environmental improvements', Environment and Planning C: Government and Policy 27(2): 279-301 (pre-print version).

Regeling van de Minister van Economische Zaken en Klimaat van 13 februari 2019, nr. WJZ/18249889, tot wijziging van bijlage 10 van Activiteitenregeling milieubeheer ter actualisatie van de daar opgenomen maatregelen. (2019). Staatscourant, 2019(8650), 1-289. Retrieved at 10-3-2020 from https://zoek.officielebekendmakingen.nl/stcrt-2019-8650.html

Rijkswaterstaat. (n.d.) Wet milieubeheer. Retrieved at 5-3-2020 from https://www.rijkswaterstaat.nl/water/wetten-regels-en-vergunningen/natuur-en-milieuwetten/wet-milieubeheer.aspx

RVO. (n.d.-a). Energy efficiency obligation. Retrieved at 5-3-2020 from https://english.rvo.nl/topics/sustainability/energy-efficiency-notification-obligation/energy-efficiency-obligation

RVO. (n.d.-b). Energy Efficiency notification obligation. Retrieved at 10-3-2020 form https://english.rvo.nl/topics/sustainability/energy-efficiency-notification-obligation

Sipma, J. M., & Rietkerk, M. D. A. (2016). Ontwikkeling energiekentallen utiliteitsgebouwen.

Stimular. (n.d.). De werkplaats voor duurzaam ondernemen. Retrieved at 29-3-2020 from https://www.stimular.nl/

Appendix A

This appendix contains the list of recognised measures, sorted by category, for office buildings. The list is published by InfoMil (n.d.-b).

Erkende Maatregelenlijst Kantoren

Inrichtingen voor het uitvoeren van administratieve werkzaamheden. De inrichting heeft een kantoor- functie zoals aangehaald in het Bouwbesluit 2012. Denk aan het openbaar bestuur, overheidsdiensten, verplichte sociale verzekeringen en zakelijke en financiële dienstverlening. Ter indicatie de SBI-codes die voor de indeling van deze diensten veelal worden gebruikt zijn SBI-code 64 t/m 74 en 84. In de bedrijfstak 'kantoren' zijn erkende maatregelen aangemerkt voor de in tabel 4 genoemde activiteiten.

Erkende maatregelen voor energiebesparing

Tabel 4. Erkende maatregelen voor energiebesparing in kantoren

Activiteiten	Nummers
Gebouw (G)	
A. Gebruiken van een energieregistratie- en bewakingssysteem	GA1
B. Isoleren van de gebouwschil	GB1
C. Ventileren van een ruimte	GC1 t/m GC5
D. Verwarmen van een ruimte	GD1 en GD2
E. In werking hebben van een ruimte- en buitenverlichtingsinstallatie	GE1 t/m GE6
Faciliteiten (F)	
A. In werking hebben van een stookinstallatie (emissies naar de lucht)	FA1 t/m FA5
B. In werking hebben van productkoeling	FB1 t/m FB4
C. Bereiden van voedingsmiddelen	FC1 t/m FC2
D. In werking hebben van een liftinstallatie	FD1 en FD2
E. In werking hebben van een roltrapsysteem	FE1
F. Gebruiken van informatie- en communicatietechnologie	FF1
G. In werking hebben van serverruimten	FG1 en FG9
H. In werking hebben van een noodstroomvoorziening	FH1
I. In werking hebben van elektromotoren	FI1

Activiteit	Gebruiken van een energieregistratie- en -bewakingssysteem		
Nummer maatregel	GA1		
Omschrijving maatregel	Borgen van de optimale energiezuinige in- en afstellingen van klimaatinstallaties door het automatisch laten registeren en analyseren van energieverbruiken met een energieregistratie- en bewakingssysteem (EBS).		
Mogelijke technieken ten opzichte van uitgangssituatie	a) Slimme meter met een energieverbruiks-manager toepassen voor elektriciteit, aardgas (a.e.) en/of warmte.	b) Een automatisch EBS met een rapportagefunc-tie (voor een overzicht van het energieverbruik per dag, week en jaar) toepassen.	c) Een automatisch EBS met een rapportagefunctie (voor een overzicht van het energieverbruik per dag, week en jaar) toepassen, in combinatie met een gebouwbe-heersysteem (GBS).
Uitgangssituatie op basis van een referentietechniek	a) Elektriciteit- en gas-en/of warmtemeters die op afstand kunnen worden uitgelezen (de zogenaamde slimme meters) ontbreken.	b) EBS ontbreekt.	c) Gebouwbeheersysteem is aanwezig zonder een EBS.
Technische randvoorwaarden	Niet van toepassing.		
Economische randvoorwaarden	a) Voor het bedoelde gebouw geldt: Jaarlijkse warmtever-bruik is meer dan 25.000 m^3(a.e.); of Jaarlijkse elektriciteits-verbruik is meer dan 88.000 kWh; of Een bruto vloeropper-vlakte van meer dan 1.500 m^2.	b) Voor het bedoelde gebouw geldt: Jaarlijkse warmtever-bruik is meer dan 75.000 m^3(a.e.); of- Jaarlijkse elektriciteitsverbruik meer dan 265.000 kWh; of Een bruto vloeropper-vlakte van meer dan 4.400 m^2.	c) Voor het bedoelde gebouw geldt: Jaarlijkse warmteverbruik is meer dan 170.000 m^3 (a.e.); of Jaarlijkse elektriciteitsverbruik is meer dan 1.000.000 kWh; of Een bruto vloeroppervlakte van meer dan 10.000 m^2.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Ja. Natuurlijk moment: Ja.		
Alternatieve erkende maatregelen	Niet van toepassing.		
Bijzondere omstandigheden	Niet van toepassing.		

Activiteit	Isoleren van de gebouwschil
Nummer maatregel	GB1
Omschrijving maatregel	Warmte- en koudeverlies via buitenmuur beperken.
Mogelijke technieken ten opzichte van uitgangssituatie	Spouwmuren isoleren. Gebouw wordt verwarmd en/of gekoeld.
Uitgangssituatie op basis van een referentie-techniek	Isolatie in spouwmuren ontbreekt. Gebouw wordt verwarmd.
Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	Niet van toepassing.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Ja. Natuurlijk moment: Ja.
Bijzondere omstandigheden	In kantoorgebouwen met minimaal een energielabel C, of kantoorgebouwen met een bouwjaar vanaf 2003 of later wordt aangenomen dat de maatregel al is genomen. Het energielabel staat voor de energieprestatie op basis van getroffen maatregelen.

Activiteit	Ventileren van een ruimte
Nummer maatregel	GC1
Omschrijving maatregel	Aanstaan van ventilatie buiten bedrijfstijd voorkomen.
Mogelijke technieken ten opzichte van uitgangssituatie	Schakelklok toepassen.

Uitgangssituatie op basis van een referentie-techniek	Automatische aan- en uitschakelingen ontbreken.
Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	Niet van toepassing.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Ja. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	Ventileren van een ruimte
Nummer maatregel	GC2
Omschrijving maatregel	Vollasturen ventilatoren beperken door afschakelen van ventilatoren bij lager ventilatiedebiet.
Mogelijke technieken ten opzichte van uit-gangssituatie	Cascaderegeling toepassen.
Uitgangssituatie op basis van een referentie-techniek	Cascaderegeling ontbreekt.
Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	Niet van toepassing.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Nee. Natuurlijk moment: Ja.
Bijzondere omstandigheden	In kantoorgebouwen met minimaal een energielabel C, of kantoorgebouwen met een bouwjaar vanaf 2003 of later wordt aangenomen dat de maatregel al is genomen. Het energielabel staat voor de energieprestatie op basis van getroffen maatregelen.

Activiteit	Ventileren van een ruimte
Nummer maatregel	GC3
Omschrijving maatregel	Warmte uit uitgaande ventilatielucht gebruiken voor voorverwarmen ingaande ventilatielucht bij gebalanceerd ventilatiesysteem.
Mogelijke technieken ten opzichte van uit-gangssituatie	Warmtewiel, kruisstroomwarmtewisselaar of twincoilsysteem toepassen.
Uitgangssituatie op basis van een referentie-techniek	Warmteterugwinsysteem ontbreekt in luchtbehandelingskast.
Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	Niet van toepassing.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Ja. Natuurlijk moment: Ja.
Bijzondere omstandigheden	In kantoorgebouwen met minimaal een energielabel C, of kantoorgebouwen met een bouwjaar vanaf 2003 of later wordt aangenomen dat de maatregel al is genomen. Het energielabel staat voor de energieprestatie op basis van getroffen maatregelen.

Activiteit	Ventileren van een ruimte
Nummer maatregel	GC4
Omschrijving maatregel	Energiezuinige ventilator toepassen.
Mogelijke technieken ten opzichte van uitgangssituatie	IE3-elektromotor of beter met toerenregeling toepassen.
Uitgangssituatie op basis van een referentie-techniek	Elektromotor met rendementsklasse IE2 of lager is aanwezig zonder frequen-tieregelaar. Benodigd luchtdebiet varieert.

Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	Niet van toepassing.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Ja. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	Ventileren van een ruimte
Nummer maatregel	GC5
Omschrijving maatregel	Warmteverlies ventilatiekanalen beperken in ruimten waar geen warmteafgifte nodig is.
Mogelijke technieken ten opzichte van uitgangssituatie	Isolatie om ventilatiekanalen aanbrengen.
Uitgangssituatie op basis van een referentie-techniek	- Isolatie om ventilatiekanalen ontbreekt. - Luchttoevoerkanalen en/of afzuigkanalen zijn verbonden met een recirculatie- of warmteterugwinsystemen.
Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	Temperatuur kanaal is minimaal 10°C hoger dan omgevingstemperatuur.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Ja, als de jaarlijkse bedrijfstijd minimaal 2.700 uur is. Natuurlijk moment: Ja, als de jaarlijkse bedrijfstijd minimaal 1.500 uur is.
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	Verwarmen van een ruimte
Nummer maatregel	GD1
Omschrijving maatregel	Warmteverlies via warmwaterleidingen en -appendages beperken.
Mogelijke technieken ten opzichte van uitgangssituatie	Isolatie aanbrengen om leidingen en appendages.
Uitgangssituatie op basis van een referentie-techniek	Isolatie om leidingen en appendages ontbreekt.
Technische randvoorwaarden	In verwarmde ruimten alleen de ringleiding isoleren.
Economische randvoorwaarden	Aardgasverbruik is minder dan 170.000 m^3 per jaar. Bedrijfstijd van installatie behorende bij leidingen en appendages is minimaal 1.250 uur per jaar.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Ja. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	Verwarmen van een ruimte
Nummer maatregel	GD2
Omschrijving maatregel	Temperatuur per ruimte naregelen.
Mogelijke technieken ten opzichte van uitgangssituatie	Klokthermostaten en overwerktimers toepassen.
Uitgangssituatie op basis van een referentie-techniek	Individuele naregeling in verblijfsruimten met radiatoren of verwarmingsgroe-pen ontbreekt.
Technische randvoorwaarden	Het regelelement van de radiator beschikt over een motorbediende afsluitklep.
Economische randvoorwaarden	Niet van toepassing.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Ja. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	In werking hebben van een ruimte- en buitenverlichtingsinstallatie	
Nummer maatregel	GE1	
Omschrijving maatregel	Onnodig branden van buitenverlichting voorkomen.	
Mogelijke technieken ten opzichte van uitgangssituatie	a) Bewegingssensors, schemer- en tijdschakelaars toepassen.	b) Schemer- en tijdschakelaars toepassen.
Uitgangssituatie op basis van een referentie-techniek	Automatische aan- en uitschakeling ontbreekt. Buitenverlichting (niet zijnde reclame- of noodverlichting) is overdag, in de avond en/of 's nachts aan.	
Technische randvoorwaarden	Niet van toepassing.	
Economische randvoorwaarden	Minimaal 20 armaturen zijn aanwezig. Buitenverlichting is 's nachts minimaal 6 uur uit.	
Toepasbaar op een zelfstandig of natuurlijk moment?	a) Zelfstandig moment: Ja, als minimaal 50 armaturen aanwezig zijn. Natuurlijk moment: Ja.	b) Zelfstandig moment: Nee. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.	

Activiteit	In werking hebben van een ruimte- en buitenverlichtingsinstallatie
Nummer maatregel	GE2
Omschrijving maatregel	Onnodig branden van reclameverlichting voorkomen.
Mogelijke technieken ten opzichte van uitgangssituatie	Schemer-, en/of tijdschakelaars toepassen.
Uitgangssituatie op basis van een referentie-techniek	Automatische aan- en uitschakeling ontbreekt Reclameverlichting is overdag en/of 's nachts aan.
Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	Reclameverlichting kan in de nacht minimaal 6 uur worden uitgeschakeld.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Nee. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	In werking hebben van een ruimte- of buitenverlichtingsinstallatie	
Nummer maatregel	GE3	
Omschrijving maatregel	Geïnstalleerd vermogen buitenverlichting beperken.	
Mogelijke technieken ten opzichte van uitgangssituatie	Ledlampen in bestaande en/of nieuwe armaturen toepassen.	
Uitgangssituatie op basis van een referentie-techniek	a) Halogeenlampen en/of breedstralers zijn aanwezig.	b) Hogedrukkwiklampen zijn aanwezig.
Technische randvoorwaarden	Technische staat van de bestaande armaturen is volgens de installateur voldoende.	
Economische randvoorwaarden	a) Niet van toepassing.	b) Aantal branduren is minimaal 4.000 uur per jaar.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Ja. Natuurlijk moment: Ja.	
Bijzondere omstandigheden	Niet van toepassing.	

Activiteit	In werking hebben van een ruimte- of buitenverlichtingsinstallatie
Nummer maatregel	GE4
Omschrijving maatregel	Geïnstalleerd vermogen reclameverlichting beperken.
Mogelijke technieken ten opzichte van uitgangssituatie	Ledlampen in bestaande armaturen toepassen.
Uitgangssituatie op basis van een referentie-techniek	Gloei- en/of halogeenlampen zijn aanwezig.
Technische randvoorwaarden	Technische staat van de bestaande armaturen is volgens de installateur voldoende.
Economische randvoorwaarden	Niet van toepassing.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Ja Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	In werking hebben van een ruimte- en buitenverlichtingsinstallatie
Nummer maatregel	GE5
Omschrijving maatregel	Geïnstalleerd vermogen verlichting vluchtwegaanduiding beperken.
Mogelijke technieken ten opzichte van uitgangssituatie	Nieuwe armaturen met ledlampen toepassen.
Uitgangssituatie op basis van een referentie-techniek	Conventionele armaturen met langwerpige fluorescentielampen (TL) zijn aanwezig.
Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	Niet van toepassing.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Nee. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	In werking hebben van een ruimte- en buitenverlichtingsinstallatie	
Nummer maatregel	GE6	
Omschrijving maatregel	Geïnstalleerd vermogen accentverlichting beperken.	
Mogelijke technieken ten opzichte van uitgangssituatie	Ledlampen in bestaande armaturen toepassen.	
Uitgangssituatie op basis van een referentie-techniek	a) Gloei- of halogeenlampen zijn aanwezig.	b) Hogedrukkwiklampen zijn aanwezig.
Technische randvoorwaarden	Technische staat van de bestaande armaturen is volgens de installateur voldoende.	
Economische randvoorwaarden	a) Niet van toepassing.	b) Aantal branduren is minimaal 4.000 uur per jaar.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Ja. Natuurlijk moment: Ja.	
Bijzondere omstandigheden	Niet van toepassing.	

Activiteit	In werking hebben van een stookinstallatie (emissies naar de lucht)
Nummer maatregel	FA1
Omschrijving maatregel	Opstarttijd cv-installatie regelen op basis van buitentemperatuur en interne warmtelast.
Mogelijke technieken ten opzichte van uitgangssituatie	Optimaliserende regeling toepassen.
Uitgangssituatie op basis van een referentie-techniek	Optimaliserende regeling ontbreekt.
Technische randvoorwaarden	Niet van toepassing.

Economische randvoorwaarden	Aardgasverbruik is minder dan 170.000 m^3 per jaar.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Ja. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	In werking hebben van een stookinstallatie (emissies naar de lucht)	
Nummer maatregel	FA2	
Omschrijving maatregel	Energiezuinige warmteopwekking toepassen.	
Mogelijke technieken ten opzichte van uitgangssituatie	Hoogrendementsketel 107 (HR 107-ketel) toepassen.	
Uitgangssituatie op basis van een referentie-techniek	a) Conventioneelrendementsketel (CR-ketel) of verbeterdrendementske-tel (VR-ketel) is aanwezig voor basislast.	b) Hoogrendementsketel 100 (HR 100-ketel) is aanwezig voor basislast.
Technische randvoorwaarden	Niet van toepassing.	
Economische randvoorwaarden	Niet van toepassing.	
Toepasbaar op een zelfstandig of natuurlijk moment?	a) Zelfstandig moment: Ja. Natuurlijk moment: ja.	b) Zelfstandig moment: Nee. Natuurlijk moment: Ja.
Bijzondere omstandigheden	In kantoorgebouwen met minimaal een energielabel C, of kantoorgebouwen met een bouwjaar vanaf 2003 of later wordt aangenomen dat de maatregel al is genomen. Het energielabel staat voor de energieprestatie op basis van getroffen maatregelen.	

Activiteit	In werking hebben van een stookinstallatie (emissies naar de lucht)
Nummer maatregel	FA3
Omschrijving maatregel	Energiezuinige warmteopwekking van tapwater toepassen.
Mogelijke technieken ten opzichte van uitgangssituatie	Gasgestookte hoogrendementsboiler (HR-boiler) toepassen.
Uitgangssituatie op basis van een referentie-techniek	Conventionele gasgestookte boiler is aanwezig.
Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	Niet van toepassing.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Ja. Natuurlijk moment: Ja.
Bijzondere omstandigheden	In kantoorgebouwen met minimaal een energielabel C, of kantoorgebouwen met een bouwjaar vanaf 2003 of later wordt aangenomen dat de maatregel al is genomen. Het energielabel staat voor de energieprestatie op basis van getroffen maatregelen.

Activiteit	In werking hebben van een stookinstallatie (emissies naar de lucht)	
Nummer maatregel	FA4	
Omschrijving maatregel	Aanstaan van ruimteverwarming buiten bedrijfstijd voorkomen.	
Mogelijke technieken ten opzichte van uitgangssituatie	a) Tijdschakelaar (met of zonder overwerktimer) toepassen.	b) Tijdschakelaar met weekschakeling (met of zonder overwerktimer) toepassen.
Uitgangssituatie op basis van een referentie-techniek	Automatische aan- en uitschakelingen ontbreken.	
Technische randvoorwaarden	Niet van toepassing.	
Economische randvoorwaarden	Niet van toepassing.	
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Ja. Natuurlijk moment: Ja.	
Bijzondere omstandigheden	Niet van toepassing.	

Activiteit	In werking hebben van een stookinstallatie (emissies naar de lucht)
Nummer maatregel	FA5
Omschrijving maatregel	Aanvoertemperatuur cv-water automatisch regelen op basis van buitentem- peratuur.
Mogelijke technieken ten opzichte van uit- gangssituatie	Weersafhankelijke regelingen toepassen.
Uitgangssituatie op basis van een referentie- techniek	Weersafhankelijke regeling ontbreekt op cv of op cv-groepen met hogetempe- ratuurverwarming.
Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	Niet van toepassing.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Ja. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing

Activiteit	In werking hebben van productkoeling
Nummer maatregel	FB1
Omschrijving maatregel	Branden van verlichting in koel- en vriescel beperken.
Mogelijke technieken ten opzichte van uitgangssituatie	Deurschakeling of bewegingsmelder toepassen.
Uitgangssituatie op basis van een referentietechniek	Deurschakeling en bewegingsmelder ontbreken.
Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	Niet van toepassing.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Ja. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	In werking hebben van productkoeling
Nummer maatregel	FB2
Omschrijving maatregel	Beperken van ijsvorming op de verdamper(s).
Mogelijke technieken ten opzichte van uitgangssituatie	Automatische ontdooiing van de verdamper(s) toepassen.
Uitgangssituatie op basis van een referentietechniek	Regeling voor ontdooiing en/of ontdooibeëindigingsthermostaat ontbreekt.
Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	Niet van toepassing.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Nee. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	In werking hebben van productkoeling
Nummer maatregel	FB3
Omschrijving maatregel	Energiezuinige lampen in koelcel toepassen.
Mogelijke technieken ten opzichte van uitgangssituatie	Ledlampen in armaturen toepassen.
Uitgangssituatie op basis van een referentietechniek	Conventionele armaturen met langwerpige fluorescentielampen (TL8) zijn aanwezig.

Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	Niet van toepassing.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Nee. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	In werking hebben van productkoeling
Nummer maatregel	FB4
Omschrijving maatregel	Binnentreden van warme en/of vochtige lucht in koelcel beperken.
Mogelijke technieken ten opzichte van uitgangssituatie	Deurschakeling toepassen om verdampingsventilatoren te onderbreken.
Uitgangssituatie op basis van een referentietechniek	Deurschakeling ontbreekt.
Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	Niet van toepassing.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Ja. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	Bereiden van voedingsmiddelen
Nummer maatregel	FC1
Omschrijving maatregel	Het debiet van afzuigsystemen in grootkeukens beperken.
Mogelijke technieken ten opzichte van uitgangssituatie	Rook- en/of dampdetectieapparatuur in combinatie met meet- en regelapparatuur van de afzuiginstallatie toepassen.
Uitgangssituatie op basis van een referentietechniek	Meet- en regelapparatuur van de afzuiginstallatie ontbreekt.
Technische randvoorwaarden	Motoren zijn geschikt om frequentie te schakelen.
Economische randvoorwaarden	Niet van toepassing.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Nee. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	Bereiden van voedingsmiddelen
Nummer maatregel	FC2
Omschrijving maatregel	Een infrarood salamander met aan/uit of tijd schakelaar wordt ingezet voor het verwarmen of grillen van producten.
Mogelijke technieken ten opzichte van uitgangssituatie	Automatische pan detectie, waardoor onnodig aanstaan van het grill element wordt voorkomen.
Uitgangssituatie op basis van een referen- tietechniek	Ongeregelde infrarood salamander worden ingezet voor het verwarmen of grillen van producten.
Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	Niet van toepassing.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Nee. Natuurlijk moment: Ja
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	In werking hebben van een liftinstallatie
Nummer maatregel	FD1

Omschrijving maatregel	Energieverbruik voor verlichting en ventilatie voorkomen als lift niet in gebruik is.	
Mogelijke technieken ten opzichte van uitgangssituatie	a) Stand-by schakeling op liftbesturing toepassen.	b) Aanwezigheidsdetectie toepassen.
Uitgangssituatie op basis van een referentietechniek	Verlichting en ventilatie cabine zijn continu in gebruik.	
Technische randvoorwaarden	Niet van toepassing.	
Economische randvoorwaarden	Niet van toepassing.	
Toepasbaar op een zelfstandig moment of natuurlijk moment?	a) Zelfstandig moment: Ja. Natuurlijk moment: Ja.	b) Zelfstandig moment: Nee. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.	

Activiteit	In werking hebben van een liftinstallatie
Nummer maatregel	FD2
Omschrijving maatregel	Geïnstalleerd vermogen verlichting liftcabine beperken.
Mogelijke technieken ten opzichte van uitgangssituatie	Ledlampen toepassen.
Uitgangssituatie op basis van een referentietechniek	Gloei- en halogeenlampen zijn aanwezig.
Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	Niet van toepassing.
Toepasbaar op een zelfstandig moment of natuurlijk moment?	Zelfstandig moment: Nee. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	In werking hebben van een roltrapsysteem
Nummer maatregel	FE1
Omschrijving maatregel	Energiezuinige roltrapbesturing toepassen.
Mogelijke technieken ten opzichte van uitgangssituatie	Aanbodafhankelijke onderbrekende besturing toepassen.
Uitgangssituatie op basis van een referentietechniek	Roltrap is zonder aanbodafhankelijke regeling uitgevoerd en draait continu tijdens gebruikstijden.
Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	Niet van toepassing.
Toepasbaar op een zelfstandig moment of natuurlijk moment?	Zelfstandig moment: Nee. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	Gebruiken van informatie- en communicatietechnologie
Nummer maatregel	FF1
Omschrijving maatregel	Pas energiezuinig printen en/of kopiëren op de werkplek toe.
Mogelijke technieken ten opzichte van uitgangssituatie	Centraal printen en kopiëren.
Uitgangssituatie op basis van een referentietechniek	Minimaal 10 lokale printers en/of kopieermachines zijn aanwezig.
Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	Niet van toepassing.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Nee. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	In werking hebben van een serverruimte
Nummer maatregel	FG1
Omschrijving maatregel	Inzet van fysieke servers in serverruimten beperken.
Mogelijke technieken ten opzichte van uitgangssituatie	Meerdere gevirtualiseerde servers werken op een minder aantal fysieke servers.
Uitgangssituatie op basis van een referentietechniek	Geen gevirtualiseerde omgeving aanwezig.
Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	Serverruimte heeft opgesteld vermogen van minimaal 5 kW.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Nee. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

<table>
<tr><th>Activiteit</th><th colspan="3">In werking hebben van een serverruimte</th></tr>
<tr><td>Nummer maatregel</td><td colspan="3">FG2</td></tr>
<tr><td>Omschrijving maatregel</td><td colspan="3">Vrije koeling in serverruimten toepassen om bedrijfstijd van koelinstallatie te beperken.</td></tr>
<tr><td>Mogelijke technieken ten opzichte van uitgangssituatie</td><td>a) Direct vrije luchtkoeling toepassen inclusief compartimenteren en back-up door koelinstallatie toepassen.</td><td>b) Verdampingskoeler(s), adiabatische of hybride koeler(s) via (vorstbestendige) bypass toepassen.</td><td>c) Verdampingskoeler(s), adiabatische of hybride koeler(s) via (vorstbestendige) bypass toepassen inclusief compartimenteren en plaatsen van zaalkoelers die werken op hogere temperaturen.</td></tr>
<tr><td rowspan="2">Uitgangssituatie op basis van een referentietechniek</td><td rowspan="2">a) Airconditioning of DX- (directe expansie) koeling met seizoensgemiddelde COP van maximaal 2,5 is aanwezig.
Temperatuur in koelsysteem en buitenklimaat maken minimaal 95% vrije koeling mogelijk.</td><td colspan="2">b en c) Compressiekoelinstallatie verzorgt de volledige koeling.</td></tr>
<tr><td>b) De koelinstallatie en de zaalkoelers zijn geschikt om met hogere temperaturen te werken.
Compressiekoelinstallatie met seizoensgemiddelde COP van maximaal 4 is aanwezig.
Temperatuur in koelsysteem en buitenklimaat maken minimaal 50% vrije koeling mogelijk.</td><td>c) Compressiekoelinstallatie met seizoensgemiddelde COP van maximaal 2,5 is aanwezig.
Temperatuur in koelsysteem en buitenklimaat maken minimaal 50% vrije koeling mogelijk.</td></tr>
<tr><td>Technische randvoorwaarden</td><td colspan="3">Bouwkundig moet het mogelijk zijn. Bv het dak moet het gewicht van het systeem voor vrije koeling kunnen dragen en er moet ruimte zijn voor luchtkanalen en overige installaties.</td></tr>
<tr><td>Economische randvoorwaarden</td><td colspan="3">Serverruimte heeft opgesteld vermogen van minimaal 5 kW.</td></tr>
<tr><td>Toepasbaar op een zelfstandig of natuurlijk moment?</td><td colspan="2">a en b) Zelfstandig moment: Ja.
Natuurlijk moment: Ja.</td><td>c) Zelfstandig moment: Nee.
Natuurlijk moment: Ja.</td></tr>
<tr><td>Bijzondere omstandigheden</td><td colspan="3">Niet van toepassing.</td></tr>
</table>

Activiteit	In werking hebben van een serverruimte	
Nummer maatregel	FG3	
Omschrijving maatregel	Energiezuinige koelinstallatie voor koeling serverruimten toepassen.	
Mogelijke technieken ten opzichte van uitgangssituatie	a) Computer Room Air Conditioner (CRAC) met seizoensgemiddelde COP van minimaal 5,5 toepassen.	b) Compressiekoelinstallatie met seizoensgemiddelde COP van minimaal 5,5 toepassen.

Uitgangssituatie op basis van een referentietechniek	a) CRAC met seizoensgemiddelde COP van maximaal 3 is aanwezig.	b) Compressiekoelinstallatie met seizoensgemiddelde COP van maximaal 3 is aanwezig.
Technische randvoorwaarden	Niet van toepassing.	
Economische randvoorwaarden	Serverruimte heeft opgesteld vermogen van minimaal 5 kW.	
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Nee. Natuurlijk moment: Ja.	
Bijzondere omstandigheden	Niet van toepassing.	

Activiteit	In werking hebben van een serverruimte
Nummer maatregel	FG4
Omschrijving maatregel	Met hogere koeltemperatuur in serverruimten werken.
Mogelijke technieken ten opzichte van uitgangssituatie	Volledig gescheiden koude- en warme gangen (compartimenteren) en blindplaten op ongebruikte posities in racks toepassen.
Uitgangssituatie op basis van een referentietechniek	Warme en koude gangen en blindplaten ontbreken.
Technische randvoorwaarden	ICT-apparatuur in racks moet aan één zijde van apparatuur lucht aanzuigen.
Economische randvoorwaarden	Serverruimte heeft opgesteld vermogen van minimaal 5 kW.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Ja. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	In werking hebben van een serverruimte
Nummer maatregel	FG5
Omschrijving maatregel	Inzet van servers in serverruimte afstemmen op de vraag.
Mogelijke technieken ten opzichte van uitgangssituatie	Powermanagement op servers toepassen.
Uitgangssituatie op basis van een referentietechniek	De CPU (central processing unit) draait continu op maximale snelheid.
Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	Serverruimte heeft opgesteld vermogen van minimaal 5 kW.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Ja. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	In werking hebben van een serverruimte			
Nummer maatregel	FG6			
Omschrijving maatregel	Vrije koeling in datacenter toepassen om bedrijfstijd van compressiekoelinstallatie te beperken.			
Mogelijke technieken ten opzichte van uitgangssituatie	a) Droge koeler(s) via bypass toepassen.	b) Verdampings-koeler(s) via bypass toepas-sen.	c) Kunststof kruisstroom-warmtewisselaar en verdampings-koeler aan buitenzijde toepassen (indirecte lucht/ luchtkoeling).	d) Open koelsysteem (directe vrije luchtkoe-ling) met additionele indirecte adiabatische koeler toepassen.

Uitgangssituatie op basis van een referentietechniek	Compressiekoelinstallatie verzorgt de volledige koeling.		
	a) Klein datacenter met compressiekoelinstallatie met seizoensgemiddelde COP van maximaal 2,0. Temperatuur in koelsysteem en buitenklimaat moeten minimaal 40% vrije koeling mogelijk maken.	b) Compressiekoelinstallatie met seizoensgemiddelde COP van maximaal 2,5. Temperatuur in koelsysteem en buitenklimaat moeten minimaal 80% vrije koeling mogelijk maken. Bijvoorbeeld in	c en d) Compressiekoelinstallatie met seizoensgemiddelde COP van maximaal 3,0. Temperatuur in koude gang moet nagenoeg altijd vrije koeling mogelijk maken. Flexibele operatie van temperatuur en vochtigheid is mogelijk binnen de grenzen van ASHRAE recommended envelope en SLA's.
Technische randvoorwaarden	Niet van toepsasing.		
Economische randvoorwaarden	Serverruimte heeft opgesteld vermogen van minimaal 5 kW.		
Toepasbaar op een zelfstandig of natuurlijk moment?	a en b) Zelfstandig moment: Ja. Natuurlijk moment: Ja.		c en d) Zelfstandig moment: Nee. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.		

Activiteit	In werking hebben van een serverruimte
Nummer maatregel	FG7
Omschrijving maatregel	Hogere koeltemperaturen in datacenter realiseren om efficiëntie van compressiekoelinstallatie te verhogen en om meer gebruik te maken van vrije koeling (beneden 12/13°C buitenluchttemperatuur).
Mogelijke technieken ten opzichte van uitgangssituatie	Zaalkoelers met hogetemperatuurkoeling toepassen (ter indicatie: koelwater is minimaal 18°C).
Uitgangssituatie op basis van een referentietechniek	Zaalkoelers met lagetemperatuurkoeling zijn aanwezig. Seizoensgemiddelde COP van bestaande compressiekoelinstallatie is maximaal 3,5 bij groot datacenter en maximaal 5,0 bij klein datacenter.
Technische randvoorwaarden	Gescheiden koude en warme gangen met vrije koeling zijn aanwezig.
Economische randvoorwaarden	Niet van toepassing.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Nee. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	In werking hebben van een serverruimte
Nummer maatregel	FG8
Omschrijving maatregel	Met hogere koeltemperatuur in datacenter werken door menging van warme en koude lucht bij ongebruikte posities in racks te voorkomen.
Mogelijke technieken ten opzichte van uitgangssituatie	Blindplaten toepassen.
Uitgangssituatie op basis van een referentietechniek	Blindplaten ontbreken.
Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	Niet van toepassing.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Ja. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	In werking hebben van een serverruimte	
Nummer maatregel	FG9	
Omschrijving maatregel	Toerental van ventilatoren in zaalkoelers (CRAH's) in datacenter beperken.	
Mogelijke technieken ten opzichte van uitgangssituatie	a) Toerenregeling (sensoren en actuatoren) toepassen op bestaande ventilatoren.	b) In nieuwe zaalkoelers (CRAH's) ventilatoren met toerenregeling toepassen.
Uitgangssituatie op basis van een referentietechniek	Toerentalgeregelde ventilatoren ontbreken.	
Technische randvoorwaarden	Niet van toepassing.	
Economische randvoorwaarden	Serverruimte heeft opgesteld vermogen van minimaal 5 kW.	
Toepasbaar op een zelfstandig of natuurlijk moment?	a) Zelfstandig moment: Ja. Natuurlijk moment: Ja.	b) Zelfstandig moment: Nee. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.	

Activiteit	In werking hebben van een noodstroomvoorziening
Nummer maatregel	FH1
Omschrijving maatregel	Energiezuinige uninterrupted system (UPS) toepassen.
Mogelijke technieken ten opzichte van uitgangssituatie	Efficiënt UPS-systeem (bij dubbele conversie is 96% of hoger) toepassen.
Uitgangssituatie op basis van een referentietechniek	Inefficiënte UPS (efficiëntie in deellast is maximaal 91%) is aanwezig in datace serverruimte.
Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	Niet van toepassing.
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Nee. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

Activiteit	In werking hebben van elektromotoren
Nummer maatregel	FI1
Omschrijving maatregel	Energiezuinige motoren toepassen.
Mogelijke technieken ten opzichte van uitgangssituatie	IE4-motoren toepassen of beter.
Uitgangssituatie op basis van een referentietechniek	Motoren met vermogen minder dan 375 kW en meer dan 4 kW en met rendementsklasse IE1, IE2 of lager zijn aanwezig.
Technische randvoorwaarden	Niet van toepassing.
Economische randvoorwaarden	De motor heeft minimaal 4.500 bedrijfsuren per jaar
Toepasbaar op een zelfstandig of natuurlijk moment?	Zelfstandig moment: Nee. Natuurlijk moment: Ja.
Bijzondere omstandigheden	Niet van toepassing.

Appendix B

This appendix provides an overview of the starting data from the stimulation and enforcement strategies. They are presented in four tables that represent the two subsectors for both strategies.

Enforcement strategy – Office buildings

The dataset for office buildings in the enforcement strategy consists of 31 buildings, of which 30 have information on gas data. The buildings vary in size from 924 to 18,464 square meters and are all located in the municipality of Utrecht. The average amount of measures is 3 per building.

***Table B 1:** Dataset of office buildings with the enforcement strategy.*

	Potential electricity savings	Actual electricity change	Potential gas savings	Actual gas change	Amount of measures	Surface area enforcement
1	12,716.86	-11,640.00	3,497.01	-3,977.41	9	1,961
2	-	759,210.00	-	6,260.74	0	5,568
3	46,888.18	6,078.00	18,176.40	3,416.10	6	3,365
4	-	12,570.00	-	-1,786.48	0	2,660
5	16,778.26	1,874.00	358.36	-1,877.22	7	1,413
6	23,238.62	-32,464.00	362.34	-3,621.08	5	2,280
7	-	-84,910.00	525.66	-4,778.92	2	3,456
8	5,928.38	-9,262.00	1,979.06	490.62	4	1,433
9	-	326,634.00	-	16,905.27	1	18,464
10	2,503.11	-12,702.00	-	7,778.36	1	925
11	3,191.05	-1,459.00	902.62	1,868.36	2	2,525
12	-	32,070.00	-	-522.60	0	2,555
13	75,975.35	225,055.00	-	-10,824.77	3	2,382
14	58,852.27	73,466.00	4,648.76	-23,245.24	4	3,058
15	15,811.84	-32,288.00	-	No data	3	4,403
16	-	-150,754.00	-	7,454.95	1	924
17	5,704.98	-7,642.00	-	No data	1	993
18	44,449.71	33,826.00	454.75	1,437.01	9	2,615
19	-	50,029.00	757.98	-	6	2,613
20	17,203.91	-21,020.00	-	1,579.69	3	1,975
21	62,064.47	-70,718.00	-	-11,524.06	4	2,203
22	1,243.98	-66,825.00	-	21,266.33	5	2,320
23	-	23,893.00	-	No data	0	2,505
24	-	182,250.00	788.68	481.14	2	3,700
25	71,317.50	-1,200.00	-	No data	3	4,839
26	48,401.56	-	4,206.08	1,435.04	5	7,719
27	-	14,627.00	-	-61,437.38	0	15,068
28	-	37,899.00	-	981.89	1	1,212
29	16,011.97	1,208.00	287.83	-358.53	6	1,989
30	-	-3,199.00	-	806.07	0	930
31	225,734.89	-135,761.00	16,421.76	-25,411.50	9	5,116

Enforcement strategy – Restaurants

The dataset for restaurants in the enforcement strategy consists of 23 buildings, which all use gas. The buildings vary in size from 100 to 9,265 square meters and are all located in the municipality of Utrecht. The average amount of measures is 5 per building. Furthermore, among the restaurants are also some hotels.

Table B 2: *Dataset of restaurants with the enforcement strategy.*

	Potential electricity savings	Actual electricity change	Potential gas savings	Actual gas change	Amount of measures	Surface area enforcement
1	-	-22,166.00	268.62	129.47	5	1,000
2	16,589.29	15,760.00	-	No data	3	431
3	-	2,404.00	No gas	No gas	2	350
4	124,271.19	57,600.00	-	342.68	8	9,265
5	-	-4,000.00	-	No data	1	2,116
6	9,550.09	10,360.00	56.17	2,402.12	2	400
7	10,477.11	-6,096.00	-	343.99	3	1,011
8	-	21,552.00	232.52	82.11	3	450
9	-	-136,580.00	505.65	14,615.13	6	100
10	-	-64,472.00	525.98	No data	7	647
11	-	-1,074.00	246.89	-1,107.39	5	250
12	2,132.58	-12,859.00	206.52	-4,364.38	6	298
13	18,295.61	25,238.00	289.45	176.40	7	282
14	-	9,197.00	415.79	-8,371.70	6	184
15	816.66	2,914.00	500.48	-4,576.61	6	295
16	2,403.93	5,754.00	1,087.85	-94.76	8	245
17	-	25,085.00	548.38	8,993.39	7	230
18	340.11	11,937.00	1,106.53	6,929.12	7	1,205
19	-	-13,696.00	No gas	No gas	2	115
20	45,364.02	3,452.00	1,351.76	39,070.73	5	2,800
21	-	9,728.00	-	-3,853.66	2	3,580
22	-	3,587.00	-	-3,835.76	0	385
23	1,510.76	3,137.00	115.04	-5,474.47	9	266

Stimulation strategy – Office buildings

The dataset for office buildings in the stimulation strategy consists of 31 buildings, of which 29 have gas. The buildings vary in size from 211 to 9,905 square meters and are located in parts of the province of South-Holland. The average amount of measures is 10 per building.

Table B 3: *Dataset of office buildings with the stimulation strategy.*

	Potential electricity savings	Actual electricity change	Potential gas savings	Actual gas change	Amount of measures	Surface area enforcement
1	91,400.00	55,160.20	11,125.00	9,576.73	18	3,770
2	51,300.00	6,844.90	9,037.00	No data	17	458
3	64,000.00	-18,222.18	-	15,208.19	12	2,200
4	6,475.00	-61,385.06	7,700.00	25,780.00	7	1,932
5	140,700.00	-946,133.42	No gas	No gas	14	4,371
6	26,300.00	-2,465.30	5,300.00	4,394.94	9	2,030
7	5,100.00	59,968.83	No gas	No gas	4	5,479
8	66,000.00	5,405.11	3,085.00	-675.65	7	3,000
9	14,825.00	21,335.02	1,160.00	No data	21	1,300
10	25,250.00	788.28	1,500.00	No data	10	1,235
11	23,400.00	7,378.20	350.00	12,482.00	7	660
12	105,750.00	14,537.38	4,178.00	9,893.00	12	2,000
13	16,500.00	7,774.02	2,270.00	No data	11	1,075
14	317,610.00	-285,822.24	-	47,708.31	7	1,250
15	8,610.00	7,267.32	875.00	3,578.27	6	1,475
16	26,055.00	4,787.53	1,550.00	1,559.64	13	614
17	145,000.00	-1,602.60	280.00	1,894.89	7	1,489
18	9,870.00	3,840.58	4,690.00	No data	10	2,568
19	195,296.00	110,714.73	11,150.00	8,676.57	22	2,340
20	30,450.00	4,667.50	2,190.00	No data	11	220
21	6,770.00	5,865.55	1,390.00	1,150.73	7	1,730
22	6,320.00	19,480.66	12,451.00	11,406.46	9	600
23	29,000.00	1,413.16	1,360.00	1,877.12	8	610
24	62,996.00	152,206.95	1,871.00	No data	11	2,719
25	24,000.00	13,093.99	500.00	No data	4	9,905
26	3,220.00	6,561.36	1,450.00	6,499.92	8	700
27	25,590.00	7,154.88	150.00	2,825.63	6	806
28	11,500.00	6,002.84	700.00	-757.99	9	250
29	85,225.00	12,708.99	7,241.00	No data	15	1,300
30	16,000.00	3,676.76	No gas	No gas	6	211
31	8,700.00	1,847.96	100.00	-13.95	5	211

Stimulation strategy – Restaurants

The dataset for restaurants in the stimulation strategy consists of 16 buildings, of which 15 have data on gas usage. The buildings vary in size from 69 to 7,029 square meters and are all located in the area of West-Holland and parts of the province South-Holland. The average amount of measures is 9 per building. Among the restaurants are also some hotels.

***Table B 4:** Dataset of restaurants with the stimulations strategy.*

	Potential electricity savings	Actual electricity change	Potential gas savings	Actual gas change	Amount of measures	Surface area enforcement
1	13,025.00	5,070.00	890.00	No data	8	335
2	32,385.00	-34,594.56	8,737.00	5,176.84	22	270
3	19,980.00	35,131.04	1,320.00	3,750.70	5	180
4	8,550.00	7,347.02	250.00	1,554.48	6	170
5	6,990.00	4,456.45	1,530.00	1,516.89	8	423
6	1,470.00	2,472.17	1,610.00	5,143.37	8	350
7	5,260.00	-886.90	50.00	637.10	10	92
8	7,700.00	-4,116.28	180.00	459.06	5	69
9	22,230.00	2,182.87	210.00	1,973.14	10	400
10	113,280.00	1,851.76	3,255.00	16,844.05	8	977
11	2,752.00	3,911.03	335.00	1,092.90	6	500
12	3,950.00	7,769.48	2,906.00	7,727.87	7	380
13	12,000.00	6,064.48	750.00	-182.08	6	300
14	38,862.00	37,851.71	3,500.00	No data	19	1,000
15	10,900.00	19,014.56	No gas	No gas	5	2,000
16	30,020.00	2,472.48	630.00	1,260.54	11	7,029