

AUTHOR

Charlotte van de Water

WHAT IS THE IMPACT?

**An evaluation of data collection for
climate policy effectiveness analyses
from the perspective of SMEs.**

SUPERVISORS

Tejo Spit - Willem de Neve
Wouter Kersten

UNIVERSITY OF UTRECHT

June 7th, 2011



Universiteit Utrecht



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Charlotte van de Water - 3488152
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Internship	DCMR Environmental Protection Agency, Schiedam and Aida, Rotterdam
Supervisors	Prof. dr. Tejo Spit (University of Utrecht) Willem de Neve (DCMR Environmental Protection Agency) Wouter Kersten (AIDA)
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EXECUTIVE SUMMARY

In order to address the environmental costs that firms pose on society, policies are created to internalize those costs (Jaffe et al., 2005; Oates et al., 2003). There are many different types of policies to choose from that each affect firms in a different way, which can be defined by multiple categories (Jänicke et al., 2010). The question remains: Which policy is most effective? The effectiveness of policies in research is assessed by policy effectiveness analysis (Rossi et al., 1989) for which multiple methods have been developed, such as the econometric analysis method. The econometric method consists of the design of a framework including the intended target of the policy as the dependent variable and the determinants, which can be defined as the concepts that are expected to have an impact on the dependent variable. For all these variables a measurement unit needs to be established to represent the degree of impact. Although the econometric effectiveness analysis has mainly been applied to assess the effectiveness of a single policy instrument, it is more likely that a firm is affected by multiple policies at a time (Jänicke et al., 2010). These policies are likely to influence effectiveness of other policies. Therefore policy effectiveness analyses should take into account multiple policies simultaneously. The selection of the policies that were included in an econometric effectiveness analysis is based on the intended target to ensure that all policies that possibly have an impact are taken into account.

Another issue, which has not been addressed in most policy effectiveness researches, is that most analyses focus on large industrial firms, while SMEs make up more than 95% of the total number of firms in Western economies (Revell, 2008) and are expected to be responsible for 70% of all global pollution (Hillary, 2000). SMEs differ in characteristics from large industrial firms as they are believed to be more flexible, the entrepreneur has a more central role and there is a limited access to resources among other things (Aragón-Correa, 2008; Keijzers et al., 2008). The differences will likely cause determinants defined for SMEs to be different as well (Del Río González, 2009). In order to carry out an econometric policy effectiveness analysis regarding climate policies that are aimed at SMEs, the appropriate determinants and measurement unit need to be established. The problem addressed in this research is that there is a lack of knowledge on which data is needed based on determinants. The data needed to represent the change in the environmental problem as a result of the impact of climate policies on SME behaviour, in order to carry out an econometric mixed policy effectiveness analysis. Therefore, the research question that is posed in this research is *to what extent do determinants of climate policies provide insight into what kind of data is needed to assess the effectiveness of mixed climate policies on a specific environmental problem caused by SMEs?*

In order to establish which data can be used as the measurement unit for the mixed policy effectiveness analysis, it needed to be established which determinants are appropriate concepts to represent the impact of the policies on the desired outcome of the policy with respect to SMEs and which other characteristics of SMEs could possibly affect that desired outcome. Another important aspect is in what way and to what extent the data can actually be obtained. Therefore the following sub-research questions have been addressed in the research:

1. *How can determinants that are defined to represent the change in the targeted environmental problem as a result of the impact of climate policies on SME behaviour be measured?*
2. *To what extent do SME characteristics influence the data that is needed to measure the determinants that describe the change in the environmental problem as a result of the impact of climate policies on SME behaviour?*
3. *To what extent is the data that is needed to measure the determinants of climate policies in regard of their effectiveness in changing the environmental problem caused by SMEs currently publicly available?*

The research was based on a case study of energy. Through an inventory of climate policies that apply to SMEs in the city of Rotterdam it was found that energy is most often mentioned as the intended target. Based on an analysis of the content of the energy policies it is assumed that all energy policies result in energy reduction measures. To see if energy reduction measures can be used as the measurement unit for the determinants of energy policies in regard to the energy use of SMEs, the impact of energy reduction measures is compared to other factors that impact energy use. These factors are established through conversations with a professional and academic advisor.

The research was conducted based on a combined method. The quantitative part was used to establish general patterns. For this part data was collected through a survey by phone among SMEs that reside within the city of Rotterdam according to the registry of the Dutch Chamber of Commerce. Other selection criteria for the sample were the size of the SME, which needed to be between 5-250 employees and whether the SME belonged to one of the following 6 sectors according to NACE-coding: administrative and support sector, construction, financial and insurance activities, wholesale and retail trade, professional, scientific and technical services, transport and storage. In total 87 respondents were willing to participate in the interview and 115 respondents indicated that they could not participate due to lack of knowledge on energy use. Two respondents were selected for the participation in a more elaborate semi-structured interview for the qualitative part of the analysis. Through this part of the research further insight was gained into the patterns that were found in the results of the first part.

Based on the results four main patterns could be identified. Firstly, the research showed that energy use of SMEs does not seem to be influenced by the policy knowledge of the respondents. Secondly, the results demonstrate that the majority of SMEs have taken energy reduction measures, even though the initial response to a yes or no question indicated that the overall awareness of energy reduction measures is very low. Thirdly, the owner or manager is the appropriate person to approach for information on energy reduction measures, although in several cases the administrative assistant or accountant was also able to provide information on energy reduction measures or energy use. Lastly, it was found that in collecting data on energy use and energy reduction measures a 3rd party is frequently involved. The results suggest that data on policy knowledge should also be collected from both SMEs and 3rd parties, such as branch organizations and suppliers.

In regard to the research questions, the research found that in the case of energy use, energy reduction measures could be used as data for the measurement unit of the determinants of energy policies to estimate their effectiveness in regard of energy use of SMEs. The characteristics of SMEs differ in their effect on the decision to take energy reduction measures. Some of the characteristics, such as whether a SME has moved, do seem to have an influence, while others, such as the size of the SME, do not. The public availability of the data that is needed for the effectiveness analysis is limited. The information can be obtained from the manager or the owner, but also administrative assistants and accountants proved to be good data sources. The research also showed that 3rd parties play an important role in the collection of data on energy use, energy reduction measures and policy knowledge. A survey by phone is a very efficient way to collect data, however, it restricts the collection of data on energy use to a qualitative indicator. In regard of climate policies, it can be concluded that although energy reduction measures specifically apply to research on energy use, the measures that are taken often also address other environmental or climate issues. Respondents do not distinguish between different kinds of policies, such as adaptation versus mitigation. Instead they focus on the problem that they want to address.

Further research should focus on the causality between energy policies and energy reduction measures, as in this research the causality could only be established based on the results of the policy inventory. Furthermore, further research could focus on several characteristics that did not have a clear impact on the decision of a SME to take energy reduction measures, such as the influence of the change in managers. Based on the results of this research it is recommended that policy makers consider the role that 3rd parties have in the decision-making process on whether or not to take energy reduction measures and in the access of the SME to information of energy reduction measures. Finally future researchers should also consider the important role of the 3rd parties, especially as a source for data.

EXECUTIVE SUMMARY in Dutch

Een van de doelen van beleidsmaatregelen is het internaliseren van milieukosten, die veroorzaakt worden door bedrijven (Jaffe et al, 2005; Oates et al., 2003). Er kan hiervoor een keuze gemaakt worden uit verschillende typen maatregelen, die elk een bedrijf op een andere manier beïnvloeden. De verschillende typen beleidsmaatregelen zijn in de literatuur ingedeeld in categorieën (Jänicke et al., 2010). De vraag blijft welke categorie het meest effectief is? In onderzoek wordt de effectiviteit van beleidsmaatregelen bepaald met behulp van een beleid-effectiviteitanalyse. Een van de methodes, die daarvoor kan worden gebruikt, is de econometrische effectiviteitanalyse. Deze methode bestaat uit onder andere uit het ontwerpen van een raamwerk. Dit raamwerk bestaat uit het beoogde doel van de beleidsmaatregel als de afhankelijke variabele en de determinanten, die kunnen worden gedefinieerd als factoren die naar verwachting een impact zullen hebben op de afhankelijke variabele. Voor alle variabelen dient er een meeteenheid te worden gedefinieerd, waarmee de grootte van de impact kan worden vastgesteld. The econometrische effectiviteit analyse wordt vooral toegepast bij de analyse van enkelvoudige beleidsinstrumenten, terwijl het waarschijnlijk is dat meerdere beleidsinstrumenten tegelijkertijd een bedrijf beïnvloeden (Jänicke et al., 2010). Daarom zou een beleid-effectiviteitanalyse meerdere beleidsmaatregelen tegelijkertijd moeten analyseren. The selectie van de beleidsmaatregelen voor een econometrische effectiviteitanalyse wordt dan gebaseerd op het beoogde doel om er zeker van te zijn dat alle maatregelen met een mogelijke impact in de analyse zijn meegenomen.

De meest econometrische effectiviteitanalyses richten zich op grote industriële bedrijven, terwijl van het totale aantal bedrijven in Westerse economieën 95% een Midden- of Kleinbedrijf (MKB) is (Revel, 2008). MKB zijn verantwoordelijk voor 70% van de globale vervuiling (Hillary, 2000). MKB hebben andere kenmerken dan grote industriële bedrijven. Ze zijn onder andere flexibeler, de ondernemer neemt een centrale rol is en ze hebben beperkte toegang tot middelen (Aragón-Correa, 2008; Keijzers et al., 2008). Het is dan ook waarschijnlijk dat er andere determinanten moeten worden gedefinieerd voor MKB (Del Río González, 2009). Om een econometrische effectiviteitanalyse van klimaatbeleid gericht op MKB uit te kunnen voeren, moet er bepaald worden welke determinanten en meeteenheid de impact representeren. Het probleem is dat het niet bekend is welke data er nodig is om op basis van de determinanten, die gedefinieerd zijn als de verandering in het milieukundige probleem als gevolg van de impact van klimaatbeleid op het gedrag van MKB, een econometrische effectiviteitanalyse uit te kunnen voeren. Daarom is in dit onderzoek de centrale vraag gesteld: in hoeverre determinanten van klimaatbeleid inzicht geven in welke soort gegevens er nodig zijn om de effectiviteit van meerdere klimaatbeleidsinstrumenten in relatie tot een specifiek milieukundig probleem te kunnen bepalen?

Om te kunnen bepalen welke gegevens er gebruikt kunnen worden als meeteenheid voor de effectiviteitanalyse, moet er worden bepaald welke determinanten geschikt zijn om de impact van klimaatbeleid op de beoogde uitkomst van het beleid op het MKB te representeren en welke andere kenmerken van een MKB een impact zouden kunnen hebben op de beoogde uitkomst. Een ander belangrijk aspect is op welke manier en in hoeverre de gegevens ook daadwerkelijk kunnen worden verzameld. Daarom zijn in dit onderzoek de volgende subonderzoeksvragen gesteld.

1. Hoe kunnen determinanten, die gedefinieerd zijn om de verandering in het beoogde milieukundige probleem als gevolg van de impact van klimaatbeleid op het gedrag van MKB te representeren, worden gemeten?
2. In hoeverre beïnvloeden kenmerken van een MKB de gegevens, die nodig zijn om de determinanten, die gedefinieerd zijn om de verandering in het beoogde milieukundige probleem als gevolg van de impact van klimaatbeleid op het gedrag van MKB te representeren, te kunnen meten?
3. In hoeverre is de data, die nodig is om de determinanten van klimaatbeleid in relatie tot de effectiviteit in het veranderen van het milieukundige probleem veroorzaakt door MKB te kunnen meten, beschikbaar via openbare kanalen?

Het onderzoek is gebaseerd op een casusstudie over energie. Uit een inventarisatie van klimaat-beleidsinstrumenten, die gelden voor MKB in de stad Rotterdam, is gebleken dat energie het vaakst als doel van het instrument wordt genoemd. Gebaseerd op een analyse is er aangenomen dat de implementatie van alle energiebeleidsinstrumenten tot doel heeft een MKB te stimuleren om energiereductie maatregelen te nemen. Om te zien of energiereductie maatregelen kunnen worden gebruikt als meeteenheid voor determinanten van energiebeleidsinstrumenten in relatie tot het energiegebruik van MKB, is de impact van energiereductie maatregelen vergeleken met andere factoren, die het energiegebruik beïnvloeden. Deze factoren zijn bepaald op basis van gesprekken met professionele en academische adviseurs.

Het onderzoek is uitgevoerd op basis van een combinatie van kwantitatieve en kwalitatieve methodes. Met het kwantitatieve deel is getracht patronen in de resultaten vast te stellen. De data voor dit deel van de analyse is verzameld met behulp van een telefonische enquête onder MKB, die volgens de Kamer van Koophandel in Rotterdam geregistreerd staan. Andere selectie criteria voor de respondenten waren dat een MKB 5 tot 250 werknemers mag hebben en dat een MKB moet behoren tot een van de volgende sectoren volgens de NACE-codering: administratieve en ondersteunende diensten, bouwnijverheid, financiële activiteiten en verzekeringen, groot- en detailhandel, vrije beroepen en wetenschappelijke en technische activiteiten en vervoer en opslag. In totaal zijn 611 respondenten benaderd, waarvan er 353 ook daadwerkelijk bereikt zijn. In totaal hebben 87 respondenten deelgenomen aan de enquête en 115 respondenten aangegeven dat ze niet konden deelnemen vanwege gebrek aan kennis over het energiegebruik. Er zijn twee respondenten geselecteerd voor deelname aan de kwalitatieve interviews. Tijdens deze interviews kon dieper worden ingegaan op de resultaten van het kwantitatieve deel.

Gebaseerd op de resultaten konden er vier patronen worden vastgesteld. De eerste is dat energiegebruik niet beïnvloed wordt door de kennis van beleidsmaatregelen van respondenten. De tweede is dat de resultaten laten zien dat de meeste MKB energiereductie maatregelen hebben genomen, terwijl de respondenten hier zelf niet goed van op de hoogte zijn. De derde is dat de eigenaar of de manager de juiste persoon is om te benaderen voor gegevens over het energiegebruik van een MKB, maar dat ook de administratieve assistent of de boekhouder deze informatie kan geven. Ten vierde blijkt er dat naast MKB ook 3^e partijen benaderd moeten worden voor informatie over energiegebruik en energiereductie maatregelen. Vanuit de resultaten blijkt ook dat voor gegevens over de kennis van beleidsmaatregelen van een MKB het nodig kan zijn om een 3^e partij, zoals een brancheorganisatie of een leverancier, te benaderen.

Met betrekking tot de onderzoeksvragen laten de resultaten zien dat het waarschijnlijk is dat het aantal energiereductie maatregelen gebruikt kan worden als meeteenheid voor determinanten van energiebeleid. De kenmerken van een MKB hebben een wisselende invloed op de besluitvorming om wel of geen energiereductie maatregelen te nemen. Een aantal kenmerken, zoals een verhuizing van een MKB, hebben wel invloed, terwijl anderen, zoals de grootte van een MKB, geen invloed hebben. De openbare beschikbaarheid van gegevens die nodig zijn voor een effectiviteitanalyse, is beperkt. Informatie kan worden verkregen van de manager of de eigenaar van een MKB, maar ook de administratief medewerker en de accountant zijn waardevolle bronnen voor informatie over energiegebruik. Het onderzoek laat ook zien dat 3^e partijen een belangrijke rol spelen in het verzamelen van data. De telefonische enquête was in dit onderzoek de meest geschikte manier om data te verzamelen, maar door het gebruik van deze methode werden de mogelijkheden voor het verzamelen van data over energiegebruik wel beperkt tot het toepassen van meerdere kwalitatieve indicatoren. Met betrekking tot het klimaatbeleid, kan er worden geconcludeerd dat hoewel energie-reductie maatregelen specifiek betrekking hebben op het energiegebruik, de maatregelen door MKB worden gecombineerd met het aanpakken van andere milieuproblemen. De respondent maakt hierin eigenlijk geen onderscheid tussen verschillende soorten beleidsmaatregelen, maar redeneert vooral vanuit het probleem.

Toekomstig onderzoek zou zich kunnen richten op de causaliteit van energiebeleid en energiereductie maatregelen. In dit onderzoek kon de causale relatie alleen worden vastgesteld op basis van de inventarisatie van klimaatbeleidsmaatregelen in Rotterdam. Daarnaast zou toekomstig onderzoek zich ook kunnen richten op de kenmerken van een MKB, waarvan het niet duidelijk is of zij daadwerkelijk de besluitvorming van MKB om energiereductie maatregelen te nemen beïnvloeden, zoals bijvoorbeeld invloed van de vervanging van een manager. Gebaseerd op de resultaten van dit onderzoek zouden beleidsmakers de 3^e partij, die in het onderzoek naar voren kwam als een invloedrijke factor in het besluitvormingsproces, mogelijk een rol moeten geven in beleid gericht op MKB. Tot slot zouden onderzoekers, die zich in de toekomst met onderzoek naar energie willen bezighouden, in acht moeten nemen dat de rol van de 3^e partij erg belangrijk en mogelijk ook een goede bron voor data is.

PREFACE

This thesis is written as part of the research master Human Geography and Planning at the University of Utrecht. I carried out the research at the DCMR Environmental Protection Agency in Schiedam and Aida, powered by Enviu, as part of an internship from October 2010 till the end of April 2011. To complement my knowledge on the topic of the thesis I participated in the Climate-KIC summer school on climate change, innovation and entrepreneurship in at Imperial College London, Paris Tech and ETH Zürich from July till August 2010. In September 2010 I participated in the International Summer School of Applied, Environmental and Regulatory Economics on the regulation of public services.

Originally I planned to write my thesis about a totally different topic, although this topic was also related to Climate Change. The idea for this topic developed while I was participating in a class on economic geography and I came to realize that there is quite a gap between abstract theory and the practical solutions that I studied during my previous master in Architecture, Urbanism and Building Sciences at the Technical University of Delft. To me it seems that policy design is the combination of theoretical and practical knowledge and this made me curious about how policies actually work out in a real-life setting. Therefore I decided to focus my thesis on effectiveness analyses of climate policies.

Over the course of the past eight months many people have contributed to the realisation of this project. First I would like to especially thank my supervisors Tejo Spit, Willem de Neve en Wouter Kersten for taking on the project, believing in the potential of the topic and always being available when I had questions or just needed to discuss the project. Thanks to my colleagues at the DCMR Environmental Protection agency and Aida – powered by Enviu for taking this project on as an internship and for providing a great work environment. I would also like to thank Veronique Schutjens, Stefan van Tongeren, Jan Venselaar, Barend van Engelenburg and Gideon Bolt for being available to discuss the project and offering additional advice on specific parts of the thesis in relation to SMEs.

Thanks to all the respondents that were willing to participate in the interviews and special thanks to the two respondents who volunteered to participate in the qualitative interviews. Special thanks to the respondents Guus van de Water, Elly van de Water-Plaisier and Hugo Koole, who participated in the interviews as testcases and provided me with valuable information on how (not) to ask questions. I would also like to thank Tessel Kans, Will Rovers and Marjon Olijdam for giving additional advice on parts of the project based on their expertise. Thanks to all the participants and teaching staff of the Climate-KIC summer school, the International Summer School of Applied, Environmental and Regulatory Economics 2010 and especially to Maria Rita Ebano, Daniele Russolillo and Carlo Cambini for offering lots of inspiration and literary tips! Finally, thanks to all my family and friends for their support!

Charlotte van de Water
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GLOSSARY

Before-and-After design: A reflexive design in which only a few before-intervention and after-intervention measures are taken (Rossi et al., 1989).

Control group: Firms that have not implemented any policies from the policy category (Rossi et al., 1989).

Determinant (in general) = A concept used to describe the change in a variable as a result of a disturbance of the equilibrium.

Determinant (in this research) = A concept used to describe the indicators for the impact of a policy within a firm.

Dependent variable = "A variable that is causally influenced by another variable" (Bryman, 2008).

Environmental policy = "The set of techniques by which governmental authorities wield their power in attempting to ensure support and effect or prevent social change" (Vedung, 2007; 21).

Experimental group: Firms that have implemented policies from the policy category (Rossi et al., 1989).

Explanatory variable = A variable that is used to predict a causal impact on another variable. It is used as an alternative for the independent variable.

Independent variable = "A variable that has a causal impact on another variable" (Bryman, 2008).

Policy effectiveness analysis = A method of policy evaluation that focuses on the impacts and whether the implementation of the policy has caused the desired changes (Rosse et al., 1989).

Policy efficiency analysis = A method of policy evaluation that focuses on choices need to be made between the division of resources and through assigning cost values the assessment for the best investment of resources can be made (Rossi et al., 1989).

Policy evaluation = The systematic application of social research procedures for addressing the conceptualization, design, implementation and utility of social intervention programs (Rossi, et al., 1989).

Proxy measure = An outcome measure that is used as a stand-in for a goal that is not measured directly (Rossi et al., 1989).

Quasi experiments = A research approach that makes use of non-equivalent comparison groups (Rossi et al., 1989).

Reflexive controls = Taking multiple measures on targets for an analysis before and after the program is in place (Rossi et al., 1989).

Stochastic effects = "The difference or variation that is already present between the experimental group and the control group" (Rossi et al., 1989).

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Ch. 1 – INTRODUCTION

As the consequences of Climate Change are posing more pressure on society, new environmental quality standards need to be adopted by firms. Public policy is used to translate these standards into incentives for firms. There are many different types of climate policies to choose from that each affect firms in a different way. The choice between instruments is based on many considerations, among which the impact that a policy is expected to have on the targeted environmental problem. Policy effectiveness analysis is an approach in policy research that studies the impact of policies. A problem in the current literature (Jaffe et al., 1997; Brunnermeier et al., 2003; Frondel et al., 2008) on policy effectiveness analyses is that there is a lack of knowledge on the data that is needed to carry out an analysis of multiple policies that are applied simultaneously. There is also a lack of knowledge on which data is needed from specific types of firms other than large industrial firms, such as Small and Medium Enterprises (SMEs), to carry out these type of analyses. This research therefore aims *to provide more insight into the data that is needed to carry out a mixed policy effectiveness analysis based on the environmental problem that is caused by SMEs.*

The lack of knowledge on the data that is needed from SMEs to carry out a policy effectiveness analysis is the result of a focus of policy effectiveness research on large industrial firms despite good reasons to focus on smaller firms. SMEs make up 95% of the total sector of private firms in most industrialized economies (Revell, 2008). In some countries, such as the UK, this percentage is even 99,8% (Revell, 2008). The impact of the total body of SMEs on the environment is considered quite substantial. As Revell (2008) explains “the Marschall report (1998) estimates that SMEs in the UK are responsible for as much as 60% of the industry’s carbon dioxide emissions, whilst the Environmental Agency (2003) estimates that UK SMEs are responsible for 60% of commercial waste, and 80% of pollution accidents” (Revell, 2008). SMEs are considered to be responsible for 70% of all global pollution (Hillary, 2000). Even though these numbers are significant, regulator still have difficulties focusing their policies on SMEs.

The lack of knowledge on which data is needed to carry out an effectiveness analysis of multiple policies that are applied simultaneously, is the result of the focus of most of the policy effectiveness analyses on single policy instruments. Recent articles, such as ‘Governing Environmental Innovations’ by Jänicke en Lindemann (2010), explain that policies are more likely to be applied simultaneously and this could impact their effectiveness. They therefore argue that the focus to effectiveness analyses should be on the impact of the implementation of multiple policies simultaneously. There are several different methods that have been developed for the evaluation of policies, such as cost-benefit analysis, multi-criteria analysis and the econometric method. Based on a research by Rehfeld et al. (2007), which compares multiple policy instruments belonging to one policy program, the econometric analysis is selected as the focus of this research as it is expected allow for the impact of multiple policies to be studied simultaneously.

The data that is needed for econometric policy effectiveness analyses depends on the determinants that have been defined and the intended outcome of the policy. A determinant is a concept in econometric literature (Rehfeld et al., 2007) that represents those factors that are expected to have an impact on the intended outcome that is chosen to be the focus of the econometric policy effectiveness analysis. The data that is needed for the analysis is defined based on the way the change in the intended outcome as a result of the determinants can be measured. In this research the determinants will be defined based on how the environmental problem is changed by a certain change in the behaviour of a SME as a result of the implementation of an environmental policy. The research question is therefore defined as:

To what extent do determinants of climate policies provide insight into what kind of data is needed to assess the effectiveness of mixed climate policies on a specific environmental problem caused by SMEs?

To address this research question three issues need to be considered. First, it needs to be established which measurement unit is to represent the impact of the determinants, or in this case the climate policies, on the desired outcome of the policy with respect to SMEs. Second, it needs to be established that the impact of the determinants is truly caused by that determinant and not the result of the influence of a characteristic of the SME on the intended outcome. Third, it needs to be established to what extent and in what way this data can actually be obtained, as econometric analyses require large amounts of data to ensure reliable results. Therefore the following sub-research questions are defined for this research:

1. *How can determinants that are defined to represent the change in the targeted environmental problem as a result of the impact of climate policies on SME behaviour be measured?*
2. *To what extent do SME characteristics influence the data that is needed to measure the determinants that describe the change in the environmental problem as a result of the impact of climate policies on SME behaviour?*
3. *To what extent is the data that is needed to measure the determinants of climate policies in regard of their effectiveness in changing the environmental problem caused by SMEs currently publicly available?*

This research will contribute to the scientific literature in two ways. First, the research focuses on the data that is needed to carry out a policy effectiveness analysis focused on SMEs. Until now, research into the effectiveness of policy instruments had mainly been focused on large companies, which individually can realize a large reduction in pollution. Due to the small scale and limited individual environmental impact of SMEs, it is likely that these smaller companies will be subjected to time constraints and limitations in resources and knowledge (Keijzers et al., 2008) and therefore it is expected that they will deal with policies in different ways than large firms. Consequently it is expected that the determinants that are defined for industrial firms will not be suitable for SMEs (Del Río González, 2009). The contribution of this research is to provide more insight into the determinants that can be defined for SMEs and consequently in the data that is needed to carry out a mixed policy effectiveness analysis as this depends how the determinants are defined.

Second, this research will contribute to scientific knowledge through the focus on mixed policy effectiveness analysis. Previous research, such as the research by Rehfeld et al. (2007), has a similar approach, however, the focus of this research lies on multiple policy instruments that are related to one policy program. This research will not be conducted based on a pre-selection of or focus on specific policies. This means that the policies that are included in the policy effectiveness analysis are selected based on the environmental problem they are addressing. This change of approach is essential to the research question, as the policies that included in the analysis affect both the definition of the determinants and consequently the data that is needed. The mixed policy approach will not only provide insight into which policies have the largest impact on an environmental problem. It is also expected to provide further insight into concepts currently used in policy research and practice, such as the relationship between adaptation and mitigation policies, different categories of policies and geographical characteristics of policies.

The research will be located in Rotterdam, which is the second largest city in the Netherlands. Rotterdam is considered one of the most ambitious regions in regard to energy reduction. The Rotterdam Climate Initiative, a collaboration of various public and private bodies, aims to reduce the output of CO₂ by 50% in 2025 (Rotterdam Climate Initiative, n.d.). Due to the ambitious program it is expected that in Rotterdam it will be possible to study the most advanced climate policies that address SMEs. In 2011 it is also one of the hotspots defined by Kennis voor Klimaat (Knowledge for Climate), which is a temporary research program founded by the University of Wageningen and the University of Utrecht to develop measures that allow the Netherlands to address future climate challenges (Kennis voor Klimaat, n.d.). This research addresses current demand by the DCMR Environmental Protection Agency to gain further insight into the response of SMEs to climate change and climate change policy.

The research will continue with a discussion of the theoretical framework, which consists of two chapters. The next chapter of the research reviews theory on policy effectiveness analysis, the econometric method and determinants. The third chapter will provide a definition for environmental policy and SMEs and discuss theory on the impact of environmental policy from the viewpoint of multiple scientific paradigms and the relationship between environmental policy and SMEs. The fourth chapter will include an inventory of existing environmental policies that are in effect in the city of Rotterdam until 2011. Within this analysis a distinction will be made between the environmental target of each policy and the type of firm the policy is targeting. Chapter five will explain the methodological framework, which includes a combined research method for the analysis of the case study energy, which has been selected as the focus of this research based on the policy inventory. In chapter six the results of this analysis will be discussed based on the topics energy use, SME characteristics, energy reduction measures and policy knowledge. Chapter seven will discuss the results of the analysis of the energy case study, which includes an overview of the main patterns that were found and the discussion of the results in light of the research questions. Finally, chapter eight includes a reflection of the research and recommendations for both policy makers and future researchers.

Ch. 2 – ENVIRONMENTAL POLICY IMPACT ASSESSMENT

2.1 INTRODUCTION

This chapter discusses the literature that is currently available on the econometric method used to conduct policy effectiveness analysis and the role that determinants play in this type of analysis. The first part of the chapter will provide a theoretical overview of policy effectiveness analysis and determinants. The second part of the chapter contains a discussion of several researches in which determinants are included either as the main objective of the research or as variables in an econometric effectiveness analysis.

2.2 POLICY EFFECTIVENESS ANALYSIS

Policy effectiveness analysis is part of policy evaluation research, which can be defined as “the systematic application of social research procedures for addressing the conceptualization, design, implementation and utility of social intervention programs” (Rossi, et al., 1989). Policy evaluation based on effectiveness implies that the analysis is focused on impact and whether the implementation of the policy has caused the desired changes (Rossi et al., 1989). “The concept of impact assessment implies a set of specified operationally defined objectives and criteria of success” (Rossi et al., 1989; 49). Another commonly used approach in policy evaluation research is policy efficiency analysis. This type of analysis is based on an evaluation of cost effectiveness or cost-benefit ratio of factors that are assigned a certain value in order to gain more insight into investment options (Rossi et al., 1989). Cost-benefit analysis (CBA) is one of the methods used to assess efficiency. The choice between the two approaches to policy evaluation depends on the type of policy target that is the subject of the research, such as an environmental target or technological change. This is described by Jaffe et al. (2002): “First, one can ask - both with theoretical models and with empirical analyses – what effects alternative instruments have on the rate and direction of relevant technological change. Second, one can ask whether environmental policies encourage an efficient rate and direction of technological change, or more broadly, whether such policies result in overall economic efficiency. (that is, whether the efficient degree of environmental protection is achieved)” (Jaffe et al., 2002). As Rossi et al. (1989) explains “impact evaluations are essential when there is an interest in either comparing different programs or testing the utility of new efforts to ameliorate a particular community problem.” As the objective of this research is to analyse the relationship between multiple policies in regard of their impact on the reduction of an environmental problem, it is most appropriate to select the effectiveness approach to policy evaluation for this research.

Determinants, with respect to policy effectiveness analysis, can be described as a means to define the change in the intended target of a policy as a result of the implementation of that policy for the purpose of analysis. Econometric analysis is a method used to assess policy effectiveness for which the definition of determinants is very important. The main idea behind this type of analysis is that the impact of a policy that is represented by the determinants is modelled as one or more independent or explanatory variables in a statistical model. These variables are expected to have a significant effect on a pre-defined dependent variable, which is for instance the intended environmental target. The econometric analysis establishes to what extent that effect actually exists and whether the effect is significant. To date several econometric researches have been conducted to assess the effectiveness of innovation-oriented policies (Jaffe et al., 2002; 52). Few researches have been conducted concerning the effect of innovation policies on the environment. In general econometric analyses are not applied often, because it is very difficult to define the appropriate determinants (Rehfeld et al., 2007). Determinants, however, can provide insight into the degree of weight that an impact has regarding desired policy outcome and therefore into the relationships between multiple variables, which is an advantage of econometric analysis over other effectiveness analyses, such as CBA or MCA.

Multiple research designs options for the assessment of the policy impacts are discussed in literature on impact assessment strategies. “An impact assessment gauges the extent to which a program causes change in the desired direction” (Rossi et al., 1989). In general it can be said that the objective of impact assessment is to establish “whether or not a program produces effects different from what would have occurred either without the intervention or with an alternative intervention”

(Rossi et al., 1989; 231). In the ideal situation, impact assessment would be established through a randomized experiment, which in general means that subjects are sorted in two groups. One group, the experimental group, is subjected to an external influence or intervention, while the other group, the control group, it not. The impact is measured by changes that have occurred between the control group and the experimental group. In order to ensure that the changes occur as a result of the intervention it is necessary to create two groups that are close to an exact match. In practice, however, this proves to be almost impossible and therefore researchers are often forced to work with the best possible design. Within that design several factors need to be considered. For instance, the researcher needs to consider the difference between the gross outcome and net outcome. The gross outcome is the total number of changes that are measured, while the net outcome consists of the only the changes that have occurred as a result of the intervention. Between the gross and net outcome several factors that can be of influence need to be considered, such as endogenous change, secular drift, interfering effects, maturational trends and uncontrolled selection¹.

A researcher also needs to consider which measurement unit is representative for the program. "The product of any effort to measure effects is usually an estimate derived from observations of the size of effects" (Rossi et al., 1989). The researcher needs determine which stochastic effects are present between two study groups and compare these effects with the outcome measure to establish whether the change of the outcome measure is large enough to be the result of the program. In case the outcome measure is found to be large enough, the effect is considered statistically significant. Other factors that need to be taken into account are measurement reliability, measurement validity, proxy measures (see glossary), delivery system contaminants, missing information and sample design effects². Both the factors that influence the outcome and the measurement unit are defined in the research design through one of the several options that are proposed in scientific literature. These options vary depending on whether the policies that are studied in a research are full coverage or partial programmes³. These programmes differ in types of control and data collection methods used. The use of an experimental-control group and before-and-after comparison are the most common.

Determinants, in respect to impact assessment analysis, can be defined as a concept used to examine impacts on the outcome of interest through a model (Barbu, unknown). As explained earlier in this section, determinants can consist of one or more independent or explanatory variables. For instance in the study by Rehfeld et al. (2007) four variables are used to describe the IPP-measure (IPP = Integrated Product Policy) determinant: whether or not the firm has EMS certification, whether or not the firm has taken measures regarding waste disposal, whether or not the firm performs life cycle activities and whether the firms applies environmental labelling (Rehfeld et al., 2007; Table 5). At the same time the environmental policy determinant is described by one variable: whether or not the firm considers meeting current and future legal requirements as an innovation goal (Rehfeld et al., 2007; Table 5). In the next section several empirical studies are discussed that have already been conducted and that either have applied of defined determinants.

¹ The following definitions are given by Rossi et al. (1989; 233-236) for the factors that can influence the outcome of changes resulting from an intervention. Endogenous changes are "effects such as ordinary or naturally sequences of events that influence outcomes." Secular drifts are "relatively long-term trends in the community, region or country may produce changes in the gross outcomes that enhance or mask the net effects of a program." Interfering effects are "short-term events can produce enhancing or masking changes." Maturational trends are the "evaluations of programs that are directed towards changing persons in any age determined target population must cope with the fact that maturational processes can produce considerable changes in individuals that mimic or mask the effects of the program." Finally, uncontrolled selections are "processes not under the researcher's control that lead to some targets to be more likely than others to participate in the program under evaluation."

² The factors influence the measurements of an outcome of an intervention are defined by Rossi et al. (1989; 233-236). Measurement reliability is "the extent that, in a given situation, it produces the same results repeatedly". Measurement validity is "the extent that it measures what it is intended to measure". Delivery system contaminants address the fact that the research needs to take into consideration that the way an intervention is implemented can affect the outcome measures. Missing information addresses the fact that no data collection can be carried out perfectly. Sample design effects address the fact that the design of the research, specifically regarding the sample, can influence the outcomes of the measures.

³ Full coverage programmes are programmes that are valid for everyone and therefore it's not possible to construct a control group (Rossi et al., 1989). Partial programmes are programmes that are only implemented for part of the population and therefore a control group can be constructed (Rossi et al., 1989).

2.3 EMPIRICAL STUDIES INCLUDING DETERMINANTS

In this section an overview is given of five empirical studies that use various methods to define determinants. A detailed description of the differences in objective, analysis and data collection methods for each study can be found in table 2.1. These methods for analysis are partly dependent on the aim of the study and the framework. The studies by Hoffmann et al. (2009) and Frondel et al. (2008) have the objective to define determinants. In the study by Hoffmann et al. (2009), the determinants are established by testing hypotheses that are constructed for each determinant. Frondel et al. (2008) define determinants based on survey data, which they test based on their significant effect on the dependent variable, which is modelled as the policy that the determinants are supposed to represent. The studies by Wagner (2008), Rehfeld et al. (2007) and Brunnermeier et al. (2003) have the objective of gaining more insight into the impacts that influence innovation and use determinants as the independent variables for their statistical models. They all base the definition of their determinants on literature and use these determinants directly in a statistical model that tests their impact on innovation. Frondel et al. (2008) use a certain policy as the dependent variable, while the dependent variable in the studies by Wagner (2008), Rehfeld et al. (2007) and Brunnermeier et al. (2003) is modelled as innovation. The studies discussed here all use quantitative methods for the analyses.

Regarding the analysis of determinants, a researcher can choose between quantitative or qualitative research methods, however, this choice has implications for the focus of the research. One of those implications is the scope of the research, which is considered top-down for a quantitative and bottom-up for a qualitative approach. Qualitative research regarding determinants is usually done by analysing case studies based on interviews or other data sources, which allows the researcher to focus on the relevance of the local context (Del Río González, 2009). However, it is more difficult to generalize the conclusions of the research when the number of case studies is limited. Quantitative research allows for a broader and more objective approach. In relation to determinants regarding environmental technologies "micro econometric methods (particularly multinomial logit and probit models) have also been proven useful to analyse the choice of different types of environmental technologies as a function of different explanatory variables (Del Río González, 2009)." The logit and probit models are the most suitable choice in case the researcher wants to know the probability that a firm makes a certain choice and the influence of the determinant on this choice. In case a researcher aims to gain insight into the probability that a firm invests to realize a certain choice and the level of this investment, a tobit model is the most appropriate model for the analysis. Because both approaches have their advantages and disadvantages, the ideal situation is to use a combined method for the research. Another consideration that a researcher can take into account when choosing between quantitative and qualitative approaches is the amount and type of data available, as for quantitative research the large amount of data that is required can be difficult to obtain.

The data sources used in the studies that are discussed in this section are similar. All researchers have used a survey that was either carried out by the researchers or by an external party at the request of the researchers or the researchers have used available data sources, such as the EBEB by Wagner (2008). The EBEB is a "bi-annual survey on the state of environmental management in practice carried out in several European countries based on a mail questionnaire. The questionnaire asked firms for a self-assessment of their main environmental effects and stakeholder demands" (Wagner, 2008). The application of the data varies. In the studies by Wagner (2008) and Hoffmann et al. (2009) the survey data is specifically collected to use in an econometric analysis. Rehfeld et al. (2007) and Frondel et al. (2008) also use their collected data to define the determinants. Rehfeld et al. (2007) collect additional data for this purpose through conducting interviews and analysing reviews of environmental reports and other relevant firm documents. Brunnermeier et al. (2003) use patent data to quantify the dependent variable innovation, while the data collected through the survey is still only used for the econometric analysis. During the selection of data, the researcher also needs to establish from which period the data will be collected and whether future (Rehfeld et al., 2007) or past (Wagner, 2008) data is included in the analysis, especially in the case of environmental innovations.

In addition to the considerations described in the previous paragraph, the researcher also needs to consider the framework in which the determinants will be established. Similar frameworks are used in several other scientific disciplines, such as political economy, to define for instance political variables. When a researcher uses a certain dependent variable, the independent variables will need to each represent a certain impact on the dependent variable in order to measure the significant influence that independent variable has on the dependent variable. This can be illustrated by the difference between researches by Brunnermeier et al. (2003), who consider innovation as the dependent variable, and Hoffmann et al. (2009), who consider corporate adaptation to climate change as the dependent variable. Brunnermeier et al. (2003) aim to research the impact of external factors on innovation, which they quantify as the number of successful environmental patents the firm has applied for. As the external factors they define PACE (the pollution abatement capital and operating costs by manufacturing firms), VISITS (innovation by a firm increases when the number of inspections regarding existing water and air regulations increases), VALSHIP (level value of shipment), CONC (four-firm concentration ratio), CAPINT (capital intensity), EXPINT (export intensity). Most of the quantifications of these determinants are related to innovation, i.e. PACE is considered positive "if industries respond to heightened abatement costs by engaging in more research" (Brunnermeier et al., 2003) and VISITS is considered positive when regular inspections generate more innovation activities. In the research conducted by Hoffmann et al. (2009) the independent (or explanatory) variables are defined as the awareness of possible climate change effects, vulnerability of the affected business, dependency on the affected business, ability to adapt and perceived uncertainty. A scale that ranges from 'very badly informed' to 'very well informed' models the variable 'awareness of possible climate change effect'. All the defined variables have in common that they somehow are expected to have an effect on the corporate adaptation to climate change measures. In this context the framework (see image 2.1) can be seen as a tool for the researcher to clearly define the conditions the independent variables need to meet in order to have an impact on the dependent variable. The quantification of that dependent variable should be included in those conditions in order to ensure good coherence between the dimensions of the independent and dependent variables.

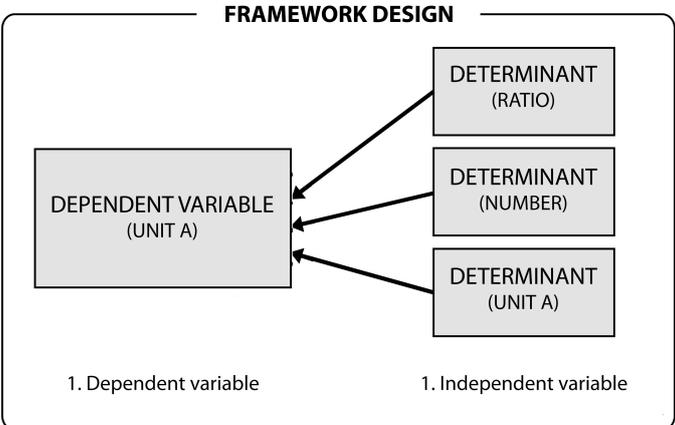


Image 2.1 Scheme of framework determinants I

An important aspect of the framework design is the decision regarding the measurement unit. According to Rossi et al. (1989; 273) "the choice of unit is determined by the nature of the intervention", or in the case of an econometric analysis by the change in the dependent variable. In the studies discussed in this section, the dependent variable is measured by units ranging from the number of adaptation measures adopted by a firm to dummy variables. "The evaluator attempting to design an impact assessment should begin by identifying the units designated as the targets of the intervention in question and hence to be specified as the units of analysis" (Rossi et al., 1989; 273). In the case of an effectiveness analysis on the impact on innovation, the unit of measurement that is defined has to be representative of something that can measure innovation. For instance, it makes more sense to measure innovation by only the number of new products instead of the total number of products produced by a firm. Multiple levels of measurement can be applied, such as nominal, ratio and dichotomous (binary). In the studies that are discussed in this section these levels have been applied as well (see table 2.1, proxies independent variables). The measurement unit is part of the framework design.

TABLE 2.1: OVERVIEW CONDUCTED STUDIES DETERMINANTS

	Hoffmann et al. (2009)	Wagner (2008)	Frondel et al. (2008)	Rehfeld et al. (2007)	Brunnermeier et al. (2003)
Object of study?	Determinants	Impacts on innovation	Determinants (or incentives)	Impacts on innovation	Impacts on innovation
Aim	To analyse the determinants that have been defined in literature for corporate adaptation measures	To analyse if EMS(1) influences the probability of firms to pursue environmental innovations positively	Incentives for voluntary adoption of EMS(3) by a firm & which aspects trigger environmental behaviour	To analyse whether the implementation of IPP(5) measures increases environmental innovations	To study the relationship between abatement pressures and innovation
Dependent variable	Corporate adaptation to Climate Change	"Green" design of new products & implementation of cleaner technology both during 1998-2000	EMS adoption	Environmental product or process innovation	Innovation
Proxy dependent variable	Number of adaptation measures adopted	Yes or no	Yes or no	An or no environmental innovation or both	Number of successful environmental patent applications
Proxies independent variables	Quantitative (number) or ratio	Scale*, dummy variables	Dummy variables	Dummy variables	Numbers, monetary unit, ratio
Control variables	Altitude of the peak station & regional dummies	Logarithms of firm size and age	Facility characteristics & Industry dummies	Firm specific characteristics size and age	-
Method	Hypotheses & econometric analysis; Linear, Ordinary least square & Poission models	Binary and multinomial discrete choice models	Bivariate discrete-choice model for correlation & FIML(4) methods	Binary and multinomial discrete choice models	4 models; Linear, Poisson, Negative binomial fixed and random effects models
Definition determinants	Through a hypothesis based on literature	Based on literature	Survey data	Based on literature	Based on literature
Data collection	Nation-wide survey of Swiss ski lift operators by questionnaire	EBEB survey(2) of 2001	Survey through standardized questionnaires	Interviews, review environmental reports/ documents case studies & telephone survey	Patent data & Annual Survey of Manufacturers (US)

(1) Environmental management systems; here management activities to reduce negative environmental impacts

(2) European Business Environment Barometer

(3) Environmental management systems

(4) Full-Information-Maximum-Likelihood

(5) Integrated Product Policy (European Commission)

2.4 CONCLUSION

Based on the literature review, the determinants, with respect to econometric analyses, are regarded impacts that are expected to have a significant effect on a certain variable. The definition of this variable can vary according to the objective of the research and is defined by a framework. The objective of this research is to establish which information is needed in order to carry out an econometric mixed policy effectiveness to assess the success of climate policies in reducing environmental problem caused by SMEs. In other words, the determinants in this analysis need to represent the impact a policy has on the environmental performance of an SME. The determinants should be proxied by the unit defined to represent the change in the environmental target. Based on this measurement unit, it can be established which data is required to carry out an econometric effectiveness analysis.

When these factors are translated into a framework, the environmental problem becomes the dependent variable and the policies become the independent variables or determinants for the initial analysis (see image 2.2). After this step, it is possible to conduct an econometric analysis that provides insight into which policies have a more significant effect on the change of the environmental problem. This is similar to the analysis that is conducted in the study by Rehfeld et al. (2007) in which the policies were modelled as dummy variables. In this research, insight is required into the significance of the impacts of policies to study any possible relationships that might exist between those policies. Therefore it is preferable to establish a nominal measurement unit to represent the change in the environmental problem. Next to representing the change in the environmental problem, the measurement unit also needs to be causally related to the policies that are studied in order to be regarded as the impact of those policies. To establish which kind of measurement unit can meet those two criteria, more insight is needed into the characteristics of SMEs, environmental policies and their relationship. This is discussed in chapter 3 'The impact of policies on SMEs'.

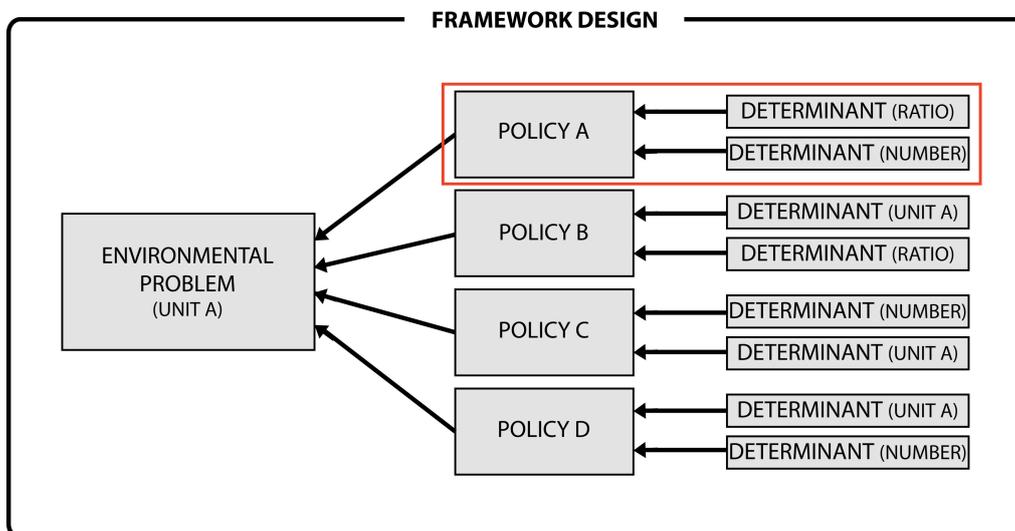


Image 2.2 Scheme of framework determinants II

Ch. 3 – THE IMPACT OF ENVIRONMENTAL POLICIES ON SMEs

3.1 INTRODUCTION

Based on the previous chapter it is found that more insight is needed into the relationship between environmental policies and SMEs. The first part of this chapter explains in which context this relationship should be understood, which actors are involved and which impacts are created by the interactions between them. The second part explains in more detail the role of environmental policies and SMEs in theory and what the nature of their relationship is. Within this chapter climate policies are addresses as environmental policies, because environmental policies have been studied more extensively than climate policies. This approach is similar to other studies, such as Telli et al. (2008). Designs for both types of policies are based on the concept 'the polluter pays' and therefore theory on environmental policies is expected to apply to climate policies as well.

3.2 POLICY STUDIES IN SOCIAL SCIENCES

Policy impact research has been a focus of policy studies (Hambrick Jr., 2000), which can be described as a collection of studies regarding policy analysis and program evaluation. Policy studies draw upon theories from multiple scientific disciplines, such as Economics and Political Science (Hambrick Jr., 2000), and therefore the first part of this chapter is focused on discussing these two scientific disciplines in addition to a third discipline of Geography. Within the first discipline Economics the sub-discipline Environmental Economics is concerned with environmental policy instruments that can be used to deal with unwanted externalities. Environmental Economics can be described as a sub-discipline that is mainly concerned with "the design of efficient and effective policy measures for protection of the environment" (Oates et al., 2003). Political Economy, which is regarded a sub-discipline within the discipline Political Science, contributes a focus more on the politics behind the choice that needs to be made between multiple policy instruments to the discussion and specifically discusses influence of the multiple actors and the political setting involved with making this choice. The final discipline is Geography in which the sub-discipline Urban Governance is concerned with the spatial dimension within governance research. Where Environmental Economics and Political Economy remain theoretical in their approach to policy impact, Urban Governance can contribute a more applied focus to the research by adding a spatial dimension to the discussion.

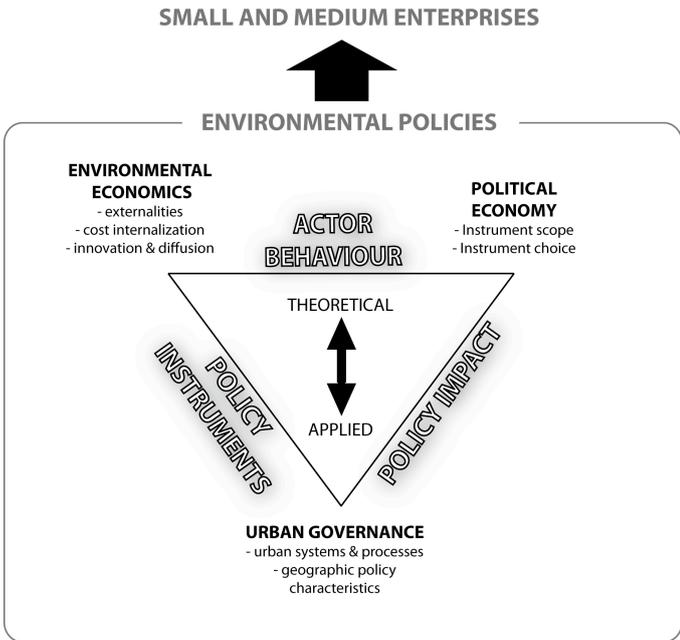


Image 3.1: Theoretical model

ENVIRONMENTAL ECONOMICS

Environmental economics is a sub-field of economics that aims to find ways to address environmental benefits or costs through economic theories. The main assumption in this sub-field is that polluters need to be held accountable for the costs they pose on society through pollution and that victims choose a defence strategy against this pollution, but do not receive any compensation for this from the polluters (Cropper et al., 1992). Within environmental economics there are two general viewpoints from which theories are developed: normative and hedonic. A normative approach is based on assigning certain value to certain goals of a policy, while a hedonic approach is based on the notion that a price is composed of several parts that make up a good and within this price environmental quality can be included as one of these parts (Cropper et al., 1992). In relation to the hedonic approach a geographical components is included, because environmental qualities that are dependent on their urban setting, such as air quality, can be taken into account (Cropper et al., 1992).

Environmental economics deals with several concepts, such as externalities, public goods, property rights, non-market valuation, and social cost-benefit analysis. (Harris School University of Chicago, 2010). Several of these concepts are discussed in paragraph 2.3 'Policy implementation and the interaction between firms'.

Environmental policy is a specific focus of research within the field of environmental economics. The aim of environmental policy is to internalize the costs of externalities, such as environmental pollution. "Economic analysis of environmental policy is based on the idea that the potentially harmful consequences of economic activities on the environment constitute an "externality," an economically significant effect of an activity, the consequences of which are borne (at least in part) by a party or parties other than the party that controls the externality-producing activity" (Jaffe et al., 2005). There are two steps that need to be taken in the design of an environmental policy. The first is the definition of a standard for environmental quality. The second is that a regulatory system needs to be designed to ensure those standards are met. The choice that needs to be made between several options of policy instruments and the fact that different instruments give different profit abilities are two main considerations that are discussed in environmental economics regarding policy research (Cropper et al., 1992). Several methods have been developed in order to take into account these considerations, such as CBA (Cost-benefit analysis) and MCA (Multi-criteria analysis).

POLITICAL ECONOMY

Political economy is considered a sub-discipline of political science that uses economic methods to analyze how environmental policy is affected by political institutions. Within this scientific discipline, influences on the impact of environmental policy are discussed through the analyses of choice making and definition of scope. Policy maker have a choice to make amongst several policy instruments when addressing environmental issues. There are several factors that contribute to the decision, such as "the ease of monitoring and enforcement, political feasibility, and the expected costs of policy instruments in the presence of uncertainty, firm heterogeneity and pre-existing tax distortions" (Fisher et al., 2003; footnote 1). Another factor is the actual impact that policies have on the incentives of a firm to address environmental issues (Fisher et al., 2003). The environmental impact is not always the most important consideration in the choice made between multiple environmental policy instruments. Sometimes the symbolic value of a policy or the environmental problem the policy is addressing is more important. This is discussed in choice-making theory.

Next to choice-making theory, the scope of a policy is an important consideration that is discussed in policy impact research. Traditionally analyses of decision-making were conducted through an institutional approach. In the current context, however, this approach has limitations as there are too many actors involved in the decision making process (Hahn, 1990; 39). Hahn (1990) therefore argues to be careful with selecting institutions to focus on in the research. In line with this discussion is the discussion on the reach of policy instruments. As Hahn (1990; 40) argues "The assumption that the feasible space of instruments can be specified is problematic. Certainly, instruments that are being used can be identified. ... However, defining the entire feasible space of instruments is virtually impossible. At best, we can hope to get a reasonable grasp of political constraints that limit on the choice of instruments."

GEOGRAPHY AND GOVERNANCE

Policy research in the scientific discipline Geography has been a widely discussed subject already since the 1970s, when David Harvey (1974) wrote an article on how geography would be able to contribute to policy research in addition to contributions already made by more experienced scientific disciplines, such as economics and political science. Geography, understood as ways of capturing political, economic, social and cultural worlds as a moving spatial matrix of possibilities under capitalism (Jones, 2008), contributes to this research by adding a practical dimension to the discussion as “geographers have contributed to the growing research on environmental problems and their causes and politics” (Martin, 2001). Also methodologies that have been developed in Geography to study the spatial context, ranging from “extensive empirical analyses of policies to evaluate their intended impacts and unintended consequences, to intensive ethnographic type investigations of precisely how particular policies affect specific individuals, groups and localities” (Martin, 2001), can contribute policy research.

The scientific discipline Governance contributes to policy research by stressing that “collective action in the realm of public affairs, in conditions where it is not possible to rest on resource to the authority of the state” (Stoker, 1998). “Governance involves working across boundaries within the public sector or between the public sector and private or voluntary sectors. It focuses attention on a set of actors that are drawn from but also beyond the formal institutions of government” (Stoker, 2000). The types of actors involved vary, including individuals and institutions, public and private initiatives and formal institutions as well as informal arrangements (UN-Habitat, 1999). Governance contributes to the discussion on policy research by pointing out that the “examination of underlying values in political conflict highlights how the interests of some groups can be rhetorically cast as the interest of a whole community, obscuring alternative interpretations of policy choices” (Martin et al., 2003).

CONCLUSION: MULTIPLE ACTORS

All the scientific disciplines discussed in this section show that there are many different actors involved in the creation and execution of environmental policies. In general there are three main actors that can be identified; the policy instrument, the polluter and the environmental problem (see image 3.2). The polluter causes an environmental problem for which environmental policy is designed in order to internalize the costs of that problem. In the context of policy impact analysis, the impact of a policy represents the degree to which a polluter reduces its polluting output, which is measured by the pollution factor, as a consequence of the implementation of a policy instrument. The policy maker has to make a choice between multiple policy instruments that can be implemented. In the next section, further insight is provided into the characteristics of environmental policies regarding the policy instruments and the characteristics of SMEs, which take the role of the polluter in this research.

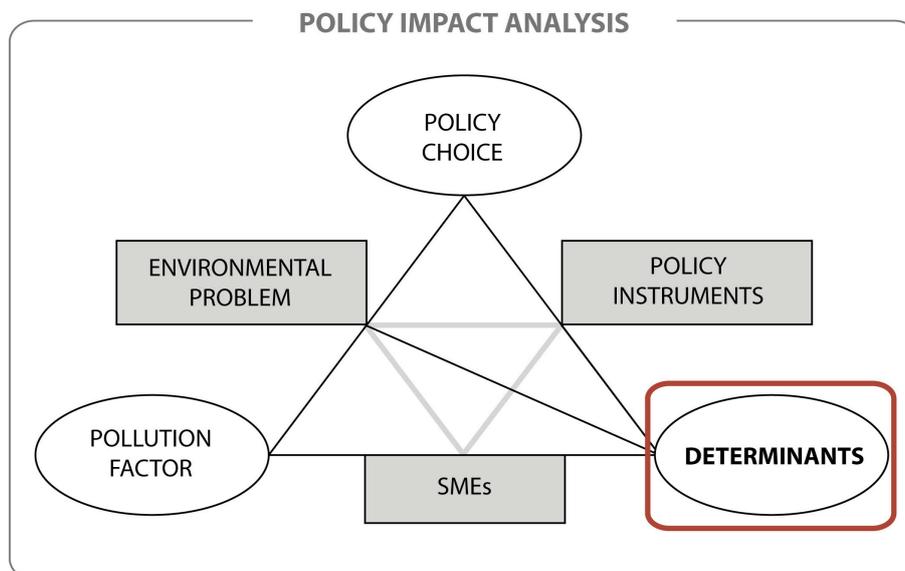


Image 3.2 Conceptual model

3.3 SME AND ENVIRONMENTAL POLICY

The second part of this chapter gives an overview of the discussions on environmental policies, SMEs and their relationship in scientific literature. The first two parts on environmental policies and SMEs describe their characteristics and establish a definition for both concepts. The final part describes the characteristics of the relationship between environmental policies and SMEs.

ENVIRONMENTAL POLICY

As explained in the paragraph on environmental economics, environmental policies are a means for governments to deal with externalities that can result in market failure. Environmental policies can be defined as "the set of techniques by which governmental authorities wield their power in attempting to ensure support and effect or prevent social change" (Vedung, 2007; 21). There are two important concepts that are addressed in environmental policy research. The first is that both new and existing policies need to be considered in environmental policy research. The environmental policy measures can be divided in organizational and technical measures. Corporate Social Responsibility (CSR) and Environmental Management Systems (EMSs), which include measures such as environmental reports, the monitoring of environmental performance, and the assessment of achievement, are considered to be organizational measures. The process of including climate change into policies is called climate policy integration (CPI) (Urwin et al., 2008). Policies that are perhaps not specifically defined as climate policies, might already address climate change issues. More attention needs to be paid to the extent of this development. The second important issue is policy interplay. Regulators can choose from a wide range of policy instruments, which include product or process bans, technology standards, performance standards, taxes, subsidies, tradable permits, tort liability, information disclosure, industry self-regulation, and management-based regulation (Bennear et al., 2007). These instruments are expected to interact with each other, which is called policy interplay. With the many actors involved in the climate change debate on many different scales, the horizontal and vertical interplay between policies becomes more important. Horizontal interplay refers to "the relationship between policies at the same level of governance e.g. international, European, national, sub-national, etc (Urwin et al., 2008)." Vertical interplay refers to the interactions between policies that are functioning at different spatial scales of governance. Several researchers have argued that policy research should be discussed looking at policy mixes instead of single policy instruments for reasons such as policy interplay.

The discussion on policy interplay concentrates on both instruments targeting different types of climate change and different types of instruments. On the level of climate change there is a lot of discussion on whether the current practice of separation of policies into either the 'adaptation' or 'mitigation' category is justified. In the current situation mitigation, which can be defined as "actions taken to reduce greenhouse gas emissions and hence to tackle the causes of climate change" (Tompkins et al., 2005; 563), and adaptation, which can be referred to as "actions taken to deal with the consequences of climate change, both before and after impacts are felt" (Tompkins et al., 2005; 563), are considered to be two separate actions. Consequently, they are addressed through separate policies, which becomes especially clear at the national level, where adaptation and mitigation are "usually occurring in different policy domains and engaging in different communities" Tompkins et al. (2005; 563). This is contradictory to the claims of choice theory and institutional theories that adaptation and mitigation should not be approached separately (Tompkins et al., 2005; 563). Tompkins et al. (2005) argue however, that it is not necessary to disregard the concepts of adaptation and mitigation completely. Instead their separate definitions should be followed less strict to ensure that no problems occur with respect to policy integration and a sufficient number of climate change responses. Tompkins et al. (2005) propose to instead focus on fundamental elements of adaptation and mitigation when making government policy. The research suggests that policy interplay between adaptation and mitigation does occur, but further empirical research is necessary to gain more insight into the interactions between policy instruments targeting adaptation and mitigation.

The discussion on policy interplay between different types of policy instruments is related to the discussion on whether the consideration of mixed policies in policy analysis is a more realistic approach than the analysis of single policy instruments, because the instruments are expected to influence each other. For instance, a firm that has to pay tax on its environmental output tries to reduce that output by developing a new technology. In case the firm applies for a subsidy to develop that new technology, the subsidy indirectly has an effect on the reduction of the total amount of tax that the firm has to pay. Therefore the relationship between multiple policy instruments should be considered in the analysis of policies. This relationship between market-based policy instruments, such as taxes, tradable permits, subsidies or other supporting instruments is discussed in several researches. Jänicke et al. (2010) describe in their article that "the increased use of taxes and tradable permits as market-based 'trend-steering' is therefore an indispensable cornerstone of innovation-oriented environmental policy" (Jänicke et al., 2010). Supporting instruments, such as the use of eco-labels, are also considered to have a positive effect on innovation and the diffusion of the new technology. Jänicke et al. (2010) explain that the effectiveness of the relationship between supporting or market-based policy instruments and innovation depends on whether the environmental targets are set at a strict level. The claims by Jänicke et al. (2010) are supported by Jaffe et al. (2005), who describe that "environmental policy interventions, such as carbon cap and trade systems and carbon taxes, generate incentives that will affect which technologies will be developed and how rapidly and deeply they will diffuse." Jaffe et al. (2005) consider both instruments, such as taxes and tradable permits, and subsidy-support to be market-based instruments. Frondel et al. (2008) describes that "the voluntary adoption of international EMS norms, such as the standards of the International Standards Organization (ISO 14001) and the European Union Environmental Management and Auditing Scheme (EMAS), have become a vital supplement to mandatory environmental policies based on regulation and legislation." Revell (2008) argues that "small firms need to be targeted with a mix of policies which include: environmental regulations, market-based instruments (MBIs) (= taxes, subsidies, tradable permits), infrastructural developments, networks, voluntary initiatives (best practice programmes and eco-labelling schemes)". As these examples illustrate, there several reasons to assume that a relationship between different types of instruments exists and therefore this research will continue to consider multiple instruments functioning simultaneously instead of focusing on single policy instruments.

As the previous section illustrates, current environmental policy research has divided policy instruments in different categories based on multiple definitions. Mickwitz (2003) explains that environmental policy instruments can be categorized based on their authoritative power or based on the target of the instrument. Based on their authoritative power, Vedung (2007) proposes three categories: regulation, economic means and information. Jänicke et al. (2010) distinguishes between similar categories that are called market-based, regulatory and supporting instruments and separates the supporting instrument category in a voluntary and information-based category (Jänicke et al., 2010). Rousseau et al. (2005) also considers categories based on their authoritative power, but separates the categories in regulatory and enforced instruments. Regulatory instruments are considered emission taxes, emission standards and technology standards, while enforced instruments include criminal fines, civil fines and transaction offers (Rousseau et al., 2005).

In current policy research categories have been used to generate a discussion into which policy instruments are most effective regarding innovation. In general these researches conclude that market-based instruments are the most effective due to their cost and innovation efficiency (Requate et al., 2001; Rennings et al., 2006). This is even described by Rennings et al. (2006) as "the basic lesson of ecological economics for a long time". Rennings et al. (2006), however, question the superiority of market-based instruments, as their success depends on the circumstances of the policy implementation. As Rennings et al. (2006) explain the advantages that innovations can bring a firm can influence the strategic position of that firm regarding the competitive position and information asymmetry. These advantages can result in a higher effectiveness. The different conclusions of several researches conducted on the effectiveness of different instruments within the category market-based permits illustrate the difficulties in the discussion. Jung et al. (1996) present a very clear result ranging instruments from most to least effective. Auctioned permits are considered most effective, followed by emission taxes and subsidies, which is in turn followed by issues marketable permits and finally performance standards are considered least effective. This result is contradicted by

Fisher et al. (2003), who does not find a preference regarding effectiveness between auctioned permits and emission taxes, but instead concludes that similar to the conclusion of Rennings et al. (2006) it depends on the circumstances. Concluding from these researches it can be said that there is still not one clear conclusion that can be drawn on the ranking based on the current research and similar to the discussion in mixed policy use it is questioned whether the analysis of single policy instruments is sufficient to shed more light into these issues.

Concluding from this section this research addresses several concepts that are still open for discussion among scientists. In order to avoid the difficulties in selecting policies for analysis based on the criteria defined in the literature, such as a focus on adaptation versus mitigation or vertical policy interplay, the approach in this research is to select policies for the analysis based on whether they address a pre-defined environmental target. As this will likely result in a large number of policies that need to be included in the result, this research will also use the policy category approach as explained by Jänicke et al. (2010). They distinguish the regulatory, enforced and voluntary category based on their authoritative power. In this research, however, the information-based category is also included as a separate category. The policy category approach will also allow policies that address the environmental problem through a specific target group to be included, while it is still possible to determine which type of policy instrument is most effective.

SMALL AND MEDIUM BUSINESSES

In scientific literature there is a consensus on the fact that small and medium enterprises (SMEs) are different from large firms in both size and characteristics, however, there is not an agreement on how SMEs should be defined (McAdam et al., 2005). In most scientific literature the definition of SMEs by the European Union is used as a guideline. The Commission Recommendation 96/280 (SME definition) defines SMEs as "companies with fewer 250 employees with either an annual turnover not exceeding 40 million euros or an annual balance sheet not exceeding 27 million euros and those that were independent with less than 25% of the capital or voting rights owned by one enterprise or jointly by several enterprises. Keijzers et al. (2008) further specify this definition by taking into account specific organizational and internal innovation characteristics of companies. They propose 9 different types of SMEs within the definition set by the EU. With the 9-type definition Keijzers et al. (2008) move away from the traditional classification of SMEs in leaders, followers and stragglers and instead use specific characteristics to further specify the definition set by the European Union. In practice, the definitions of SMEs in the literature are not always found to be the suitable and therefore other definitions tend to be used based on for instance the task division within a governmental organization.

SMEs are generally considered to have different characteristics from large firms. Typical characteristics of SMEs are considered "flexibility, entrepreneurial orientation and innovativeness, closer interaction between departments, shorter lines of communication, better personal links, more unified culture and stronger identity" (Aragón-Correa, 2008; 89-90). Keijzers et al. (2008) identify specific characteristics for SMEs to be the central role of the entrepreneur, lack of resources, niche markets and flexibility, short term focus, labour productivity as the norm for performance, local orientation, the occurrence of many family businesses and a low complexity in organization. The central role of the entrepreneur is frequently mentioned in scientific literature. Manager-founders and their personal vision are found to be defining factors for the willingness among SMEs to respond to environmental policies. The personal vision tends to differ per geographic location according to a comparative study by Revell et al. (2003) of the Netherlands and the UK. UK small firms were found to think of environmental protection as less relevant than the Dutch small firms. This development was traced back to the different approaches of environmental instruments to SMEs (Revell et al., 2003).

Characteristics that are considered internal weaknesses of SMEs are the limited size and means, short-term focus, organization as the weak link and a low orientation on sustainability (Keijzers et al., 2008). External weaknesses are considered the limited access to financing, no demand on the market for sustainable innovation, laws and regulation can be unfavourable to SMEs, limited access to knowledge and information and collaboration that is difficult to realize (Keijzers et al., 2008). Motivation as the generator, flexibility and the specializing nature of these types of companies are considered internal strengths and societal pressure and law enforcement, economic chain relations, motivated cooperation and branches are considered external strengths of SMEs. Due to the fact that these characteristics differ from large industrial firms, it is likely that determinants of SMEs will be

different as well (Del Río González , 2009). "Barriers of SMEs should be empirically analyzed and, accordingly, the most dynamically efficient instruments should be identified" (Del Río González , 2009). This discussion should especially focus on the type of environmental technology response of SMEs and the impact of strict law and regulations on these firms (Del Río González , 2009; 871).

POLICY IMPLEMENTATION AND INTERACTION BETWEEN FIRMS

The interaction between firms and environmental policies is characterized by cost internalization. The motivation of cost internalization is that pollution of air, water or land caused by a firm results in a cost imposed on society. This cost from the point of view of the firm can be compared to the costs of materials needed to make a product, but while these material costs are internalized by the firm, the minimization of externalities of a firm needs to be realised through implementation of environmental policies by translating the pollution costs into financial incentives for the firm (Jaffe et al., 2005; Oates et al., 2003). This minimization of externalities can either be achieved by internalizing the environmental costs or by setting a limit on the amount of environmental pollution that the firm is allowed to produce (Jaffe et al., 2005). Next to internalizing pollution costs, implementing an environmental policy can stimulate a firm to invest in developing new technologies. In case these technologies are more environmental friendly, it can cause a decrease in pollution. This is regarded a spin-off effect of the policy. Innovation is, however, also defined as a direct aim of environmental policies, because without the internalization of the cost of pollution the firm has no direct incentive to conduct any costly R&D investments. For instance, a firm can directly use R&D subsidies to invest in the development of new technologies. In all policies addressing innovation, either as a spin-off or directly, it is still a voluntary choice for a firm to invest in R&D. Therefore the relationship between mandatory and voluntary policy measures is especially important.

The ability to address environmental problems through innovation is a characteristic that is specific to firms. Innovations have the unique ability to be able to generate both economic and environmental results simultaneously (Murphy, 2000). This unique ability has generated an interest of policy makers, who want to develop policies that stimulate innovation, and of researchers, who want to study what policies are most effective in generating innovation. The effect of policies on stimulating innovation has been a widely discussed subject within policy research. The concept of innovation originates from the three steps of technological change described by Schumpeter (2003): invention, innovation and diffusion. Researchers generally accept the concept of these three steps, although sometimes two steps are combined, such as in the research of Jänicke et al. (2010) for the purpose of simplicity. Research into the effectiveness of environmental policy regarding stimulating innovation varies in both the approaches and the results. Rehfeld et al. (2007) conclude in their research that while "environmental policy seems to be a driver for environmental product innovations, albeit the positive effect is rather weak." Jaffe et al. (2005) describes that "technology innovations-such as new pollution control equipment, cleaner production methods or new substitutes for environmentally harmful products-typically reduce the marginal costs of achieving a given unit of pollution reduction." Del Río González (2009) concludes that environmental technology developments by firms are the result of pressures through the implementation of different instruments ranging from market pressures to collaboration partnerships. The consensus among researchers is that innovation has a positive effect on environmental performance of a firm, however, the cause of this effect is still not clear.

In addressing innovation another important concept to consider is diffusion, which can be defined as the way an idea or technology is adopted. Diffusion can play a significant role in the effectiveness of environmental policy addressing innovations (Murphy, 2000). Within the firm the implementation of innovations is not only dependent on their costs or the quality. The innovation also needs to be compatible with the existing systems and structures of the firm (Murphy, 2000). Another factor that can affect diffusion within firms is the time that the innovation will take before it generates any benefits. As Murphy (2000) explains it is more likely that a firm will adopt an innovation that will generate benefits short-to-medium term. "This is the case partly because they have yet to benefit from the scale and learning effects that would reduce their costs and improve their quality" (Murphy, 2000; 36). Therefore it might not be possible to stimulate a firm into adopting the most environmental friendly option. Regarding policy developments it is therefore important to consider diffusion in addition to innovation.

In diffusion processes information exchange is especially important. When two actors communicate they can choose which and how much information they share. As Jaffe et al. (2002) describe "information is a public good that may be expected in general to be underprovided by markets." From the point of view of the technology the adoption of a technology by a firm is already considered a transfer of information, which can promote diffusion and thus create a positive externality (Jaffe et al., 2002). From the point of view of the firm, the adoption of technology by other firms is considered a knowledge externality. This externality can be negative when other firms profit from the new technology and consequently the firm that has invested in R&D to develop the technology gets a lower return. If a firm is afraid of running the risk of a negative externality, it might be hesitant to invest in R&D. However, adoption of the technology by other firms can also create trust among consumers and in that case it can result in a positive externality. Because of externalities firms are careful about sharing information. The amount of information that's shared depends on the level of trust between actors.

There are many actors involved in environmental policy making. Pimenova (2004) identifies several support programmes and actors involved: Envirowise, EEBPP, Environment and Energy Helpline, Federation of Small Businesses, SBS, Local authority (NW London TEC), Groundwork. Del Río González (2009) explains that next to regulation several other actors can stimulate a firm to implement more environmental friendly technologies, such as "industrial associations and chambers of commerce, equipment and input suppliers, investors, insurance firms, final consumers/ industrial clients, competitors, environmental NGOs, green parties, civil society (influenced by mass media), public and private research centres and financial institutions" (Del Río González, 2009).

The type of actors involved in and the approach to regulation varies per geographic location. The research of Revell et al. (2003) shows specific characteristics of the Dutch approach of environmental action towards SMEs. "At a macro level, Dutch SMEs have been actively targeted both by legislation, licensing and voluntary initiatives" (Revell et al., 2003). Revell et al. (2003) find that it is especially the mix of voluntary instruments complemented with regulatory and licensing measures makes the Dutch policy approach very successful.

3.4 CONCLUSION

This chapter demonstrates that several factors need to be taken into account to establish the impact that climate change policies have on SMEs. For instance, regarding the selection of policies that are included in the research, the literature shows that there are many different concepts that can be used as selection criteria. To deal with the large amount of policies that can be included in an analysis, categories are used by researchers to make groups of policies based on their authoritative power for the purpose of the analysis. The definition of categories varies slightly among researches. As the selection of policies in this research is based on the pre-defined environmental target, the issue of the selection criteria for policies is likely to be avoided. A consequence of this decision is, however, that many policies addressing multiple specific target groups will be included in the research. This issue will be resolved by using policy categories. Another factor that needs to be taken into account is that governmental related organizations are not the only actors involved in the creation of policies. Several actors, such as the chamber of commerce, NGOs and specialized organizations, also create policies. As these policies are likely to affect the pre-defined environmental target as well, they should also be included in the selection of policies addressed in this research. Regarding this research it means that also policies developed by actors that are not related to the government will be included in the policy selection. A third aspect that needs to be taken into account is that the impact of a policy cannot always be established by looking at the intended target. As the discussions on innovation and diffusion show, policies that are specifically intended for R&D activities first need to lead to an actual innovation before they can have an impact. These innovations then need to create a change regarding the environmental target. In these cases the impact can be established by selecting the innovations that an SME has created, for instance by looking at patent data, after which the impact of those innovations on the intended policy target can be established.

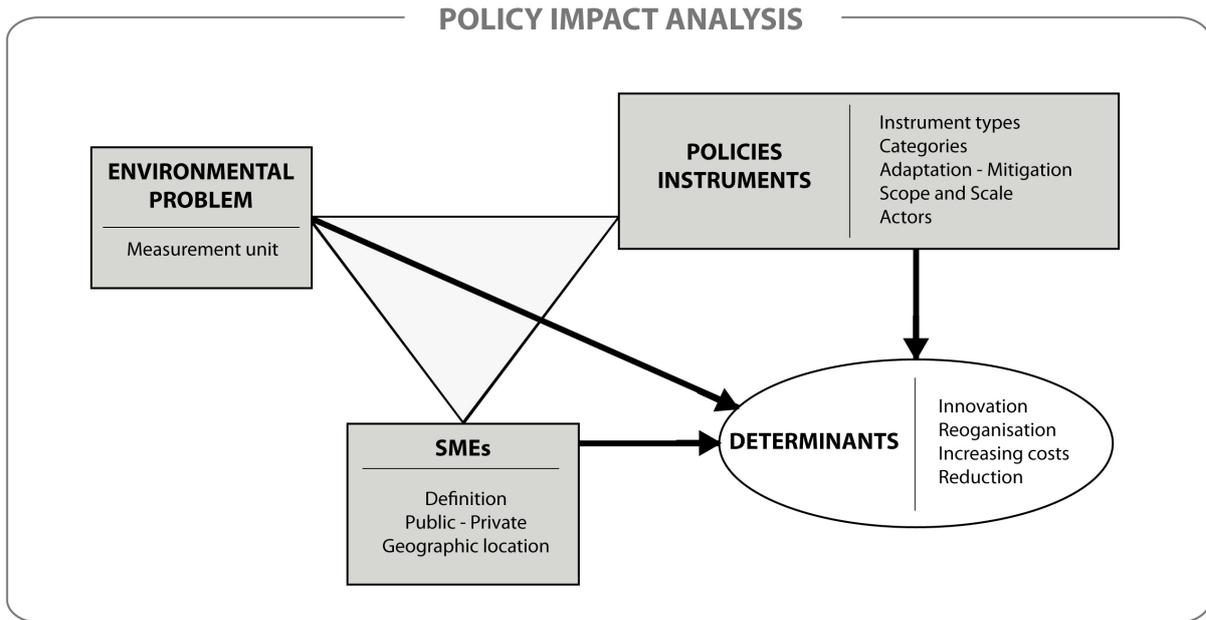


Image 3.3 Conceptual model, expanded

Finally, the literature review shows that there is not a clear definition for SMEs. As Del Río González (2009) explains, determinants can be quite different for SMEs from large industrial companies due to the difference in characteristics. Therefore it is expected that the definition of SMEs, especially regarding the size of the firm, will affect the number and type of policies included in the analysis and consequently the outcome of the analysis. In general it needs to be stated that the majority of the literature on environmental policies concerns firms and specific discussions on SMEs are very rare. Articles on climate policies that are aimed at SMEs are even harder to find. The literature review could therefore not provide insight into a way to identify an environmental target that is addressed by policies aimed at SMEs and which can be used as a case study for the research. In order to provide some more clarity regarding these issues, the next chapter will provide an overview of the climate policies aimed at SMEs that are currently implemented in the city of Rotterdam.

Ch. 4 – CLIMATE POLICIES IN ROTTERDAM

4.1 INTRODUCTION

This chapter provides more insight into the target that is most frequently mentioned in climate policies aimed at SMEs located in the city of Rotterdam. The first section provides an overview of the selected climate policies, which are analysed based on the policy category the instrument belongs to, the way SMEs are defined in the description of the target group and the environmental target that is addressed by the policy. In the second part a case study is defined based on the conclusions of the theoretical framework and the inventory.

4.2 CLIMATE POLICIES TARGETING SMEs

Using criteria that were defined based on the previous theoretical discussions, a total of 124 policies were identified to be in effect in 2010 that concerned both SMEs and climate change. The policies were collected through information in policy documents or on the websites of actors involved in policy making, SMEs or climate change. Governmental institutions on the European and National level were selected as the first actors. Other actors that have created climate policies were identified based on the information collected from these first actors. The policies were selected based on three criteria (see table 4.1). An overview of the selected policies can be found in appendix 2. The policies were analysed based on the environmental target they address, whether the target group of the policies include SMEs, whether the policies are aimed at firms in general and finally based on the policy category the policy belongs to. The categories are defined in chapter 2.3 based on their authoritative power. Data on the policies was collected from the descriptions of the policies on the websites.

Table 4.1 Criteria for policy selection	
	1. The policies need to address issues relating to climate change
	2. The policies address firms
	3. The target group of the policies needs to include SME defined by 'less than 250 employees' (<250) and/or 'all firms that aren't industry' (NO_IND)

Several types of policies that meet the three selection criteria were excluded from the analysis for various reasons. The Daey Ouwens Fund, the Fund for Sustainable Biomass Global and the Fund for Sustainable Biomass Import were excluded as the direct environmental benefit is experienced outside of the Netherlands. Also subsidies that support projects that are carried out outside of the Netherlands have been excluded. Several policies that were found on the European Level function as an agreement on a certain attitude towards policy-making, such as the DOHA agreements. These policies were also excluded, because they only affect the environmental target indirectly. In some cases the policy instruments that are implemented by the Dutch national government can be traced back to policies that have initially been implemented by the European Union. In these cases the information on the websites of the lowest government level were used in the analysis, because they are expected to give the most accurate information regarding the consequences of the policies for firms in the Netherlands. The policy known in Dutch as the 'milieusteunkader' (environment support frame) has been excluded from the analysis. This policy defines a limit for the amount of subsidy that can be received by a firm or organization. This limit can influence the decision of a firm to implement policies. The policy is excluded from the analysis, because it is expected to only have an indirect effect on the environmental target. Finally, there are several policies that were initially not selected for the analysis due to the criteria, but were taken into consideration. These policies, such as 'local climate initiatives' and 'City & SME', are implemented by the Dutch national government and aimed at local governments in order to stimulate firms to take climate related measures. In cases where the Dutch government provides specific means to the local governments, such as subsidies, the policies were excluded from the analysis, since firms cannot actually access those arrangements. In case, however, the policies provided additional information that was also accessible to firms, such as the program for sustainable shopping, the policies are expected to have a direct effect on the environmental target and are therefore included in the analysis. These additional criteria led in total to the exclusion of 25 policies.

After the final list of policies was established the first analysis was carried out based on the categories that were defined in the literature review (paragraph 2.3). These four categories Market-Based, Voluntary, Information-based and Regulatory as defined by Jänicke et al. (2010) were used to classify the policies. The following definitions for each of the categories were used in the analysis.

- Voluntary - Those policies for which participation by a firm is optional, but once a commitment is made there are obligations that the firm needs to honor.
- Information-based – Those policies that merely provide information that can be accessed without obligations regarding the environmental target
- Market-based – The policies where the impact of a policy is linked to the performance of the company.
- Regulatory - Laws and rules that a company is obligated to obey.

During the analysis these four categories defined by Jänicke et al. (2010) proved to be insufficient to classify all policies and therefore several categories have been added. In total three of the categories have been further specified.

- The market-based category has been split up in a tax and a general component. The reason is that many of the market-based policies, such as tax, are considered full coverage programmes and therefore their impact has to be established through another approach than is used for policies that are considered partial programmes, which are included in the general market-based category.
- The subsidy category, which in previous literature is defined as a component of the market-based category (Jaffe et al., 2005; Revell, 2008), is defined as a separate category and split in a general and R&D component. R&D subsidies are considered separately, because based on the literature it is established that they first need to result in an innovation before the impact of that innovation on the environmental target can then be determined. For the general subsidy category it is expected that these will be invested directly into measures that will address the environmental target.
- The regulatory category has been split in regulatory general and regulatory license. Also here the distinction has been made between full coverage and partial programmes, because a license is always required and therefore it is not possible to create a control group without a license.

The total list of categories that have been used in the analysis can be found in table 4.2.

A second analysis has been carried out based the different definitions for SMEs that were found in the literature. In the literature the most frequently used definition was the one set by the EU Recommendation 96/280 (SME definition), which states that a firm is considered a SME when it has less than 250 employees and an annual turnover of less than 40 million. The literature review on SMEs and Environmental Policies (section 3.3) concluded that there isn't a clear consensus between the definition for SMEs used in literature and in practice. Therefore an analysis of the definition of SMEs regarding the target group defined for the policies is included in this chapter. The first definition that has been considered is the definition set by the European Union (<250). There were in total 10 policies found that met this definition. The second definition that has been included is the definition of SMEs as set by the Rotterdam Climate Initiative (RCI), which includes all companies that are not industry (NO_IND). In this case also the information-based policies that are aimed at SMEs have been considered, because it is expected that firms that visit these websites consider themselves to be SMEs. The fact that the RCI defines these firms as SMEs is likely to encourage this belief. Finally a third group is considered, which includes all the policies that include SMEs in the target group, but the target group is not restricted to SMEs. This group is defined as firms (FIRM). From the analysis it is concluded that the number of policies that are targeting SMEs specifically, both considering the <250 and NO_IND definition, is limited compared to the number of policies that apply to firms in general.

As explained in section 3.4, the literature on the relationship between climate policies and SMEs didn't provide insight into which environmental target is most frequently targeted by policies aimed at SMEs. Therefore an analysis of the environmental targets of the policies is also included in this paragraph. The environmental target of the policies has been defined based on the aim of the policies as described in the policy description. From the literature review it was concluded that in addition to

TABLE 4.2: OVERVIEW CLIMATE CHANGE POLICIES IN ROTTERDAM

	Number of policies per category	Definition SMEs			Environmental target								
		>250	NO_IND	FIRM	Energy	Innovation	Transport	GHG	Biodiversity	Sustainable development	Waste	Water	Air Pollution
Market-based (tax)	6	0	0	6	3	1	0	0	0	2	0	0	0
Market-based (other)	7	3	0	4	1	4	1	3	0	2	1	0	0
R&D subsidies	7	4	3	0	0	7	0	0	0	0	0	0	0
Other subsidies	26	3	1	22	16	5	1	2	1	1	0	0	0
Voluntary	12	0	1	11	6	0	0	2	0	5	5	0	0
Information	52	0	24	28	28	2	1	0	0	20	4	0	0
Regulatory	8	0	0	8	5	0	0	0	0	0	2	1	1
Regulatory (license)	3	0	0	3	1	0	0	1	0	1	0	0	0
Totaal	124	10	29	82	60	19	3	8	1	31	12	1	1

policies that address a specific environmental target, also policies that are aimed at stimulating innovation can address an environmental target. Therefore innovation is also included as a separate target. In total 9 environmental targets were found (table 4.2). For each environmental target a policy was found to address, a one is added in the table, which means that in case a policy addresses multiple targets, multiple ones are added in the table. One of the targets, sustainable development, cannot be related to one specific problem, but instead it promotes more sustainable practice through which multiple problems are addressed, such as the prevention of waste of raw materials, the use of clean energy, to avoid damaging substances and to create new markets of used raw materials. Since it cannot be predicted which of the targets a firm will address, sustainable management is mentioned as a separate target in table 4.2. From the analysis on environmental target it has become clear that with 60 out of 124 policies energy is the most frequently addressed targets by climate policies for SMEs. With 31 out of 124 policies sustainable development is the policy the second most frequently targeted policy.

4.3 CONCLUSION

Based on the conclusion from this chapter that energy is the most frequently targeted climate problem by climate policies in Rotterdam until 2011, the framework for the definition of the determinants can be completed. The final design of the framework (image 4.1) consists of the change in energy usage by SMEs as the dependent variable, as described in paragraph 2.4, and five policy categories as the independent variables, as described in paragraph 3.4. Based on the approach by Hoffmann et al. (2008) energy reduction measures are proposed as the measurement unit for the determinants. Energy reduction measures are expected to be a sufficient measurement, because the inventory of the climate policies has shown that each of the energy policies is expected to result in an action that reduces energy usage. In practice this means that the desired impact of an energy policy would be for an SME to realise energy reduction measures.

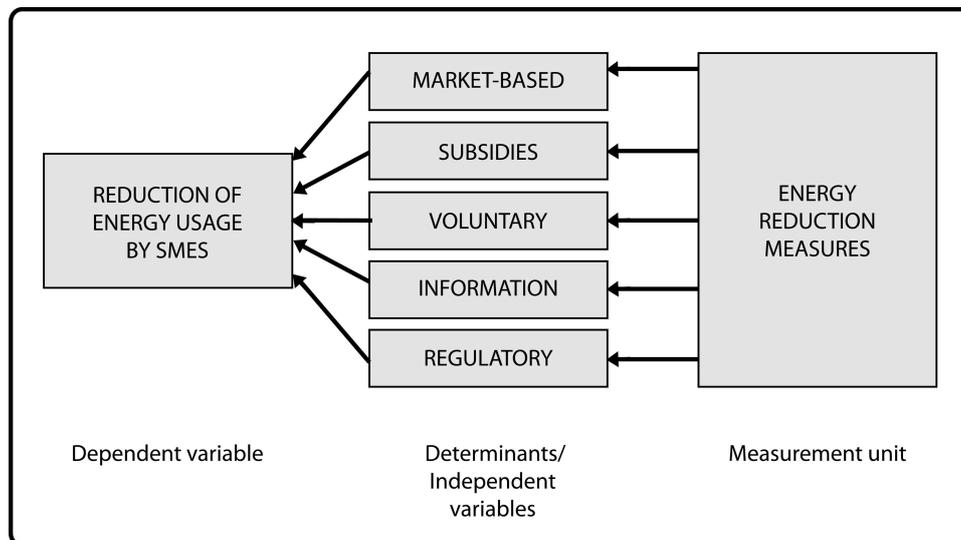


Image 4.1 Final design of the framework

With the framework completed and the case study selected, it is possible to complete the conceptual model. Central in the conceptual model are the determinants, which can be described as the impact of energy policies on the energy use of SMEs. Based on the framework, the determinants are defined by policy categories and measured by energy reduction measures. It is expected that the determinants will be affected by the characteristics of a SME. The SME characteristics are split up in those that affect the energy use directly and those that are expected to influence the characteristics of energy use. The types of policies that are in effect, which include policies from multiple governmental levels, affect the policy categories. The inventory of policies in Rotterdam has demonstrated that the aim of energy policies is to stimulate a SME to take energy reduction measures. Energy reduction measures are in turn expected to influence the energy consumption of an SME in addition to several SME characteristics.

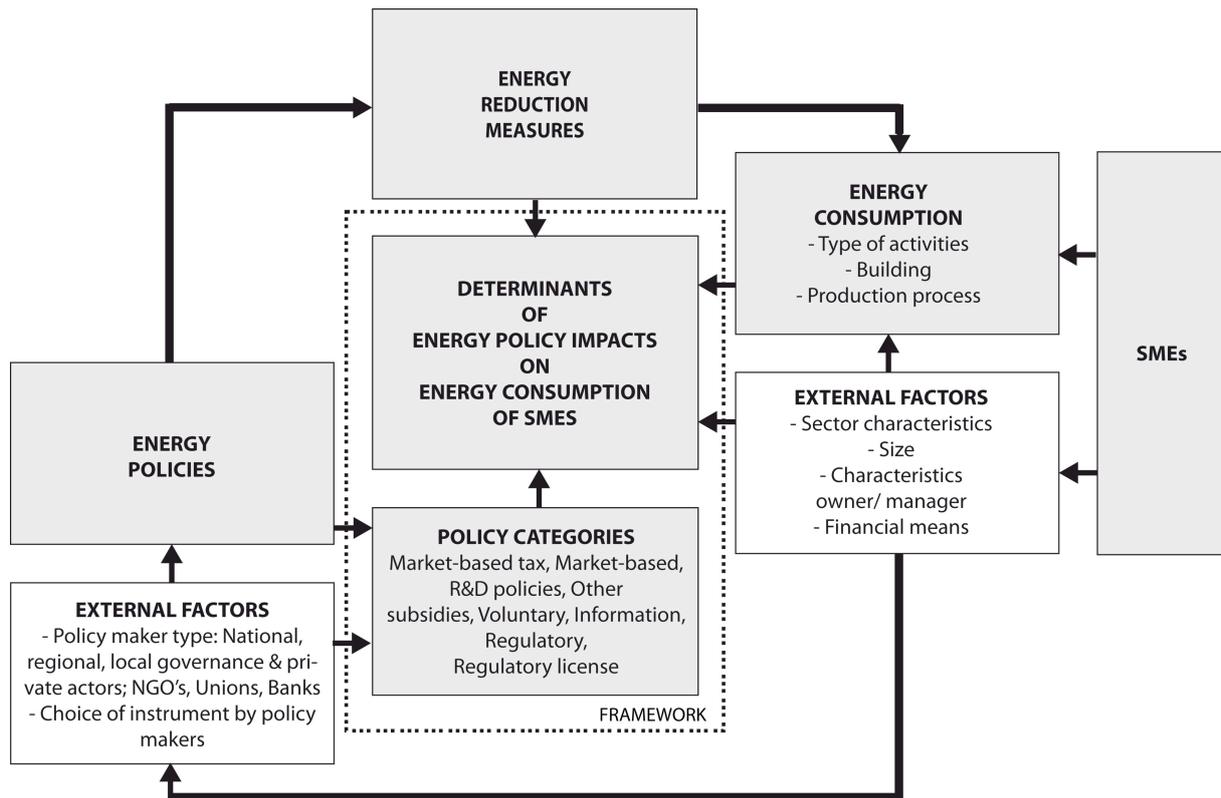


Image 4.2 Conceptual model, case study energy

The conceptual model shows that, in order to be able to use the number of energy reduction measures to measure the impact of energy policies on energy use of SMEs, it needs to be established whether energy reduction measures are a significant factor influencing energy use. Therefore it is assumed that *energy reduction measures have a large effect on the reduction of energy use of SMEs in Rotterdam.*

Ch. 5 – METHODOLOGY

5.1 INTRODUCTION

In the first part of this chapter an additional review of literature that specifically addresses the case study energy is included. The chapter continues with a research design for a case study through a combined method of quantitative and qualitative analysis. In this chapter it will further be explained which sampling, data collection and data analysis methods will be used regarding the quantitative and qualitative part.

5.2 CASE STUDY: ENERGY

Energy use of SMEs is dependent on several factors among which the firm characteristics, which influence the impact of the energy reduction measures. Every SME has a certain set of activities, composed of the manufacturing process of goods or the provision of services that use energy. Next to the nature of these activities, also the type of management that is applied can have an effect on the usage of energy. The literature states (Keijzers et al., 2008) that one of the characteristics of SMEs is that its management is often very dependent on the owner of the business. Therefore the involvement of the SME in the reduction of energy use is also expected to be highly dependent on the personal view of the manager or owner. Another large factor in energy consumption by SMEs is the type of building in which they reside. The type of heating system and insulation can make a large difference in the resulting energy consumption. Finally, the behaviour and awareness of staff members regarding energy use can also be of great influence on the level of energy use.

Innovation is a separate factor that needs to be considered in regard to energy use of SMEs. In the literature innovation is considered a means for a firm to generate economic and environmental benefits simultaneously (Murphy, 2000). Innovation can be implemented in order to find ways to optimize the energy efficiency of products, services and their manufacturing processes. However, the conduction of R&D cannot guarantee an improvement in energy efficiency. Especially SMEs are generally considered to have limited resources and will therefore be less likely to make large investments in R&D without the expectation of certain results. Therefore, the level of success of R&D regarding energy efficiency also affects the energy consumption of SMEs indirectly. External factors that affect this consumption are the type of sector the SME belongs to and the size of the SME. Also activities per sector can be linked to a certain type of energy use. These activities can be specified based on levels of energy consumption for which sector-specific energy efficiency targets can be identified. The DCMR Environmental Protection Agency uses these sector-specific characteristics as a strategy to address SMEs on their energy consumption. Finally the size of the SME also affects the energy use, because on the one hand a smaller sized SME is expected to be more dependent on the manager's personal characteristics and on the other hand SMEs have a more limited capital available for energy reduction measures or R&D.

The factors that are expected to influence energy use of SMEs have been established through conversations with a professional and an academic advisor. Firm characteristics that are expected to influence energy use are the size of the firm, the sector of the firm, the age of the building the firm is located in and whether the activities of the firm mainly take place in- or outside. In addition the literature review has shown that the manager characteristics are expected to have an effect on the energy use. Several other firm characteristics can be defined for which the change is expected to influence the energy use. When a firm grows, it is expected that the firm will use more energy. Growth can take place either by an increase of the number of employees or turnover, but a firm can also decide to grow by expanding the number of products and services offered. In the case of energy use, even when the turnover, number of employees or the number of products and services remains unchanged, the energy use can still be impacted by a change in the production process or the way that products are offered to the customer, which is therefore also expected to be an important factor that influences the energy use of SMEs. Again, as the manager plays an important role in the behaviour of SMEs regarding energy use, the change of management also needs to be taken into consideration. Image 5.1 provides a summary of the factors that influence energy use that are considered in the analysis including the energy reduction measures.

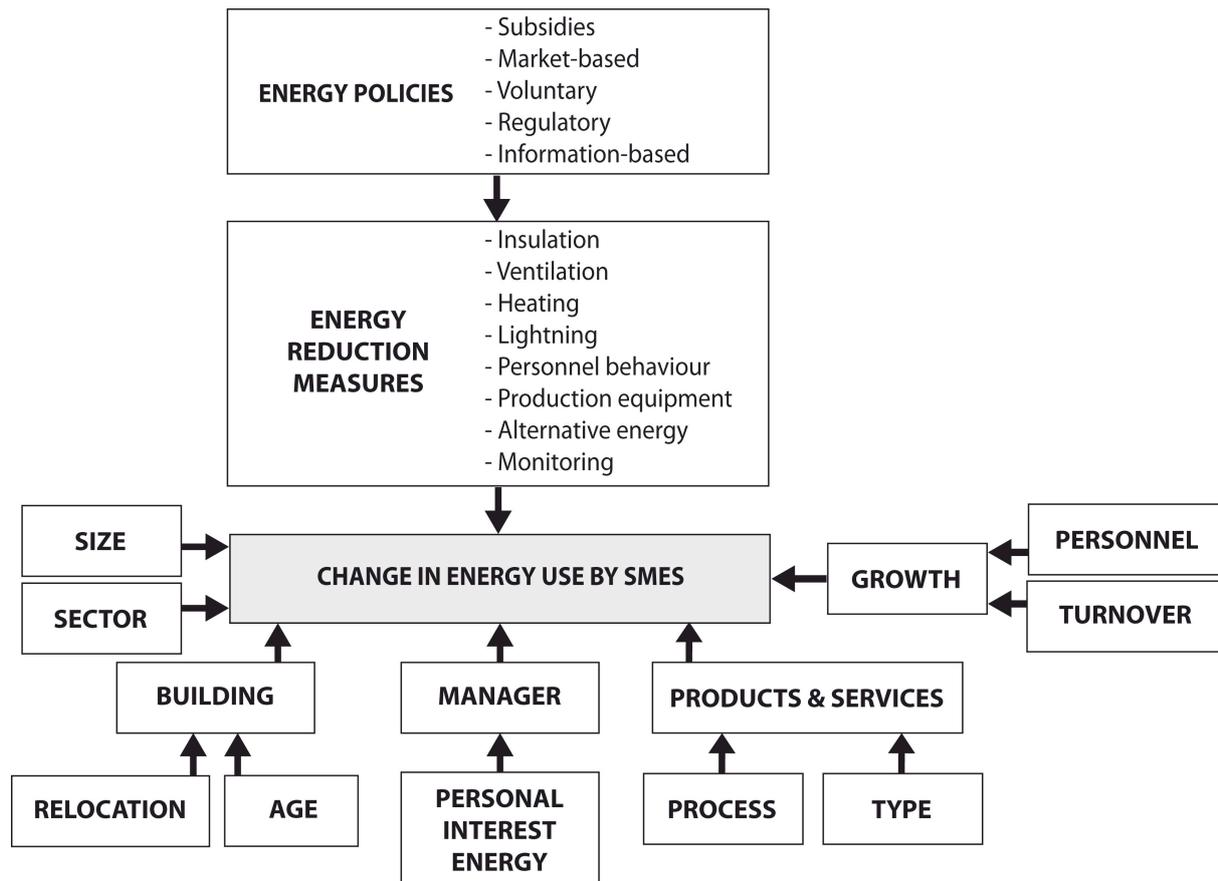


Image 5.1 Detailed conceptual model for energy use SMEs

5.3 COMBINED METHODOLOGY

The research will consist of a combined methodology of quantitative and qualitative research. The quantitative approach allows for broad conclusions on the research topic that can be validated for large groups of respondents (Del Río González , 2009). The qualitative approach allows for more detailed insights into the motivations of the respondents. In this research the aim is to see whether data on energy reduction measures can be used as a valid measurement unit for determinants of energy policy impacts on SMEs. To achieve more insight into this impact, this research will study the relationship between energy policies, energy reduction measures and energy use from the viewpoint of SMEs. Because there are more than 700.000 SMEs in the Netherlands (Statline, 2010), it would not be justified to take a qualitative approach for this research. The total number of respondents that can be included in the research would be limited. Therefore in the first step a quantitative approach is used to establish the general relationship between energy policies, energy reduction measures and energy use. However, the quantitative approach will merely show which relationships exist, while the research question also requires insight into the nature of these relationships. Further insight into the relationships is provided by a second part of the analysis for which a qualitative approach is used. The aim of this second part is to establish to what extent the relationships are exclusive for energy policies, energy reduction measures and energy use and to what extent other factors play a role.

5.4 DATA COLLECTION

The data was collected through conducting a survey by phone among SMEs in Rotterdam. This method is very effective for contacting a large number of respondents in a short time span as is the written questionnaire. However, for the construction of a written questionnaire it is necessary to define the questions very exact as only the answers written down will be collected. In a survey by phone additional data can be collected based on the way the respondents answer the questions and

this method allows the interviewer to redirect the question in case it is misinterpreted or the respondents is unable to answer. This is especially important in this research, as the amount of literature available on the energy use of SMEs is limited and because the central research question of this research is focused on data collection. In this paragraph further information is provided on the strategy for data collection; the research domain, sample definition, construction of the survey and the background of the data collection are explained.

RESEARCH DOMAIN AND SAMPLE DEFINITION

As paragraph 5.2 explains, the domains for this research have been defined as energy policies, energy reduction measures, energy use and SMEs. Based on the first three domains a survey is constructed, which is to be conducted by phone. A similar method is used in the research of Rehfeld et al. (2007). The SMEs are the domain from which a respondent sample is taken.

On January 2011 there are 79488 firms registered in the Dutch Trade Register of the Chamber of Commerce (Chamber of Commerce, 2011). Due to this large number it is necessary to select a sample. The sample is taken from the companies listed in the online address database of the chamber of commerce for which registration is obligatory for all companies in the Netherlands. Based on this address list, three steps have been taken in order to construct this sample.

- First, a selection was made from the online database based on two criteria; their location in the city of Rotterdam and companies and NGO's.

- Secondly, it was decided to focus on eight sectors. As the database includes more than 20 sectors, a focus on a selected number of sectors is expected to allow for more solid conclusions to be drawn from the analysis. The sectors are selected based on whether the largest numbers of businesses belong to this sector and whether the sector includes commercial businesses or not. Government related businesses, such as Education and Human health and social work activities, are excluded as they are expected to behave in a different way than commercial SMEs. The selection of the sectors is based on Statistical Classification of Economic Activities in the European Community (NACE) coding, which is the European industry standard classification system. This system is similar to the Standard Classification system and has been used in previous researches as a condition for the selection of the sample (Rennings et al., 2006; Rehfeld et al., 2007). As both the Dutch Tax Services and the Chamber of Commerce use the NACE coding standard to classify companies into sectors, this system is most appropriate for this research.

- Thirdly, the selection based on size of the companies. As explained in the literature the EU Recommendation 96/280 (SME definition) defines SMEs as companies with 1-250 employees and a maximum annual turnover of 50 million or annual balance sheet of maximum 40 million euros. To avoid that firms that share the energy bill with a household are included, the SMEs that have 0-4 employees are excluded from the sample. As the energy use and energy reduction measures taken by these SMEs are expected to be inseparable from the private energy use and energy reduction measures, these SMEs are expected not to be able to answer the questions in the survey.

The first sample of 400 respondents was taken by the stratified sampling method. However, the survey among these 400 respondents did not result in enough completed interviews and the number of interviews per sectors was very uneven, which made it difficult to draw conclusions on the sector variable. Therefore, in total four additional samples were taken based on the systematic random sampling method until the appropriate number of interviews per sector was collected. In case a respondent was unable to indicate the change of energy use of their company for the past 5 years, an additional interview was conducted to reach a sufficient amount of data for this variable.

The respondents for the qualitative part of the research are drafted from the respondents that participate in the survey by phone, as the aim of the qualitative research is to provide more insight into the given answers. In total two respondents were asked to participate in an additional interview. The respondents are selected based on whether they have implemented a high number of energy reduction measures to be able to further investigate the decision-making process for taking those energy reduction measures.

SURVEY

The survey, which is added to this document as appendix 3, has three parts:

1. Energy use & energy reduction measures
2. Energy policy
3. Firm characteristics

The survey is started with the energy related questions and ends with the questions on the characteristics of the SME. Through this order it is prevented that questions on energy reduction measures trigger biased answers for the questions on energy use and it is ensured that the survey starts with the questions that are most relevant for the topic.

Based on the domains of this research, the survey aims to collect data on energy policies, energy reduction measures and energy use. The data on energy policies will be analysed by the policy categories that have been defined based on the literature (Jänicke et al., 2010; Jaffe et al., 2005; Revell, 2008) and the inventory of climate policies in chapter 4. It is the aim of the research to inquire after impact of a policy based on the experience of the respondent of the SME. Therefore the questions regarding policies consist of two parts. The first part establishes the degree of awareness of the respondent regarding policies. The second part aims to establish whether or not, in the opinion of the respondent, the policy has had an impact on the likelihood of the SME to implement energy reduction measures.

As the energy reduction measures that SMEs can take vary per sector and scientific literature does not provide sufficient knowledge on how to address the measures independent of their sector, the questions addressing energy reduction measures have been formulated as open questions. Based on this approach the research also aims to establish the level of knowledge regarding energy reduction measures among SMEs. The aim is to collect as many energy reduction measures as possible, which will be combined based on categories for the analysis.

As it is expected based on expert opinion that the level of knowledge of the respondents on energy use will not allow the respondents to give exact numbers of percentages, the questions that inquire after the energy use and possible influencing factors have been defined as statements that will be valued based on a 1-5 Likert scale. The statements include an estimation of the energy use of the company and external factors that are expected to influence the energy use of the SME. These external factors have been established based on literature (Keijzers et al., 2008) and expert opinion. In order to ensure that no external factors are left out, one statement is included that allows the SME to contribute possible additional factors.

The aim of the interview questions for the qualitative part of the research is to acquire additional information on the thoughts behind the decisions that were taken according to the survey by phone. Based on the results of the survey, the framework for the interview consists of four main topics; the estimation of the energy use of SMEs, the decision making process regarding energy reduction measures, the awareness of energy policies and finally the relation of the given answers to climate/ environmental policies. Each topic is addressed by 2-4 questions, however, based on the answers of the respondent the questions will be adjusted during the interview. These questions address specific outcomes of the quantitative research, such as the estimated effect of the change in turnover on the energy use of the SME by the respondent, but also those topics that lacked sufficient information to be able to derive solid conclusions.

BACKGROUND

As the respondents are employees of SMEs within the city of Rotterdam, the survey is conducted in Dutch as the respondents will be Dutch native speakers and are not expected to be able to speak fluent English. The researcher that is responsible for conducting the research is also a Dutch native speaker. A geographical selection is necessary, because due to the many levels of government, rules and regulation are expected to differ per municipality or even per municipality district. The geographical boundary allows for a feasible inventory of the policies. The choice for Rotterdam as the geographical location can be explained by the fact that Rotterdam has been selected by the Dutch government and the research institute Kennis voor Klimaat (Knowledge for Climate) as a research hotspot. Rotterdam is also part of the work domain of the DCMR Environmental Protection Agency.

The respondents are approached by phone without any prior notice. During the survey the University of Utrecht is mentioned as the institute in light of which the research is conducted instead of the DCMR Environmental Protection Agency. This approach has been chosen, because the DCMR Environmental Protection Agency is responsible for executing Dutch regulations that require SMEs that consume over 50.000 kWh or 25.000 m3 of natural gas to take energy reduction measures that have a rate of return of 5 years. As the SME might be aware of these regulations and requirements, the mentioning of the DCMR Environmental Protection Agency might affect the reliability of the measurements. In order to minimize the risk of affecting the reliability by mentioning the DCMR, Environmental Protection Agency, and at the same time increase the chance of a higher response rate, the approach of the respondents has been discussed with a communication advisor of the DCMR Environmental Protection Agency.

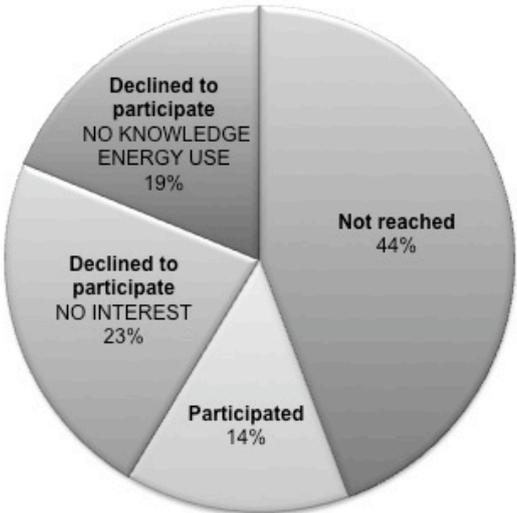
The interviews of the qualitative part of the research are designed as semi-structured interviews with a framework of topics that are defined based on the results of the quantitative part. The interview is conducted by one interviewer in Dutch, which is the native language of both the interviewer and the respondents. The interview takes place at the company of the respondent. Although no time limit has been defined prior to the interview, both interviews took approximately 1 hour.

5.5 DATA ANALYSIS

DATA CHARACTERISTICS

The 6 samples that were taken to create the sample resulted in a list of 751 respondents of which 27 were double and 113 were finally not contacted, because the appropriate number of respondents per sector was reached. Of the remaining 611 respondents that were contacted, 271 could not be reached for various reasons, such as a disconnected phone line, answering machines, inability to find a phone number etcetera. In total 353 respondents that were reached 87 participated in the interviews, 138 respondents indicated they had no interest in participating and the remaining 115 respondents indicated that they could not participate due to lack of knowledge on energy use of their company. In total 80 out of the 87 respondents that participated in the interview were able to give an indication of the change in energy use of the company in the past 5 years.

As the initial stratified sample of respondents resulted in an uneven number of respondents per sector, additional systematic random samples were taken. The final result shows that the number of respondents that needed to be approached in order to collect the same number of interviews for each sector is highest in the financial sector. The number of respondents reached out of the total respondents list is around 50% with the exception of the 'Professional, scientific and technical services' (70%) and the 'transportation and storage sector' (61%).



Graph 5.1 Participation respondents

The data is collected through a survey by phone and the answers to the questions are directly entered into a digital form. From this form a download is made in an excel format, which can be directly used for the analysis. For the dependent variable energy use data is collected based on a 5-point scale and this data is recoded into a dichotomous variable for energy reduction. For the variables size of the SME, the age of the business premises, growth of the number of products and services, growth of the number of employees, growth in the number of managers, the number of private energy reduction measures taken, the number of times the SME has moved and the number of energy reduction measures taken in relation to the business, the actual number that is named by the respondent is used to model the variable. For the sector variable each sector is assigned a number. Whether the work activities take place mostly inside or outside, a 5-point scale is applied through which the respondent can indicate the degree of work that takes place outside. The changed management is assessed through a question on whether the management has changed and is modeled by a dichotomous variable for management exchange. The change in turnover is assessed through a question whether the turnover has increased, stayed the same or decreased, which is modeled by the values 1, 0 and -1 respectively. These are the variables that are included in the logistic regression analysis.

In addition several variables are recoded for the descriptive analysis. Although building age is modelled in the logistic regression analysis by the number of years the building exists, the many different ages make it difficult to interpret the results. Therefore several categories are created based on the construction period of the building. The four categories are before 1980 (older than 30/31 years), 1981-1990 (between 20 and 29 years), 1991-2000 (between 10 and 19 years), 2001 and 2010 (between 0 and 9 years). The definition of these periods is determined in collaboration with several advisors at the DCMR Environmental Protection Agency and is based on the changed building rules between each of those periods and the improvements on energy efficiency that resulted from that. A categorization has also been used for the number of employees of the SME. These four categories are 5-9 employees, 10-49 employees, 50-99 employees and 100-250 employees. This distinction is based on the definition of SMEs in the EU Recommendation 96/280 (SME definition). The variable for the degree to which the work activities take place outside has been reduced to the categories outside, 50/50 and inside for the descriptive analysis.

In regard to the policy awareness variable it has been established whether a policy was mentioned that could be attributed to the mentioned categories. A policy that is mentioned during the interview within a category is only taken into account when a specific site is mentioned. For example in the case of the information category the respondents often replied with the search engine www.google.com as their answer, but this was not written down as a valid response, because the search engine in itself is not a policy measure. The policy category variables were modelled as the number of policies mentioned. In case a policy is mentioned with an example, the question whether the policy would motivate the respondent to take energy reduction measures is taken into account. For the descriptive analysis this variable was also recoded into a dichotomous variable on whether the respondent has policy knowledge or not. This manner of recoding was also used for the number of business, private and future energy reduction measures taken by the SME. Finally variables are added based on the results of the data collection that relate to the problem of split incentives that SMEs experience in relation to their energy bill. This variable included whether the respondent is dependent on a third party for their energy bill and energy reduction measures and what type of 3rd party this is.

The respondents that have participated in the analysis are divided into 6 sectors and four size categories. Although initially 8 sectors were selected for data collection, two sectors were excluded due to difficulties regarding the collection of interviews for these two sectors. For both of these sectors the respondents were mostly unwilling to participate or the available times for an interview could not be combined with the time constraints in which the data needed to be collected. The number of interviews per sector is controlled for through the data collection method. Most of the companies fall in the size categories 5-9 or 10-49 employees. For the sectors administrative and support services, financial and insurance activities and wholesale and retail trade most companies are part of the size category 5-9. For the sectors construction, professional, scientific and technical services and transport and storage most companies are part of the size category 10-49.

Table 5.1 Respondents per sector

Sector	Respondent list	Interviews
1. Administrative and support services	112	13
2. Construction	76	16
3. Financial and insurance activities	123	13
4. Wholesale and retail trade	108	14
7. Professional, scientific and technical services	74	16
8. Transport and storage	92	15
Other sectors	26	0
Total number of respondents	611	87

Table 5.2 Respondents per size

Size	Interviews
5-9 employees	38
10-49 employees	39
50-99 employees	5
100-250 employees	4
NoData	1
Total number of respondents	87

The respondents that have been selected for the qualitative interviews are both part of the wholesale and retail sector. The first respondent is a supplier of machinery and equipment for working wood, aluminium and plastic. They supply both the machines and the maintenance contracts. The second respondent is the owner of a health food supermarket. The health food supermarket has 48 employees, while the supplier has 9 employees. Most of the SMEs that participated in the interview belong to the same size categories as these two firms. The two respondents have several similarities. Both companies belong to the wholesale and retail sector, are headquarters and their number of employees has not changed in the past 5 years. While the health food supermarket indicated that the work activities mainly take place inside, the supplier indicated that only half their activities take place outside of the office building. In the remainder of this article the respondents will respectively be referred to as the supplier and the grocery store.

Both companies indicated to have taken a larger number of energy reduction measures than the average of two energy reduction measures per respondent. The grocery store has taken more energy reduction measures than the supplier. Both respondents have also taken a high number of private energy reduction measures compared to the average number of 1,5 private energy reduction measures per respondent. On the account of energy use both respondents differ. The supplier indicated that the energy use has not changed, while the supermarket indicated that the energy use has increased. An expansion in size is the reason for this increase. The respondents differ also in terms of policy knowledge. The supermarket does not mention any policies, while the supplier mentions policies of two different categories.

ANALYSIS SCHEME

The analysis consists of a regression analysis and several tables containing descriptives. The programs used for the analysis are SPSS and Microsoft Excel. The logistic regression analysis aims to study the assumption that *'energy reduction measures have a large effect on the reduction of energy use of SMEs in Rotterdam'*. The dependent variable is modelled as energy reduction. The variable is a recalculation of the data on the energy use of the SME that is based on a Likert scale of 5-points. The remaining variables are added in three steps. First, the control variables are added in the analysis, which are the number of employees working in the company, the age of the building the company resides in, the degree to which the work activities take place inside or outside and the sector that the company belongs to according to the Chamber of Commerce database. Finally the key variable, the number of energy reduction measures taken by the SME, is added. Indicators for all these variables can be found in the table 5.3. In regard of both energy use and energy reduction measures the descriptives for both the independent and the control variables (see table 5.3) are analysed.

Table 5.3 VARIABLES QUANTITATIVE ANALYSIS

VARIABLE TYPE	VARIABLE	NAME	INDICATOR	TYPE
Dependent	1. Decrease energy use	EN_USE	0 = Energy use of SME has increased or hasn't changed, SME has decreased (between 2011 and 5 years ago)	Ordinal
Control	2. Size	SIZE	Number of employees (in 2011)	Ratio
	3. Building age	AGE_BUILD	Either number of years (in 2011)	Ratio
	4. Inside or outside	IN_OUT	1 = never works outside, 2 = doesn't work outside, 3 = 50/50, 4 = works outside, 5 = works always outside (in 2011)	Ordinal
	5. Sector	SECTOR	1 = Administrative, 2 = Construction, 3 = Finance, 4 = Wholesale/retail, 5 = Hospitality, 6 = Specialist, 7 = Transport (in 2011)	Nominal
Key variables firm	6. Growth employees	GROW_EM	Δ number of employees (number in 2011- number 5 years ago)	Ratio
	7. Growth products & services	GROW_PS	Δ number of products and services (number in 2011- number 5 years ago)	Ratio
	8. Change in management	Changed_Man	0 = no change of manager, 1 = change of manager (between 2011 and 5 years ago)	Ratio
	9. Growth Turnover	D_TURNOVER	1 = Δ turnover increased, 0 = Δ turnover same, -1 = Δ turnover decreased (between 2011 and 5 years ago)	Ordinal
	10. Changes in product process	D_PROCESS	Number of changes in the product process (number in 2011- number 5 years ago)	Ratio
	11. Growth Management	D_Management	Δ number of managers (number in 2011- number 5 years ago)	Ratio
	12. Change in management	Changed_Man	0 = no change of manager, 1 = change of manager (between 2011 and 5 years ago)	Ratio
	13. Private ERM respondent	ERM_PRIV	Number of energy reduction measures (between 2011 and 5 years ago)	Ratio
	14. Move	MOVE	Number of moves of the SME (number in 2011- number 5 years ago)	Ratio
Key variable analysis	15. ERM SME	ERM_NOW	Number of energy reduction measures (between 2011 and 5 years ago)	Ratio

Ch. 6 – Results

6.1 INTRODUCTION

In this paragraph the results of the quantitative analysis are presented. The first section focuses on how energy reduction measures impact the energy use of SMEs. The second and the third section show the impact of internal and external factors related to the characteristics of the SME on its energy use. The fourth section shows the impact of policies on energy use, the fifth section discusses the qualitative indicator for energy use and in the final section the role that split incentives played in the data collection is discussed.

6.2 THE IMPACT OF ENERGY REDUCTION MEASURES ON ENERGY USE

In order to establish whether energy reduction measures have a large effect on the energy use of SMEs, a logistic regression is executed with energy reduction modelled as a binary dummy. The regression is executed in three separate steps (see table 6.1). In the first step the control variables for the SMEs are included. In the second step the key variables of the SMEs are added. These variables are expected to impact energy use in case they have changed in the past 5 years. In the third step the energy reduction variable is added, which is the key variable of the analysis.

The analysis shows that three variables have a significant impact on the dependent variable energy use: the construction sector, the professional, scientific and technical services sector and the energy reduction measures that have been taken by the SME. The construction variable has a large positive impact, while the professional, scientific and technical services sector seems to have a large negative impact. Of the variables that are significant, the professional, scientific and technical services variable has the largest impact on the dependent variable. The results show that the energy reduction measures do have a significant impact on the energy use of an SME, but the impact is not very large (see appendix 4).

The types of energy reduction measures that are taken most frequent are 'personnel behaviour' and 'production appliances'. These two energy reduction measures categories are the most frequent taken energy reduction measures for all sectors except for the wholesale and retail sector, where lighting measures are taken most frequently.

The average number of energy reduction measures taken per sector is 31. The most energy reduction measures were taken in the transport and storage sector (37), the least in the administrative and support sector (26). Most SMEs took either 2 (26 SMEs) or 3 (21 SMEs) energy reduction measures. The combinations that were taken most frequently were personnel and production measures in the cases that 2 measures were taken and lighting, personnel and production measures in the cases 3 energy reduction measures were taken. The average number of energy reduction measures taken per SME is the highest for the size group 50-99. This size group has also taken the most private energy reduction measures per SME.

Overall the SMEs do not seem to be aware of the energy reduction measures they have taken. In total 39% of the respondents indicated that they had taken energy reduction measures when they were asked this as an open question. When the SME were given specific categories of energy reduction measures, the total percentage of respondents that applied energy reduction measures rose to 85%. The sector 'Financial and insurance activities' experienced the largest increase in percentage going from 2% of SMEs that positively replied to the open question on whether or not they had taken energy reduction measures to 85% of SMEs that had actually taken energy reduction measures. The percentage of SMEs that indicate that they are planning to take energy reduction measures in the future is very low (15%). The highest percentage is found in the wholesale and retail trade sector, which is almost double the percentage of the total sector.

Table 6.1 Energy reduction measures per sector

Sector	Yes to the open question (in %)	Energy reduction measures (in %)	Future energy reduction measures (in %)	Private energy reduction measures (in %)
1. Administrative and support services	46	85	8	54
2. Construction	56	94	19	63
3. Financial and insurance activities	2	85	15	54
4. Wholesale and retail trade	50	71	29	79
7. Professional, scientific and technical services	31	81	6	69
8. Transport and storage	27	93	13	87
Total number of respondents	39	85	15	68

Based on the literature (Keijzers et al., 2008) it is expected that the manager of an SME can provide the best data for the analysis due to the important role of the manager in the decision making for the SME. In order to see if this assumption is valid in the case of data on energy use, the interview was held with the person that the SME proposed as the most knowledgeable on the energy use and their job description was included in the analysis. In most cases it was indeed the manager that participated in the survey, however, in many cases also the administrative assistant, accountant, office manager, owner and sales employee were able to provide the data needed for the survey.

In order to see if the job description of the respondent affects the number of energy reduction measures that have been taken, an analysis is made of the average number of energy reduction measures taken per job type, however, there does not seem to be a large difference between the results for the different job descriptions. The highest average number of energy reduction measures are mentioned by the owners, while the administrative assistants mention only 1,8 energy reduction measures to be taken on average. Finally the sales employees mention that 1 energy reduction measure is taken on average. A facility manager and an optician in training mentioned the highest average number of energy reduction measures taken. However, these should be regarded as individual cases and the overall conclusion remains that the job description of the respondent does not influence the data collected on energy reduction measures.

Table 6.2 Top 5 job descriptions mentioned by respondents

JOB TYPE	Job description frequency	Total number of energy reduction measures taken	Average number of energy reduction measures taken
1. Manager	16	47	2,9
2. Administrative assistant	13	24	1,8
3. Accountant	9	21	2,3
4. Office manager	5	11	2,2
5a. Owner	4	13	3,3
5b. Sales Employee	4	4	1,0

Another influence the respondent could have on the number of energy reduction measures that are taken is the personal interest in the topic. Therefore this part of the analysis looks into how the number of energy reduction measures, which the respondent has taken in private, relates to the number of business energy reduction measures taken. The analysis shows that there is a significant correlation between the number of energy reduction measures taken by SME and the number of private energy reduction measures taken by the respondents. This is supported by the data as most of the respondents that have taken energy reduction measures have also taken private energy reduction measures. There is however also a significant part of the respondents that indicated not to

have taken business energy reduction measures, while they have taken private energy reduction measures. From an analysis of the motivations and difficulties of this group it could be suggested this has to do with limitation due to a third party involved in the decision-making process regarding energy use and energy reduction measures. However, based on the current results this cannot be concluded with certainty.

The analysis of the types of energy reduction measures that are taken by SMEs, shows that measures addressing personnel behaviour and production appliances have been taken most often, respectively 52 and 56 times. Several respondents mentioned that they took these measures, because they believed that this kind of behaviour is 'right' or 'expected'. Most of the measures mentioned within these groups referred to changes in behaviour and therefore are expected to require little investment. The third most frequently mentioned type of energy reduction measures is lighting. Respondents indicated that it is difficult to buy any other light bulbs than the energy-efficient type. It seems that this is a result of regulation as it was frequently indicated by the respondents that it was almost not possible for them to buy lamps that are not energy-efficient. This is likely the result of European regulation regarding the production of energy-efficient light bulbs, which is defined by the EU Directive 2009/125/EC (Ecodesign requirements for energy-related products).

6.3 DIRECT IMPACT OF SME CHARACTERISTICS ON ENERGY USE

The conceptual model shows that several characteristics of SMEs influence their energy use. These characteristics are the type of activities of the SME and the type of building it resides in. In the analysis the type of activities of the SME are modelled as the degree to which the employees work inside, the manufacturing process, the turnover, the number of employees and the number of products. The building in which the SME resides is accounted for by both the building period and the number of moves of the SME in the past 5 years. This section presents the behaviour of these variables.

The variables for the number of moves of the SME, the manufacturing process and the expansion of the number of products and services provided by the SME do not seem to have a large impact on the energy use of the SME. In regard to the number of moves the percentage of SMEs that have reduced energy is almost equal for the SMEs that moved and those that did not move. The percentage of the number of SMEs that reduced their energy is not influenced by whether the process is changed, as the percentages with or without a process change are almost equal. If anything, it could be said that the process has a negative influence, as the percentage is lower than the general percentage of firms that have reduced energy use, but this difference is very small. The average number of additional products and services that SMEs have developed or sold in the past 5 years is quite low. The SMEs that have reduced energy use have developed less product and services (0,30) than the total average (0,39). Thus it seems like the development of new products and services has a small and negative effect on the energy use. The highest average number of products and services is found in the group for which no data is available on their energy use. It seems that there is no relevant impact of the change in products and services in the past 5 years on the energy use of SMEs.

The building age variable shows interesting results in relation to energy use. The percentage of respondents that indicate that the energy use of the SME is reduced is the same for the building age categories 'before 1980' and '1991-2000'. Within the category '2000-2010' none of the respondents indicated the use of energy had been reduced in the past 5 years, even though 88% of the respondents indicated that they had taken energy reduction measures and the average number of energy reduction measures taken by this category is actually the highest with 2,8 energy reduction measures per SME. In the category '1981-1990' 50% of the respondents claim that the energy use of the SME has been reduced, which is significantly higher than the total number of respondents of which 23% claim a reduction of energy use. This can be explained by the high number of SMEs that have taken energy reduction measures and the fact that the average number of energy reduction measures taken per SME is higher than the average of the total number of respondents.

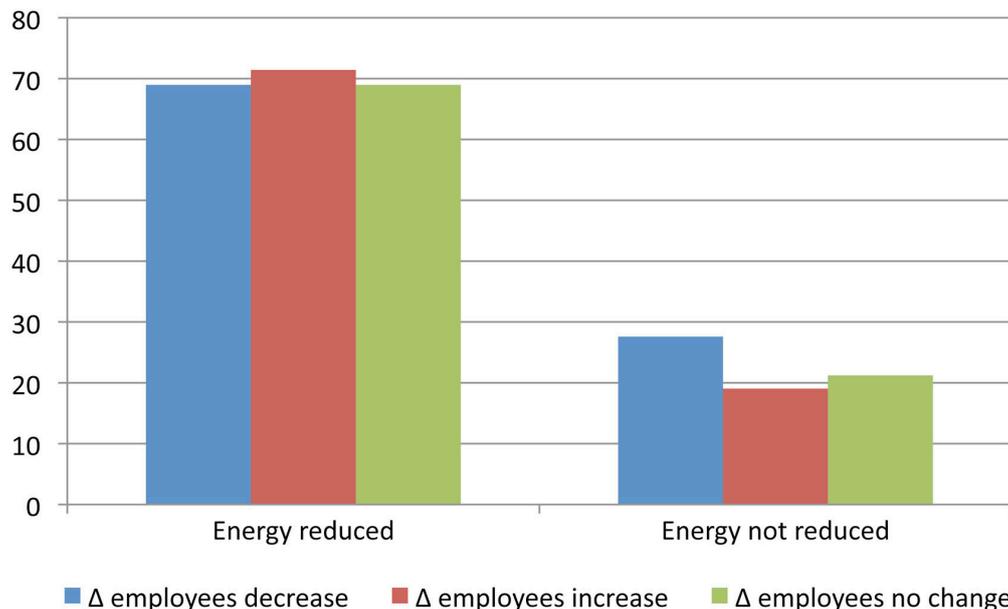
Table 6.3 Construction period of SME premises

Construction period	Total number of firms	Total number of energy reduction measures taken	Number of energy reduction measures per SME	% of SMEs that have taken energy reduction measures*	% of SMEs that have reduced energy*
Before 1980	48	101	2,1	85	23
1981-1990	8	19	2,4	88	50
1991-2000	24	47	2,0	83	21
2000-2010	6	17	2,8	83	0
NoData	1	3	3,0	100	0
Total number of respondents	87	187	2,1	85	23

* % of total per construction period category

The personnel growth variable describes the change in the number of employees of the SME in the past 5 years. In 40% of the cases where the respondent indicated the energy use had decreased over the past 5 years, the respondent also indicated that in the past 5 years the number of personnel decreased. This is double the percentage of the cases where the respondent indicated the SME had reduced energy use, but the number of employees had increased in the past 5 years. When the percentages for employee decrease, increase and no change are compared, there is little difference between the cases where the energy use decreased, increased or didn't change (see graph 6.1). It seems like the decrease in energy use and the number of employee decrease can be related to the energy use variable, although the small differences in percentages are most likely the reason it did not result in a significant effect in the logistic regression analysis.

Graph 6.1 Employee growth and energy use in %



Another aspect that is used to establish the growth of a company is the change in turnover. In case the respondents stated that the energy use of the SME has decreased in the past 5 years, 50% of the respondents also indicated that their turnover has decreased. This is a lot higher percentage than the number of respondents that indicated that their energy use has increased (25%) or not changed (15%), while their turnover had decreased. In total 36,7% of the respondents indicated that the energy use had increased or stayed the same, while the turnover had not changed. Of the respondents that indicated that their turnover had increased, 28,3% stated that their energy use had increased or not changed and 26,7% indicated their energy use has decreased. The results suggest that the turnover correlates with the change in energy use, although the small differences in percentages could be the reason that it did not result in a significant effect in the logistic regression analysis.

Table 6.4 Change in turnover in the past 5 years

Energy use	Turnover decrease	Turnover no Change	Turnover increase	NoData
Energy use increased or the same	26,7	36,7	28,3	8,3
Energy use decreased	50,0	15,0	25,0	10,0
NoData	42,9	14,3	28,6	14,3
Total	33,3	29,9	27,6	9,2

As the building age, employee growth and turnover variable show a possible relation to energy use, questions regarding the impact of these variables on the dependent variable were included in the qualitative analysis.

6.4 INDIRECT IMPACTS OF SME CHARACTERISTICS ON ENERGY USE

The conceptual model shows that based on the literature (Aragón-Correa, 2008; Keijzers et al., 2008), it is expected that several characteristics of SMEs will affect energy use and consequently the type of activities and building of SMEs. This paragraph shows the how these variables behave differently from the point of view of the sector, the size and the characteristics of the manager.

An analysis of the energy use per sector shows that the transport and storage sector has the highest percentage of SMEs that indicated that they had reduced energy and the highest average number of energy reduction measures taken per SME. The financial and insurance activities sector and the administrative and support sector have the second and third highest percentage of SMEs respectively that indicate they have reduced energy, although the SMEs in both sectors have taken the lowest average number of energy reduction measures. Compared to the total percentage of SMEs that have reduced energy, only the transport and storage sector has a significantly higher percentage of SMEs that have reduced energy. The financial and insurance activities and the wholesale and retail trade sectors show a significantly lower percentage of SMEs that have reduced energy use.

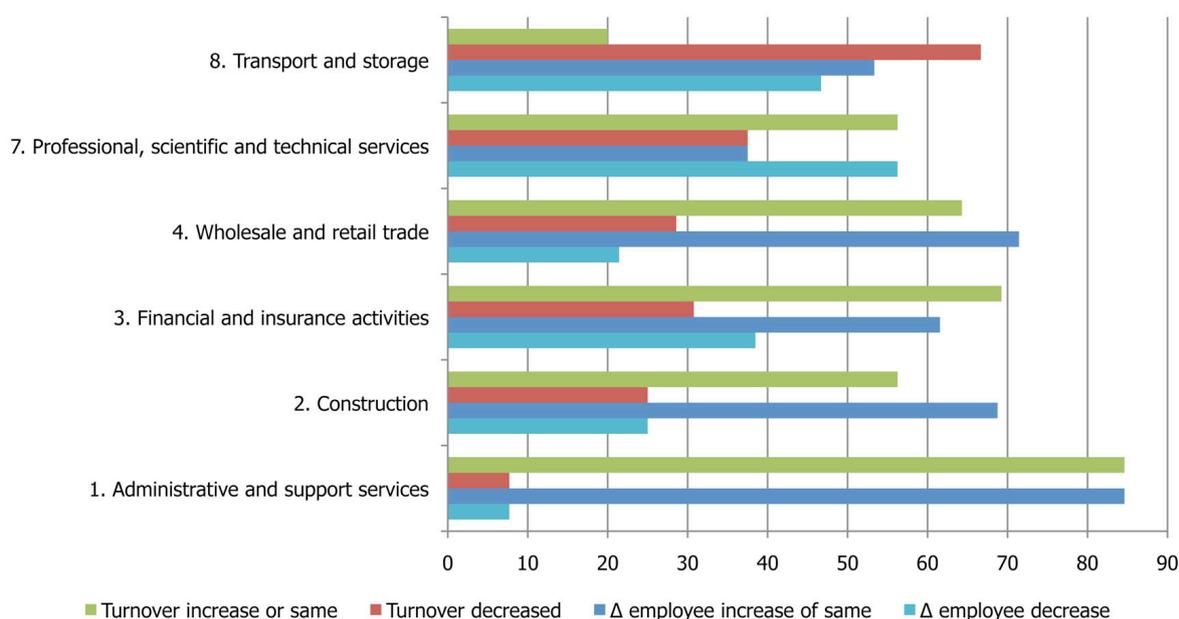
Table 6.5 Sector

Sector	Number of SMEs	Energy reduced (in %)	Total number of energy reduction measures taken	Average number of energy reduction measures taken
1. Administrative and support services	13	23,1	26	2,0
2. Construction	16	18,8	34	2,1
3. Financial and insurance activities	13	15,4	30	2,3
4. Wholesale and retail trade	14	14,3	30	2,1
7. Professional, scientific and technical services	16	25,0	30	1,9
8. Transport and storage	15	40,0	37	2,5
Total number of respondents	87	23,0	187	2,1

A further investigation of the variables in relation to the sectors shows different characteristics. In regard to whether the activities take place mostly inside or outside, it is found that in the administrative and support and the construction sector, the employees work mostly outside. This can partly be attributed to the fact that within the administrative sector several employment agencies were interviewed. The type of work activities in the construction sector are expected to take place mostly outside. In regard to the change in production process and the average change in the number of products sold or provided by the SMEs, the total number of changes is very low. In regard to the production process most changes are found in the professional, scientific and technical services sector. In regard to the change in the number of products, the wholesale and retail sector has expanded the most and the transport and storage sector the least.

The growth in employees shows the strongest increase for the administrative and support services sector and the strongest decrease in the professional, scientific and technical services sector. Regarding the change in turnover in the past 5 years, the transport and storage sector clearly shows the largest group of respondents that has indicated that their turnover has decreased over the past 5 years. The administrative and support services sector shows the largest group of respondents that has indicated an increased or unchanged turnover. As graph 6.2 shows, the development of the turnover and the employment growth variables are almost the same for the construction and administrative and support sector. The other sectors all develop in a different way. An interesting result is that the two sectors that were found to have a significant impact on energy use in the regression analysis seem to behave both in a very different way. The construction sector shows mainly an increase in the number of employers and the turnover, which could explain why this sector has a negative effect on energy use. The professional, scientific and technical services sector shows an increased or unchanged turnover, but a decrease in employment growth. This could indicate that a change in turnover affects energy use, but also that employment growth does not have the same effect. This assumption has been further addressed in the qualitative part of the research.

Graph 6.2 Change in turnover and number of employers per sector



The analysis of energy use of the SMEs regarding the size of the companies shows that the average percentage of SMEs that have reduced energy per size category is around 23%, with the exception of the 100-250 category, which the same percentage as the total number of SMEs that have indicated a reduction in energy use. The 100-250 size category includes no SMEs that have reduced energy. Interestingly the average number of energy reduction measures is the highest for the 50-99 and the 100-250 size category (see table 6.9). The results of this analysis do not show a relationship between the number of energy reduction measures taken and the reduction of energy use by SMEs according to the indication of respondent, although the results are not very clear.

Table 6.6 Size categories

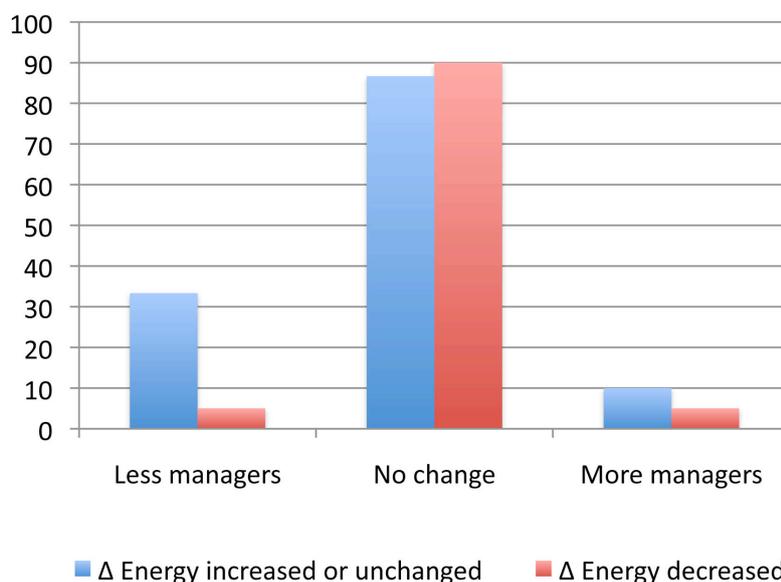
Size	Number of SMEs	Energy reduced (in %)	Total number of energy reduction measures taken	Average number of energy reduction measures taken
5 to 9	38	21	78	2,1
10 to 49	39	25,6	82	2,1
50 to 99	4	25	12	3,0
100 to 250	5	0	14	2,8
NoData	1	100	1	1,0
Total number of respondents	87	23	187	2,1

A further study of the variables based on the size categories shows ambiguous results. In regard to whether the work activities take place outside or inside, it is found that the work activities of SMEs belonging to the size categories 5-9, 10-49 and 50-99 mostly take place inside. For SMEs belonging to the category 100-250 most work activities take place outside. This same pattern is found in the variable that represents whether a SME moved or not. Most of the SMEs in the first three size categories have not moved (5-9; 78,9%, 10-49; 74,4%, 50-99; 75%). The last size category includes the most SMEs that have moved (40%), but also in this category most SMEs have not moved. In regard to changes in the process most SMEs have not made any changes, although the differences are very small. Also a small difference is found between the percentages of the number of SMEs that have changed their number of products and services in the past 5 years. The size categories 5-9 and 50-99 have the largest average number of additional products and services developed per SME. Regarding the age of the building the SME resides in, most of the buildings in which the SMEs belonging to the size categories 5-9, 10-49 and 100-250 reside are built before 1980. Only the size category 10-49 contains more SMEs that reside in buildings that are built between 1991 and 2000.

The turnover and employment growth variables in relation to size develop in a similar way to the results of the sector variable. The SMEs belonging to the 5-9 size category indicate most often that their turnover has decreased, while the turnover has mostly increased for SMEs belonging to the size category 100-250. For the other two size categories there are only very small differences between the turnover categories. Regarding the number of employees, the SMEs in the size category 100-250 have either experienced an increase or a decrease (50%), while most SMEs in the size category 5-9 have not experienced a change in the number of employees (47,4%). As the differences between the percentages per size category for each variable are very small, the size of the SME does not seem to have an impact on the other variables. This can explain the fact that the size variable did not have a significant result in the output of the regression analysis.

Based on the literature (Keijzers et al., 2008), the manager is expected to influence the decision-making process involving energy use and energy reduction measures. Most of the respondents (85%) have indicated that in the past 5 years the number of managers has not changed. As graph 6.3 shows, this does not seem to have an effect on whether or not the respondent has indicated a reduction of energy use. Both in the case of an increase or decrease in the number of managers, the number of respondents that indicated that the energy use had increased or stayed the same is higher than the number of respondents that indicated that the energy use had decreased (see graph 6.3). It seems therefore that a change in the number of managers does not stimulate a SME to reduce their energy use. However, due to the low number of respondents that have indicated that the number of managers had changed this result is not solid.

Graph 6.3 Change in number of managers



As the manager is expected to play an important part in the decision making process of an SME, it is expected that the manager of an SME is also the most suitable person to ask questions about energy use and energy reduction measures. This is confirmed by the survey results, which show that the manager is the most frequent mentioned job type of the respondents (see table 6.7). However, also several employees have been able to provide data on the energy use, such as the administrative assistant, the accountant, the office manager, the owner and the sales employee. In the administrative and support services' sectors the administrative assistant was the most frequent mentioned job type by the respondent. In the 'construction' and the 'financial and insurance activities' sectors 'administrative assistant' was mentioned as the job description as frequently as 'manager'.

Table 6.7 Job types

Top 5 Job types	Frequency	Energy decreased in %	Energy increased or unchanged in %
Manager	16	31	56
Administrative assistant	13	8	85
Accountant	9	33	67
Office manager	5	60	40
Owner	4	25	75
Sales	4	25	50

6.5 SME CHARACTERISTICS AND ENERGY REDUCTION MEASURES

In order to establish to what extent the proposed measurement unit for the determinants of climate policies affect the characteristics of an SME, the relationships between energy reduction measures and the characteristics of an SME have also been included in the descriptives. Both the number of changes in the production process and the age of the building were found not to have affected the number of energy reduction measures taken by SMEs. Although most of the SMEs that have not taken energy reduction measures have experienced a decrease in their turnover, this is not expected to have a large effect, as the differences in percentages are very small. Similarly in the case of changes in the products and services that an SME offers, it is found that more SMEs that have not changed their number of products and services have taken energy reduction measures. In case SMEs have changed their number of products and services, more SMEs haven't taken energy reduction measures. It seems therefore that changes in the number of products and services, changes in the production process or the age of the building do not affect the decision of an SME to take energy reduction measures.

The decision to take energy reduction measures does seem to be affected by the change in the number of employees, whether an SME has moved and whether most work activities take place outside. A decrease in the number of employees has not resulted in a higher number of SMEs that take energy reduction measures. Most of the SMEs that have experienced an increase in the number of employees, have also taken energy reduction measures. In case the number of employees has not changed, most of the SMEs have not taken any energy reduction measures. In case an SME has moved, it does seem to stimulate a SME to take energy reduction measures. Of the SMEs that had moved in the past 5 years, more had taken energy reduction measures and in the cases that an SME had not moved less had taken energy reduction measures. In total less SMEs had moved in the past 5 years. In contrast to expectation, more energy reduction measures have been taken by SMEs that mostly work outside. In the cases where most of the work activities take place inside, most of the SMEs indicated that they did not take energy reduction measures. In the cases where the respondent has indicated that the work activities of the SME take place both inside and outside, the percentage of SMEs that have taken energy reduction measures is the same as the percentage that has not.

Based on the literature (Keijzers et al., 2008) it is also expected that the manager or owner of the SME has an effect on whether energy reduction measures are taken or not. The analysis shows that a change in the number of managers of an SME in the past 5 years had no effect on whether energy reduction measures were taken or not. In cases where the number of managers has decreased in the past 5 years, more SMEs have not taken energy reduction measures. In fact none of the respondents that indicated a decrease in managers stated to have taken energy reduction measures. In the cases

where one or more managers have been replaced, more respondents have indicated that they have taken energy reduction measures, although the total number of SMEs that have experienced a change in management is quite low. A comparison of the number of energy reduction measures taken by SMEs to the job type of the respondent shows that the highest average number of energy reduction measures is taken by the SMEs of which the respondent indicated to be the owner. The SMEs of which the respondents indicated to be a manager have taken the second highest number of energy reduction measures. In all the cases where the respondent indicated to be either the owner or the office manager, energy reduction measures had been taken. In 94% of the cases where the manager stated to be the manager, the respondent indicated that energy reduction measures had been taken. Of the top 5 of the job types mentioned in the research, the job type sales employee is related to the the lowest percentage of SMEs that have indicated to have taken energy reduction measures. In the qualitative interviews it was confirmed that indeed the manager has a large influence on whether energy reduction measures are taken or not.

Table 6.8 Energy reduction measures

Top 5 Job types	Frequency	Total number energy reduction measures	Average number of energy reduction measures
Manager	16	41	2,6
Administrative assistant	13	24	1,8
Accountant	9	21	2,3
Office manager	5	11	2,2
Owner	4	11	2,8
Sales employee	4	4	1,0

Finally the impact of the sector and size variable on the number of energy reduction measures taken has been analysed. In the case of the sector that the SME belongs to, it is found that the highest average numbers of energy reduction measures are taken by the SMEs belonging to the transport and storage sector. SMEs in this sector have also taken the highest number of energy reduction measures. The lowest numbers of energy reduction measures are taken by SMEs in the Administrative and Support sector, while the lowest average numbers of energy reduction measures are taken by SMEs in the Professional, Scientific and Technical Sectors (see table 6.8). In the construction and the transport and storage sector the percentage of the number of SMEs that have taken energy reduction measures is the highest, respectively 94% and 93%. The lowest percentage is 71% and this percentage is found among the SMEs that belong to the wholesale and retail sector. The high percentage for the construction sector variable and the low average number of energy reduction measures taken by SMEs of the Professional, Scientific and Technical sector suggest that there might be a link between the energy reduction measures variable and the sector variable. Both of these two sectors and the energy reduction measures variable were found to be significant in the logistic regression analysis.

Regarding the size category that a SME belongs to, the highest average numbers of energy reduction measures are taken by SMEs that belong to the 50-99 and 100-250 size categories. In the size categories 5-9 and 10-49 energy reduction measures have been taken by all SMEs belonging to these categories. In the size categories 50-99 and 100-250 respectively 82% and 85% of the SMEs have indicated that they have taken energy reduction measures. These high scores in the categories 50-99 and 100-150 could be related to the uneven distribution of the respondents among the size categories. As the percentages of SMEs that have taken energy reduction measures are also high in the other two size categories, it can be concluded that in general the size of the firm does not have an affect on whether a SME takes energy reduction measures or not. The results suggest that the sector can have an impact on the number of energy reduction measures that are taken and the percentage of SMEs that take energy reduction measures, while the size of the SME does not.

6.6 THE ESTIMATION OF ENERGY USE

During the research, the decision was made to assess the variable energy use based on a quantitative indicator as the question whether or not an SME has reduced energy was established by the estimate of the respondent. The energy use variable was assessed both through an estimate on a 5-point Likert scale and a percentage. The results of the data collection prove that indeed the collection of a quantitative measure on energy use is not feasible as only a 2 out of the 87 respondents were able to provide data on their exact energy use. However, the estimate of energy use depends heavily on the interpretation of the respondents of energy use. To see how a respondent establishes this estimate, the qualitative interview included multiple questions that inquired after the factors that are expected to influence energy use, which are building age, personnel, turnover and the production process, based on the literature (Keijzers et al., 2008; see also section 6.2) and the results of the quantitative analysis. The qualitative results show that of all these factors only physical expansion of the company or an increase of the number of electric appliances will result in a change in energy use according to the respondents. They indicated that an expansion of personnel or turnover is not expected to change the energy use unless the company physically expands as well.

6.7 THE IMPACT OF POLICY KNOWLEDGE

In the definition of the statement *energy reduction measures have a large effect of the reduction of energy use of SMEs in Rotterdam* it is assumed that all energy policies will result in one or more energy reduction measures. This assumption was made based on the literature review and the inventory of climate policies taken by a SME. It did not become clear, however, how these policies motivate the respondents to take energy reduction measures. In order to address these issues, several questions were included in the survey that inquired after the degree of awareness of energy policies and to what extent these policies were taken into account when a decision on taking energy reduction measures was made.

The results show that the total percentage of respondents that indicated they know one or more policy categories is 33,3%. The best-known policy category is the subsidy category. In total 22% of the total number of respondents indicated that they were familiar with a policy that belongs to the subsidy category. The least known policy category is the market-based category, which was mentioned by 1% of the respondents. In total the awareness of policies does not seem to have a large impact on the decision of an SME to take energy reduction measures. The analysis has shown that of the total number of respondents that indicated to have taken energy reduction measures 33% is aware of policies and 67% is not.

In the cases where the respondents indicated that the energy use had decreased, the policy knowledge did not seem to have an affect as the percentage of respondents who indicate to have policy knowledge is almost equal to the percentage of respondents who claimed not to have any knowledge. In the cases where energy use was indicated to have increased or not changed, the percentage of respondents that did not have any policy knowledge is almost double the percentage of respondents that did have policy knowledge (see table 6.9). However, due to the limited number of policies mentioned in the cases where policies were known it can be said that the effect of policy knowledge is in general very small.

Table 6.9 Policy knowledge

Energy use	No policy knowledge in %	Policy knowledge in %
Energy increased or unchanged	68	32
Energy decreased	55	45
NoData	86	14
% of total number of respondents	67	33

In order to establish which motivations and difficulties play a role in the decision to take energy reduction measures, questions on these two topics were also included in the analysis. Most respondents indicated that the investment costs are an important consideration in the decision to take or not take energy reduction measures. Of the total number of respondents, 28,7% indicated costs to be a difficulty that is encountered when considering energy reduction measures. Of the respondents that found costs to be a difficulty, 68% has indicated that their energy use has remained the same or increased. Still 80% of these respondents have taken energy reduction measures. A similar pattern is found for the second most frequently mentioned difficulty, which is lack of clarity in the information regarding energy reduction measures. It's mentioned by 13,8% of the total number of respondents. Of the respondents that have mentioned a lack of clear information, 72% has indicated that they have not reduced energy use and 81,8% has indicated that they have taken energy reduction measures.

The most frequently mentioned motivation to take or not take energy reduction measures is the fact that a 3rd party is involved. This was found to also be one of the reasons for respondents not to participate in the survey. In total a number of 115 respondents indicated they could not participate in the survey, because they didn't have knowledge of the energy use of the SME. The main reason for this lack of knowledge is stated to be the problem of split incentives. SMEs that rent their office space mention that their energy use is a flat payment and that the landlord monitors the amount of energy use. The landlord is also responsible for the implementation of energy reduction measures. Some respondents indicated and that their headquarter has the responsibility to pay the energy bill and to decide whether energy reduction measures are taken or not. Of the 115 respondents that indicated they could not participate in the survey, 46% gave the landlord and 32% gave the headquarters as the reason. Of the 87 respondents that participated in the interview 27,5% indicated to have a landlord and 3,4% indicated to be dependent on their headquarters.

In these cases it was often stated that a third party is involved in the payment of the energy bill, such as a landlord or headquarter. The SME pays the bill through service costs included in the rent or in the case of headquarters the bill is their responsibility. In the cases where landlords or headquarters are involved, it is also not possible for the SME to freely take energy reduction measures. In the case of the landlord it has been frequently stated by the respondents that energy reduction measures are the responsibility of the landlord or that it is not allowed to change the rented space without the landlord's permission. In several cases respondents stated that they had asked their landlord to take energy reduction measures, such as changing to alternative resources, but the landlord was not willing to cooperate.

The split incentives problem differs per sector and per size definition. The professional, scientific and services sector has the largest percentage of the number of respondents in that sector, who indicate that they have a landlord (38,5%). As the response rate of this sector is 70%, it seems that a large percentage of respondents from this sector are dependent on a landlord. The wholesale and retail trade sector clearly has the highest percentage of the total number of respondents that indicate that they are dependent on their headquarters (26,7%). In the size categories 5-9 and 10-49 employees, the landlord is mentioned the most frequent as the 3rd party involved with the energy management of a SME. However, as this question was not specifically asked during the survey, data is not available on who is responsible for the energy bill for a significant part of the group.

Ch. 7 – Conclusion

7.1 INTRODUCTION

This chapter consists of two parts. The first part discusses the main patterns and relationships that have been derived from the results. In the second part the results are discussed in relation to the main research question and the three sub-research question, which are described in the introduction.

7.2 MAIN PATTERNS AND RELATIONSHIPS

Based on the results of the research, patterns are observed for energy use, energy reduction measures and policy knowledge. Regarding energy use the general observation is that the number of SMEs that is estimated to have reduced their energy use is very low as less than a quarter of the respondents that have participated in the interviews mentioned a reduction in energy use. The characteristics of the SME that were expected to influence the energy use, which are the age of the building, the production process and the products that the SME produces, were not found to have a significant effect in both the quantitative and qualitative analysis.

Energy use does not seem to be influenced by the knowledge on policies of a respondent. Overall the respondents know very little about policies. Especially the market-based policies are mentioned very rarely. Subsidies, which in the literature (Jaffe et al., 2005) are considered part of the market-based policy category, are the best-known policies among the respondents. This could support the claim that market-based instruments are the most effective policy instruments (Requate et.al., 2001; Rennings et.al., 2006). However, the results show that it is questionable whether the subsidies are truly the most effective. Most respondents have not used or been able to use subsidies to finance the energy reduction measures they have taken. In addition the results of this research suggest that subsidies should be studied separately from the market-based policy category, as the awareness of these two types of policies is almost opposite.

The results have shown that the majority of SMEs have taken energy reduction measures. The average number of energy reduction measures taken is 2 measures per SME. The majority of these energy reduction measures are instructions to the personnel, such as turning of lights when a room is not used, efficient use of production appliances, for which the majority of respondents mentioned that they make efficient use of their computer, and lighting measures, which includes mainly energy efficient lighting according to the respondents. Regarding the energy efficient lighting a couple of the respondents indicated that they have changed their type of lighting, because energy efficient lighting is the only type of lighting that is readily available. This can be considered the result of the fact that the European Union, through energy labels and setting standards, has stimulated the production of energy efficient lighting over regular lighting. This is described in the EU Directive 2009/125/EC (Ecodesign requirements for energy-related products). The instructions of the personnel and the efficient use of production appliances can be considered the result of information policies. This is a little bit harder to establish though and is likely to need a long time in order to take effect. The respondents indicated to have taken these measures as they feel it is appropriate or responsible behaviour. This could be attributed to the environmental awareness of Dutch companies, which was found by Revell et al. (2003) to be higher than the awareness of UK firms. Although the literature (Rennings et al., 2006) claims that market-based policies are most efficient, it seems that based on the results of this research, regulatory and information-based policies have been the cause behind the most of the energy reduction measures that have been taken.

Based on the literature (Keijzers et al., 2008) it is also expected that the best person to approach from the SME for data to use in the effectiveness analysis is the manager. Regarding the collection of data from the SME, this was indeed confirmed, as most of the participants in the interview stated that they are managers. In regard to questions about energy use, in many cases it is also possible to turn to the administrative assistants or accountants as they have proven to be valuable sources of information. Especially in the case of the administrative and support sector this was the case. It is however in the case of data collection on the energy use of SMEs not sufficient only to interview a

respondent representing the SME. The results show that in a significant percentage of cases the energy bill is not directly paid by the SME and therefore the respondent cannot provide the information on the energy use or the energy reduction measures that have been taken. In order to study the energy use of SMEs it is necessary to collect data from 3rd parties in addition to SMEs. These third parties can be landlords or representatives or headquarters. This confirms the results of Del Río González (2009), who found that there are many actors that can stimulate a firm to implement environmental friendly technology. Also to establish causality between energy reduction measures and policies, it can be concluded that it is important to collect information from policy consultants that have approached or have been approached by the respondent representing the SME. The types of 3rd parties that are involved in these cases vary widely.

The results do confirm that the manager plays an important role in the likeliness of an SME to take energy reduction measures or reduce energy use as the relationship between private and business energy reduction measures was found to be significant. In the qualitative interviews the respondents confirmed that the personal beliefs of a manager and the involvement with the issue determine the likeliness that a company will take energy reduction measures.

7.3 A MEASURE FOR DETERMINANTS OF ENERGY POLICIES

In relation to the first sub-research question, the research shows mixed results. The question stated 'how can determinants that are defined to represent the change in the targeted environmental problem as a result of the impact of climate policies on SME behaviour be measured.' This question addressed three issues; in what way do climate policies change the environmental target, can this unit be used to measure the main impact on the environmental target and to what extent can this measurement unit be related to determinants for climate policies or in other words to what extent does a causal relationship exist between energy reduction measures and determinants of climate policies? Based on the literature by Rossi et al. (1989) and Hoffman et al. (2008) and the inventory of climate policies, it was concluded that data on the number of energy reduction measures that an SME has taken will most likely provide a good measurement unit for the impact of energy policies, which are a type of climate policies that were selected as a case study for this research.

The quantitative results show that the number of energy reduction measures that have been taken by SMEs, has a positive significant effect on the reduction of energy use. Regarding the estimate of energy use the results show that the respondents mainly relate expansion in the form of space or appliances to the increase in energy use. The respondents base the estimate of the change in energy use on whether the area of physical space or the number and type of energy consuming appliances have changed. They have also indicated that they don't expect a change in turnover or in the number of employees to affect the use of energy. The results do not provide a clear answer on the question whether energy reduction measures are an appropriate measure for the impact of energy policies on the energy use of SMES. Although the research shows that energy reduction measures are one of the main causes of the reduction of energy use of SMES, the causality between energy policies and energy reduction measures remains an assumption.

In this research the causality between energy reduction measures and energy policies has mainly been established based on an analysis of the description of the policy in the policy inventory. This follows the assumption 'A is a cause of B', which means that the introduction of A increases the probability that B will occur in comparison to not introducing A (Rossi, 1989). This is a very basic assumption of causality. To further examine the nature of the causal relationship, the research included an assessment of the policy awareness of the respondents to see if according to the respondents the assumed causal relationship exists. On the one hand the results show that the policy knowledge of the respondents does not have a large effect on the decision to take an energy reduction measure. The overall knowledge of policies among the respondents is low and most of the policies are said by the respondents not to have played any role in the decision making. Subsidies, which were found to be the most familiar type of policy instrument, were quite often found to be ineffective or inapplicable by the respondents. On the other hand it seems that the most frequently taken energy reduction measures were based on regulatory and information-based policies even though many of the respondents were not able to name these types of policy instruments. This

contrasts the claim that market-based instruments are the most effective instrument (Requate et al., 2001; Rennings et al., 2006). In addition the qualitative results show that frequently external parties are consulted to get more information on the energy reduction measures or energy policies. Based on the results of this research it could not definitively be established whether a causal relationship between energy policies and energy reduction measures exists.

As the results of the research did not establish a causal relationship between energy policies and energy reduction measures, it was not possible to provide further insight into whether energy reduction measures can be used to establish the effectiveness of mixed climate policies. The framework that was designed for a mixed policy effectiveness analysis shows that the determinants are defined as policy categories. These policy categories can be distinguished based on their authoritative power (Mickwitz, 2003; Vedung, 2007, Rousseau et al., 2005). The results show that there could be a relationship between certain types of energy reduction measures and the different degrees of authoritative power. For example, several respondents indicated that behavioural energy reduction measures were taken out of the perception that it was the right thing to do, while lighting measures were taken out of a perception of lack of choice. The fact that several external factors seem to play a role in the decision of a SME to take energy reduction measures, suggests that circumstances under which policies are implemented might indeed play an important part in the effectiveness of a policy (Rennings et al., 2006). However, as the remarks were an unexpected result, it was not assessed whether the motivation that were given by respondents for taking energy reduction measures, hold up for the majority of the respondents and therefore no definitive conclusions in regard to mixed policies can be drawn yet.

7.4 SME CHARACTERISTICS AND ENERGY REDUCTION MEASURES

In relation to the second sub-research question, the research shows that several characteristics of SMEs are likely to have an effect on whether or not an SME takes energy reduction measures. The research question stated 'to what extent do SME characteristics influence the data that is needed to measure the determinants that describe the change in the environmental problem as a result of the impact of climate policies on SME behaviour?' In the literature the characteristics of an SME are described as strongly dependent on the manager or owner and their vision, which is supported by the study of Keijzers et al. (2008). They also define 'lack of resources, niche markets and flexibility, short term focus, labor productivity as the norm for performance, local orientation, occurrence of many family businesses and low complexity in organization' as characteristics of SMEs (Keijzers et al., 2008). Keijzers et al. (2008) mention several characteristics that are regarded internal or external weaknesses of SMEs, such as limited size and means, low orientation on sustainability, the limited access to financing, laws and regulation that can be unfavourable to SMEs and the limited access to knowledge and information.

Regarding the characteristics of the firm, the limited size and means of SMEs (Keijzers et al., 2008) were not found to be a limitation for taking energy reduction measures. These characteristics were assessed through the variables that measured the change in turnover and the change in the number of employees. The change in turnover was not found to have an effect on whether energy reduction measures are taken by a SME or not. Regarding the number of employees the results suggest that size does not affect the decision of a SME to take energy reduction measures or the number of energy reduction measures that the SME takes. This suggests that the definition of a SME, which is widely discussed in literature (McAdam et al., 2005), does not influence the results in contrary to what was expected (see section 3.4). Regarding labour productivity (Keijzers et al., 2008) it was found that both a change in the number of products and services and a change in the production process do not have an effect on whether energy reduction measures are taken or not. The vision of the manager or owner of a SME, who play an important role in the decision-making process of SMEs (Keijzers et al., 2008), was found to be important in the case of energy use. This result was both supported by the quantitative and qualitative results. In regard to energy reduction measures it is especially the change in management, which seems to affect the number of SMEs that take energy reduction measures, while the change in number of managers does not. This suggest that in the case of multiple managers, the established group needs to be targeted in order to change their view on taking energy reduction measures as adding a new member to the team is not sufficient.

The fact that the results show that SMEs have a very limited knowledge of policies, indicates that their access to knowledge through information provided by the government is limited. A reason that was frequently mentioned is the large amount of information and the fact that the information that is available is not clear. On the other hand the results also show that SMEs access information in different ways, for example through branch organizations. SMEs look for information based on the desire start new developments. The statement that laws and regulations are unfavourable for SMEs (Keijzers et al., 2008) is supported by the results of this research, which shows that they are not known. In addition, the energy reduction measures that are taken most frequently, which are the measures that stimulate a change in behaviour, are those measures that are already more easily taken by SMEs due to their flexibility and the fact that they require little financial investment. More difficult barriers, such as the split incentives problem, are currently not addressed in energy policies.

Other characteristics that were not specifically mentioned in the literature (Aragón-Correa, 2008; Keijzers et al., 2008), but which were found to be important characteristics of SMEs regarding their energy use are the age of the building they reside in, whether the SME has moved or not, whether the work activities take place inside or outside and what sector the SME belongs to. These last three variables were found to have an impact on whether or not a SME takes energy reduction measures. The move of a SME was found to have a positive effect on the decision of an SME to take energy reduction measures. This could be related to the fact that SMEs frequently move to buildings that fall under newer building regulations, although this could not be proven by the results of this research. A more surprising result was the fact that a higher percentage of SMEs that mainly work outside of the building, have taken energy reduction measures. The results have not given any further clarity about a reason why more work activities outside provide a higher incentive to take energy reduction measures as it was expected that more work activities inside would stimulate a SME to take energy reduction measures. Finally the sector that an SME belongs to, also has an effect on whether a SME takes energy reduction measures and how many energy reduction measures are taken. Of all the variables that were mentioned to affect the decision of an SME to take energy reduction measures, only two of the sectors were found to have a significant impact on energy use.

7.5 DATA COLLECTION

In relation to the third research question, the results show that the data availability has certain limitations. The question stated 'to what extent is the data that is needed to measure the determinants of climate policies in regard of their effectiveness in reducing energy use of SMEs currently publicly available?' From the literature review and the policy inventory three assertions were made in light of the research. The first is that the manager or owner of the SME is most likely the person who is able to provide data on the energy use as the literature review has demonstrated that the manager plays a central role in the organization of a SME (Keijzers et al., 2008). The second is that written or telephonic surveys are expected to be the best method for the data collection as this is a method that is frequently used to collect data for econometric effectiveness analyses regarding other climate issues. Finally it was assumed that a qualitative measure would be more feasible to obtain information on than a quantitative measure. These three assertions were addressed in the empirical part of the research.

The research shows that in regard of the manager being the best respondent to provide the data on energy use of SMEs it was found that this is true, however, there are several other types of employees that can also provide data for research related to energy. Especially administrative assistants from the administrative and support sector proved to be valuable data resources. In contrary to expectations it was found that data on energy use and energy reduction measures could not be collected from SMEs alone. It was also found that policy knowledge can likely be obtained through external parties and therefore, to establish the level of policy knowledge, it is not sufficient to collect data from SMEs only. These results support the findings of Del Río González (2009) that in the process of adopting environmental technologies there are many other actors involved, such as industrial associations.

Regarding the use of telephonic or written surveys for the research, it was found in this research that the telephonic survey was the most appropriate data collection method due to the time limit of the research and the fact that, thanks to the personal contact, additional information was collected. Several studies on determinants and policy analysis, such as the studies by Hoffmann et al. (2009), Rehfeld et al. (2007) and Frondel et al. (2008), used a similar method for data collection. Due to the restrictions to the accepted duration of an interview by phone, it was not possible to collect numerical data. Therefore collection of quantitative indicators for energy use is not feasible, so instead several qualitative measures were used. The qualitative results showed that the estimation of the energy use indicator was mainly based on whether the firm has bought new appliances or expanded. This type of indicator can most likely only be used in regard to energy research as it is expected that other climate or environmental issues do not have such a clear reference for the change in use.

7.6 CLIMATE POLICIES IN GENERAL

As the results are based on a case study of energy use, the qualitative research also included questions to assess to what extent the answers of the survey also apply to climate or environmental policies in general. It was stated that from the point of view of the SME climate and environmental problems are addressed as an integral issue. In some cases the personal preference of the manager or owner or the nature of the business can lead to the preference of a SME to take for instance energy reduction measures. The fact that the respondents do not consider climate issues separately from environmental issues, suggests that the two problems can be addressed through a similar approach. The respondents seem to tackle environmental and climate issues based on the problem and they do not seem to take into account different labels of policy instruments, such as adaptation versus mitigation (Tompkins et al., 2005) or different levels of governance (Urwin et al., 2008). This integrated approach of respondents to environmental problems supports the assumption that climate and environmental policies can be analysed and implemented in a similar manner, although it should be taken into account that this conclusion is based on the results of the qualitative interviews, which included a limited number of respondents.

Ch. 8 – Reflection

Through an assessment of the impact of climate policies, this research suggests that in the case of energy use of SMEs, energy reduction measures can be used for the measurement of this impact. The number of measures taken was indeed found to have a significant impact on energy use and it is possible to acquire data on these measures within the limitations of data collection options of a researcher. It is possible that the measures that are taken, also address other climate or environmental issues and that therefore the data collected in regard to one environmental problem can be applied to others as well. The development is related to observation that was made during the research that the measures that are taken by SMEs to deal with environmental problems are selected based on the demands of the business the SME is involved in. In approaching these environmental problems there is no distinction made between environmental policy concepts, such as the distinction between adaptation and mitigation measures (Tompkins et al., 2005), policy categories or even the distinction between environmental and climate policies. Based on these results it could be suggested that the approach in this research to select policies for the effectiveness research based on the problem that they address, is justified. Further insight into this development can shed a new light on the discussions in environmental policy research on whether the concepts adaptation and mitigation should be less strictly defined (Tompkins et al., 2005) and on whether the focus of policy effectiveness research should be on ranking different types of policy instruments (Requate et al., 2001; Rennings et al., 2006, Jung et al., 1996; Fisher et al., 2003).

In regard to research relating to energy use of SMEs, the research has provided multiple new insights. The strongest conclusion is that more actors than just the SMEs need to be interviewed in order to get a complete picture of the energy use of SMEs, the energy reduction measures that have been taken by SMEs and the policy impact. The SMEs are not a separate entity in itself, but part of a chain of actors that influence their decisions on energy use and energy reduction measures. Another conclusion is that both in the collection of data on energy use and policy knowledge, third parties play a very important role. These results seem to support the claim by Hahn (1990) that an institutional approach has its limitations in regard to studying the decision making process of firms due to the many actors involved. Furthermore, the results of this research show that focusing on merely formal governmental organizations as policy makers is not sufficient, which supports the results of the study by Stoker (1998). Although in agreement with prior experiences of researchers the majority respondents were not willing to participate in the interview out of lack of interest, a significant part of the respondents indicated that they were not able to participate due to that fact that they could not answer the questions posed. This can have implications for the future approach of the data collection of energy use of SMEs.

The research provides many leads for future study. The most important lead is perhaps the need for further study on the causal relationship between policies and energy reduction measures. The causal relationship between energy policies and energy reduction measures in this research was assumed based on the results of the policy inventory. Further research needs to establish if this assumption is justified. Another lead is the observation that 3rd parties play an important role in the implementation process of energy reduction measures. Further research should include these parties in order to see what role they play in the causal relationship between energy policies and energy reduction measures. Further studies in the direction of mixed policy effectiveness analysis using an econometric method could focus on a possible relationship between certain types of energy reduction measures and policy categories and on alternative ways to approach the collection of data on energy use. Future research could also focus on the valuation of energy reduction measures in regard to their impact on energy use. Although the research has demonstrated which energy reduction measures are taken most frequently, it is unknown to which degree these different measures contribute to the reduction of energy use. It's likely that certain types of energy reduction measures, such as those addressing personnel behaviour, will have a smaller impact on the reduction on energy use than for instance measures that address heating. By assessing the size of the impact of energy reduction measures on energy use, a more specific conclusion regarding the effectiveness of policies can be obtained.

Future research could also focus on the several characteristics of SMEs that seemed to have an impact on energy reduction measures. The causes for this relationship could not be established. In the case of changed management, future research could focus on what the conditions are for a group of managers to be convinced of taking sustainable measures. The research showed that a change in the number of managers does not lead to more SMEs taking energy reduction measures, while a change in managers does. Further research on this characteristic can provide insight into how target groups of policies can be approached more effectively. Another characteristic of SMEs that was found to have an effect on the decision of a SME to take energy reduction measures, was found to be whether the work activities of the SME mainly take place outside. This result was unexpected and therefore further study could provide insight into the reason why these outside work activities lead to the incentive to take energy reduction measures.

Future research could focus on the approach of environmental problems by SMEs. As explained in the first section of this paragraph, SMEs seem to deal with environmental issues through a problem-based approach. Further research could focus on whether this approach has implications for future policy effectiveness analyses. Related to this issue is the observation that the initiative of SMEs to take energy reduction measures is based on an internal desire to address a certain energy issue. Both respondents of the qualitative interviews have indicated that the initiative for the energy reduction measures they had taken were based on a combination of the availability of an opportunity and an internal desire to address an issue that was present within the SME at the time. This could suggest that the willingness of SMEs to take energy reduction measures is limited by the characteristics and the vision of the company and therefore a personal approach could be more effective than approaching the SMEs per sector for instance. However, the research has not provided enough evidence to support this argument and therefore further research is needed.

The most important finding of this research in terms of policy recommendations is the fact that SMEs are not always responsible for the energy bill or energy reduction measures and that in several cases they are dependent on third parties to address these issues. In the case of energy policies, policy makers should take the split incentives problem into account in order to realize a greater impact of policies in regard of the targeted environmental problem. A greater impact can also be realized by taking into account that SMEs do not acquire knowledge on energy reduction measures directly from the government and that perhaps 3rd parties should be defined as the target group of policies. Further research will be required to confirm this recommendation. The research has also demonstrated that the information density in regard of energy policies and energy reduction measures addressing SMEs is too high and therefore it is likely that it would be more effective if future policies are based on a personal approach of SMEs.

In light of future research, several recommendations can be made. The research has demonstrated that data collection on the energy use of SMEs requires a specific approach on several points. First of all, future research should take into account that 3rd parties are likely to also provide part of the data that needs to be collected in order to create a complete picture of the energy use of the SME. This means that for each SME an inventory is needed of other parties that are involved in the energy use of the SME. These parties also need be willing to provide the data. This could result in a lower total response rate than 10-15% and it will likely result in a more time-consuming data collection process. Second, the research showed that there is a large difference between the percentages of respondents that indicated to have taken energy reduction measures as a result of an open question compared to the answers to the questions that included several examples of energy reduction measure categories. In future research it would therefore be advised to include detailed questions in regard to energy reduction measures.

Ch. 9 - Literature

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Appendix 1: Overview Environmental Policies Rotterdam

SUBSIDY		
	InnovatiePrestatieContracten (IPC) Subsidie voor CO2 reductie van minstens 20 ton	Landelijk Meldpunt Afvalstoffen (LMA)
KP7 Competitiveness and Innovation Programme DG SANCO Health programme LIFE+	Cumulatietoets steun MSK Daey Ouwens Fonds Fonds Duurzame Biomassa Milieukwaliteit en electriciteitsproductie subsidie voor projecten	Website met informatie Seminars, thema-avonden, infomeetings Workshops/ bijeenkomsten Competentiecentrum Transities
Eco-Innovation	Reductie overige broeikassen subsidie voor projecten	Aanlevering ideeën
Marco Polo II	Unieke kansen klimaatneutrale scholen subsidie	Onderzoek
Eurostars Subsidieaanvraag Internationale Innovatieprojecten Eurostarts	LIFE + subsidies voor projecten Energie make-over Deltaport Donatiefonds Investeringsregeling ondernemers	Advies Energieonderzoek Stimuleringsprojecten Handhaving
Octrooivoucher	Overschie Subsidie Small business innovation research programma subsidie	Energie inkopen
Kennisvoucher Private voucher Zorginnovatievoucher Wajongvoucher Zon-PV	Cofinanciering TNO challenge subsidie R&D Kanszone I & II Rotterdam subsidie	Energiesubsidies Nieuwbouw en renovatie Verlichting Ruimtekoeling & Ventilatie Productkoeling Perslucht
Biomassa Waterkrachtinstallaties Windmolens op land WKK	INFORMATION Criterialijst Handleiding Duurzaam inkopen Cradle to Cradle Deelnameverklaring Implementatiecoach Duurzaam inkopen	WKK Maatregelen Energiemarkt Duurzame energie Duurzaam ondernemen Leveranciers Innovatiegroepen Diverse congressen, informatiebijeenkomsten etc, Diverse congressen, informatiebijeenkomsten etc, Website Website Website Diverse congressen, informatiebijeenkomsten etc, Website
Aanvraag subsidie via Energielijst Octrooivoucher Kennisvoucher Private voucher Zorginnovatievoucher Wajongvoucher Zon-PV	Informatiekaart Duurzaam Inkopen Kennisnetwerk Duurzaam Inkopen Presentatie Duurzaam Inkopen DuboCalc Het Nieuwe Werken CoP (Community of Practise)	
Biomassa	C2C (Cradle to Cradle)	
Waterkrachtinstallaties Windmolens op land WKK Aanvraag subsidie via Energielijst	PPP (People, Planet, Profit) DO-ladder (Duurzame Ontwikkeling) Werkinstructies Stappenplan	
Stimulering lokale klimaatinitiatieven TERM aardwarmte ondersteuningsaanvraag Actieprogramma onderwijs en ondernemen subsidie Projectvoorstellen CO2 Afvang van bedrijven	Voorbeeldbrieven Milieulijst 50 punten lijst voor lokale & regionale klimaatinitiatieven	
LT: nieuw energieonderzoek	Aanpak Uitvoering Klimaatbeleid Prestatiekaart Lokale Klimaatinitiatieven Instrument Organisatorische Borging van het Klimaatbeleid Stappenplan klimaatneutrale gemeentelijke/provinciale organisatie	VOLUNTARY
Lange Termijn (LT)	Zelfscan Klimaatbeleid Viadesk	Milieubarometer Uitnodigingen bijeenkomsten Klimaatscan
Korte Termijn Onderzoek (KTO) Demonstratie Unieke kansen regeling Subsidie innovatie	Kennisbank met tools	Centrale energie inkoop Greenkey Blauwe vlag Milieucertificaat

VOLUNTARY	MARKET-BASED	NETWERKEN
Lening Conditions Bedrijfcertificaat	JI ERUPT CDM CERUPT Innovatiekrediet Innovatiekrediet DTO	Maatschappelijk verantwoord ondernemen (MVO)
REGULATORY	Garantstelling voor lening Groene financiering	
Plan van Aanpak voor energiebesparing Milieuvergunning Projectplan Opleggen rendabele maatregelen bedrijven Energieprestatie als criterium bij gronduitgifte nieuwe bedrijven Bouwverordening Omgevingsvergunning AMICE (meldsysteem) Emissievergunning	Belastingaftrek Fiscale Winst Liquiditeits-of rentevoordeel Groen beleggen Speur- en ontwikkelingswerk (S&O) Emissiehandel (in emissierechten) Energiebelasting	
OVERIG	Aftrek energiebelasting Bijzondere vrijstelling energiebelasting Belasting	
National governments supply data Biofuel Cities Platform		

Appendix 2: Survey

QUESTIONNAIRE QUANTITATIVE DATA COLLECTION (translated from Dutch)

<p>Name of the company</p> <p>Phone number</p> <p>Sector</p> <p>Type of company: Headquarter of branch office</p> <p>Does the company want to participate in the interview? Yes or no</p>

I would like to start with a couple of questions on the energy use of your company.

1a. Did the total energy use of your company decrease over the past 5 years?	
1b. Would you say that the increase/decrease was big? (1 = increased a lot, 2 = increased, 3 = unchanged, 4 = decreased, 5 = decreased a lot, 6 = not relevant)	
1c. Could you estimate how big the increase/ decrease is?	
2. Did you company take energy reduction measures in the past 5 years? If yes, which? First let them answer, then give examples	
3a. Related to insulation?	<p>Insulation parapet behind radiator</p> <p>Insulation roof</p> <p>Insulation piping</p> <p>HR++ glass</p> <p>Other:</p>
3b. Related to ventilation?	<p>Close chinks and windows</p> <p>Good configuration draught lock with automatic doors</p> <p>Turn ventilation off outside workhours</p> <p>Other:</p>
3c. Related to heating?	<p>Weather related control for central heating boiler</p> <p>Buy sun water heating</p> <p>Buy heatpump</p> <p>Improvement heat distribution radiators</p> <p>Geothermal heat pump</p> <p>Good configuration heating appliances</p> <p>Configure heating limit</p> <p>Other:</p>
3d. Related to lighting?	<p>Apply high frequency lighting</p> <p>Energy efficient light bulbs</p> <p>Other:</p>
3e. Related to cooling?	<p>Close off cooling furniture</p> <p>Sun protection shades for cooled spaces</p> <p>Close cooling or freezing spaces</p> <p>Other:</p>
3f. Related to staff behaviour?	<p>Light off in spaces that are not used</p> <p>Instructions handling appliances</p> <p>Flexible workspaces</p> <p>Other:</p>
3g. Related to production appliances?	<p>Instruction use computers</p> <p>Instruction use machines</p> <p>Other:</p>

<i>3h. Related to alternative energy?</i>	Solar Panels Windmills Cogeneration Green energy Sustainable energy via collective shopping Other:
<i>3i. Related to monitoring energy use?</i>	Measure energy use Other:
<i>4. Which energy reduction measures are you planning to take?</i>	
<i>5. Have you taken any energy reduction measures at your home (private situation)?</i>	
<i>6. What is your motivation to take (no) energy reduction measures</i>	

I would like to continue with a couple of questions relating to policies.

<i>7a. Which subsidies do you know?</i>	Innovationvouchers Subsidy for solarcells Subsidy for windmills Subsidy for biomass Subsidy for cogeneration Other:
<i>7b. Does the availability of subsidies affect your decision to go for a more sustainable option? If yes, example.</i>	
<i>8a. Do you know other financial policies that can influence your energy use? If yes, which? Do you know tax measures?</i>	Energy tax Green-financing Energy-investment-deduction Other:
<i>8b. Do financial policy measures affect your decision to go for a more sustainable option? If yes, example.</i>	
<i>9a. Do you know organizations or resources that can help you take energy reduction measures? If yes, which?</i>	'Milieubarometer' 'Klimaatscan' EMAS registration Environmental certificate ISO 14001 ISO 26000 guidelines Other:
<i>9b. Does the availability of these organizations or resources affect your decision to go for a more sustainable option? If yes, example.</i>	
<i>10a. Which rules and regulations related to energy use do you know?</i>	'Wet Milieubeheer' 'Energieprestatienorm' 'Activiteitenbesluit' Other:
<i>10b. Does these laws or regulations affect your decision to go for a more sustainable option? If yes, example.</i>	
<i>11a. How do you collect information on energy reduction measures?</i>	Websites, like www.energiecentrum.nl Government information, like cradle to cradle, 'DO-ladder' of het 'nieuwe werken' Other:
<i>11b. Does the access to this information affect your decision to go for a more sustainable option? If yes, example.</i>	

12. What could the government do for you to convince you to take more energy reduction measures?
 First let them answer, then give examples

I would like to finish with some questions about your company.

13a. How many employees does your company have?	
13b. How many employees did your company have 5 years ago?	
14a. What are the products and services your company offers?	
14b. What were the products and services your company offered 5 years ago?	
15. What is your job description?	
16. Did a change in management take place in the company in the past 5 years?	
17. Did your company move in the past 5 years?	
18. How old is the building that your company resides in?	
19. Did the number of products and services that you sold increase, decrease or did it stay the same in the past 5 years? How big was the increase or decrease?	
20. Did you make any important changes in the production process? If yes, which?	
21. Do you work mainly inside or outside the building of your company?	(1 = mainly a lot, 2 = more inside, 3 = 50/50, 4 = more outside, 5 = mainly outside, 6 = not relevant)

Would you be interested in participating in a follow-up interview?	Yes or no
Other remarks	

Appendix 3: Quantitative analysis

Logistic regression output

Operation of the logistic regression model

	Independent variables per step	Dependent variable	Model significance	-2LL	R ² *	H&LChi ²	H&L sig.
Step 1	Size Age Sector (Cat) Work_inout (Cat)	Energy reduction	0,238	68,821	0,222	6,658	0,574
Step 2	Grow_P_S Grow_empl Changed_man (Cat) Change_Turnover (Cat) D_management ERM_prive Move	Energy reduction	0,066	52,64	0,477	2,748	0,949
Step 3	ERM_now	Energy reduction	0,023	47,252	0,550	2,062	0,979

* Nagelkerke R square

Variables in the equation – 3rd step

	Independent variables	Beta	Wald	Significance
Control variables	Size	-0,020	0,819	0,366
	Age	0,007	0,425	0,515
	Sector		8,248	0,143
	Sector(1)	3,027	3,981	0,046
	Sector(2)	1,053	0,607	0,436
	Sector(3)	0,131	0,009	0,923
	Sector(4)	-5,911	5,421	0,020
	Sector(5)	-3,232	3,361	0,067
	Work_inout_3cat		4,454	0,108
	Work_inout_3cat(1)	3,686	3,158	0,076
	Work_inout_3cat(2)	-0,915	0,586	0,444
Key variables firm	GROW_P_S	-1,978	3,444	0,063
	Grow_Empl	-0,071	2,460	0,117
	Changed_Man(1)	-0,742	0,365	0,546
	Change_Turnover		4,71	0,095
	Change_Turnover(1)	-0,367	0,088	0,767
	Change_Turnover(2)	2,208	2,929	0,087
	Change_Prod_Proc	0,849	1,125	0,289
	D_Management	-6,122	2,919	0,088
	ERM_PRIVE	0,228	0,494	0,482
	Move	1,773	2,594	0,107
Key variable analysis	ERM_NOW	0,768	4,103	0,043

Correlation matrix

Table 6.5 Correlation private and business energy reduction measures

		ERM_NOW	ERM_PRIVE
ERM_NOW	Pearson Correlation	1	,268
	Sig. (2-tailed)		,012
	N	87	87
ERM_PRIVE	Pearson Correlation	,268	1
	Sig. (2-tailed)	,012	
	N	87	87

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix 4: Research quality

Regarding the quality of the research, several external parties have been consulted to evaluate the construction of the survey, the survey questions and the execution of the survey. The discussions on the following topics included 2 academic advisors, 2 professional advisors and 3 testcases.

Validity

In the initial survey most of the questions were formulated in a qualitative way. With the help of the academic advisor the questions were translated to more fact-based questions in prevent that the answers are subject to the interpretation of the respondent. In the case of questions relating to whether policy measures stimulate SMEs to take energy reduction measures, one of the advisors mentioned that the right formulation of this question is essential as it needs to be possible that it is answered by both yes and no. Therefore it is proposed that the question is formulated to assess whether the knowledge of policy measures has stimulated the SME to take energy reduction measures.

Replicability

Regarding the replicability, many topics were discussed, such as whether the respondents contacted by the 'cold' approach or whether the survey should be announced, whether the survey should be conducted by phone, written questionnaires or interviews, which number of respondents should be included, which and how many sectors should be included in the selection, whether the DCMR Environmental Protection Agency database or the Chamber of Commerce database should be used. In case the DCMR Environmental Protection Agency database would have been used, this could have created a bias in the research regarding the companies that know DCMR Environmental Protection Agency versus the companies that do not know or are not registered with the DCMR Environmental Protection Agency. This information came mainly from discussions with the academic and professional advisors.

Reliability

Regarding reliability the main topics that were discussed addressed the survey questions. It was said that the language needed to be simplified and the survey needed to be shortened. This information came mainly out of the discussion with the testcases.

Appendix 5: Respondents characteristics

Respondent characteristics qualitative interviews

Company	Supplier of woodworking machines	Natural and organic grocery store
Job type	Manager	Owner
Energy use	No change	Increased
Nr. Employees 2006-2011	0/ in total 9 employees	0/ in total 48 employees
Nr. new products & services 2006-2011	1	0
Nr. of managers 2006-2011	1	0
Nr. of changes in managers 2006-2011	1	0
Nr. of moves	1	0
Age of business premises	31 years	70 years
Number of process changes	0	1
Change in turnover 2006-2011	Decreased	Increased
Degree of inside and outside work	50/50	Always inside
Sector	Wholesale and retail sector	Wholesale and retail sector
Company type	Headquarters	Headquarters
Energy reduction measures	2x Heating, 1x light	3x light, 1x cooling, 1 personnel, 1 alternative energy
Future energy reduction measures	1x Light	0
Private energy reduction measures	4x Private	6x private
Policy categories	Subsidies, voluntary	0
Motivation and difficulties	Costs and clear information	Principles and none