Urging residents in Eindhoven to save energy

Author:
Ingrid Nieuwenhuijsen BSc.

Graduation program:
Construction Management and Engineering

Graduation committee:
Prof. dr. ir. Bauke de Vries
Dr. ir. Erik Blokhuis
Drs. Marianne Gloudemans
Ir. Ienke de Vrieze

August 23th 2010

Table of contents

Chapter 1: Introduction

In the past few years the average energy use per household increased alongside the increasing amount of households. This trend of rising energy consumption indicates troubles for the future. There are certain problems that are related with the current energy consumption in general (BuildDesk, 2009a):

- Climate change;
- Small stock of fossil fuels left;
- Political uncertainty of the energy delivery ;
- Damage to environment by winning, processing and transport of fossil fuels.

These energy problems require action, since they are threatening our safety, food supply, water management and bio diversity. Therefore the national government is aiming for ambitious climate targets to become one of the cleanest and most energy efficient countries in the world (VROM, 2007). The targets of the policy program 'Schoon en Zuinig' (Clean and Careful) developed by the national government are:

- Cutting emissions of greenhouse gases by 30% in 2020 compared to the levels in 1990;
- To double the energy efficiency improvement rate from 1 to 2% in the coming years;
- To reach a share of renewable energy of 20% by 2020.

The national government executed many activities in the past few years to support the reduction of energy use by households. For example, the program 'Meer met Minder' (More with Less) attempts to activate private owner-residents to invest in energy saving measures (PeGO, 2007). When the results of this approach are too low, oblige measures will be taken (VROM, 2007). One suggestion is to introduce a general energy performance requirement for all existing houses in the building act (bouwbesluit). The potential introduction of energy performance requirements for the existing housing stock is a large political issue since all house owners will have to deal with it. Therefore urging residents to save energy voluntary is preferable.

Municipalities in the Netherlands joined the national policy 'Schoon en Zuinig' and determined their own environmental policies. In 2002 certain ministries and the association of Dutch municipalities (VNG) signed a climate covenant to support municipalities with knowledge and financial means to develop policies about environment and energy (Gemeente Eindhoven, 2002). The municipality of Eindhoven aims to become energy-neutral in 2035-2045. This implies that the energy that is still used by then will be supplied sustainably within the area borders of Eindhoven (Gemeente Eindhoven, 2008). This is a very ambitious target and there are still many technological, organizational and financial issues that need to be resolved.

Although many researches state that people have sufficient knowledge about the environmental problems and their relation with energy usage in general, it seems as if people are not aware of their own overconsumption of energy. Therefore, the energy consumption behaviour of residents is very important in relation to the energy neutral targets of municipalities.

The strategy of the municipality of Eindhoven to realise the energy neutral target is based on the Trias Energetica: reduce energy demand, use renewable sources, and use fossil fuels efficiently. The first step in this strategy is to reduce the demand of energy. Saving energy in the existing housing stock is appointed as largest the contributor to the realization of the energy neutral target, accounting for 25% in total. The municipality aims to realise this cutback of energy use by the voluntary participation of residents. It appeared that the energy savings obtained in this way are not sufficient yet. Therefore, it is vital to investigate the possibilities to urge residents to save energy.

1.1 Problem definition

Since the government has too little means (financial and legal) to push the energy neutral target forward in public sphere, the municipality is dependent on the participation of residents in the energy transition. About 80% of the Dutch energy consumers are convinced that it is important to save energy. Despite of this and all efforts currently taken (information campaigns and subsidies), the energy saving rate is still far below what is required to realise the energy neutral target. In addition, there is no clarity in the jungle of possibilities for municipalities to urge residents to save energy. In short, realizing the energy neutral target is a problem because:

There is no clarity in how residents can be urged to save energy.

1.2 Hypothesis

Although it is not discussed in current literature it is likely that the current incentives are not effective because these projects are not focused on specific target groups. In the attempt to urge all residents to save energy the incentives are not helpful at all. In my opinion there are diverse groups of residents which different needs in relation with saving energy and they should be approached differently. The hypothesis is that:

Multiple segments of residents can be distinguished with different preferences for intervention strategies to be urged to save energy.

1.3 Research target

This research provides knowledge to municipalities about their opportunities to urge residents to save energy. In addition this research gives more insight in the behaviour process of energy consumers and different strategies to intervene in behaviour processes. The assessment of the different intervention strategies enables municipalities to further specify their strategy to realise the energy neutral target.

1.4 Main research question

As a solution to the problem the following general research question will be investigated:

How can residents of Eindhoven be urged to save energy?

The general research question consists of multiple sub questions:

- What is the current strategy of the municipality of Eindhoven to achieve the energy neutral target?
- Which projects of the municipality of Eindhoven are connected with this strategy?
- What projects of other municipalities can be used as reference projects?
- What are the largest bottlenecks for the execution of the strategy to achieve the energy neutral target?
- What are the most important aspects of energy saving behaviour?
- What is the relation between the different aspects of energy saving behaviour?
- What are the strategies to intervene in an energy saving behaviour process?
- How can the aspects of energy saving behaviour and the intervention strategies be visualized?
- What kind of strategy (combination of intervention strategies) will enable the energy saving of residents?
- What is the relation between the intervention strategies and socio-demographic and housing characteristics?

1.5 Research boundaries

Since this research project has been executed in a limited timeframe there are certain boundaries to ensure that the research target is accomplished. The first boundary is that the research focuses on the energy neutral target of the municipality of Eindhoven. Therefore the choice of residents for certain intervention strategies will be investigated only among the residents of Eindhoven. Other cities are not taken into account. However, since residents of one city are in general not completely different from another city, the results of this research can be used as a starting point for other municipalities in The Netherlands.

Secondly, in this research only saving energy in the existing housing stock has been taken into account. This topic has been indicated by the municipality of Eindhoven as urgent for investigation and it is the key difficulty of the energy neutral target. The topic of implementation of sustainable energy sources in the existing housing stock has been excluded. This research will function as a foundation on which other researches and governmental policies can be specified on. Therefore, both energy saving by investments in the energy-quality of houses and curtailment behaviour (consuminderen), the reduction of energy use through behaviour changes, are considered in this research.

1.6 Current literature on urging people to save energy

The current state of the art literature discusses the causal aspects of pro-environmental behaviour and the strategies to intervene in the behaviour process. However, a good visualization of the energy saving behaviour process and its intervention strategies is lacking in the literature. In Chapter 4, the literature on the energy saving behaviour of households is elaborated.

A very important difference of this research with other investigations is its main focus. In other researches opportunities are proposed and professional experts such as policymakers are asked to choose their preferred opportunity. In this research the need of the residents has been analysed in the field research instead of the opinion of professional experts.

1.7 Expected results

The expected result of this research is an advice about which intervention strategies can be used to urge residents to save energy. This advice is based on a behaviour process model in which different aspects of behaviour are connected to intervention strategies. Based on the hypothesis in Paragraph 1.2, the advice consists of suggestions to urge the multiple segments of residents that have different demands in relation with saving energy.

Chapter 2: Research design

This research consists of three main parts. Desk research has been used to investigate the governmental framework on which the energy neutral target has been developed. In addition, literature on behavioural aspects has been used to analyze the behaviour process and develop an energy saving behaviour model. More contextual insight has been obtained by interviews with professional experts like advisers at municipal and national government.

In a field research the aspects of the behavioural model and the intervention strategies have been examined in surveys that are distributed randomly to residents of Eindhoven. This survey is a one moment survey type combined with a conjoint choice experiment for intervention strategies.

Based on both the contextual orientation and the field research conclusions can be made and recommendations can be given. In the research model in Figure 2.1 the different parts of the research are visualized.

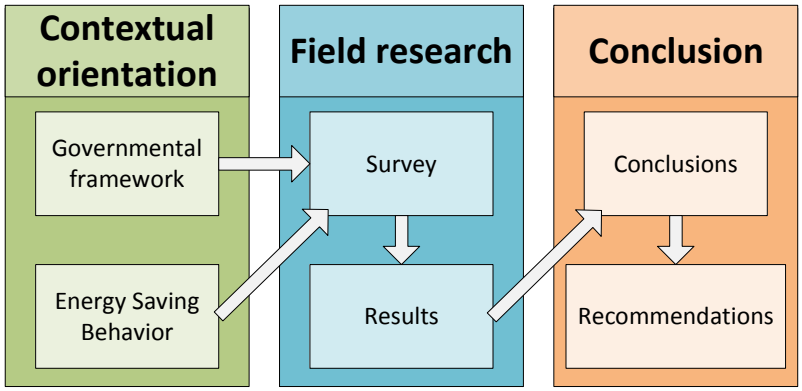


Figure 2.1: Research model

2.1 Research validity

Validity of a research means that the research investigates what it aims to investigate. Then it is fair to connect the research target, content and output to each other. The validity of this research is mainly ensured by guidance of the graduation committee. An important meeting was the colloquium at March 3rd 2010 with the entire graduation committee. In this meeting the direction of the research was set.

Another important aspect of validation was that test respondents examined the survey. About 20 test respondents (friends, family, and other acquaintances) gave feedback on the questionnaire for its clarity and ambiguity.

2.2 Reading guide

In this paragraph an overview is given about the content of this research. In the report, 3 parts are distinguished.

Part 1 is about the contextual orientation of the research. The first chapter in this part (Chapter 3) is about the energy neutral target of the municipality Eindhoven. This chapter elaborates on the importance of energy neutral targets, the energy policy of the national government and the strategy of the municipality of Eindhoven to achieve the energy neutral target.

The second chapter in this contextual orientation part is about the energy saving behaviour of households. The fact that the energy use per household increases as well as different aspects that influence behaviour of people are discussed in this chapter. Besides this, different strategies to intervene in energy saving behaviour are elaborated. At the end of this chapter, a model is elaborated that gives insight in the energy saving behaviour process.

Part 2 is about the field research that is executed to relate the contextual orientation to the real life situation. In Chapter 5 the focus of this field research is discussed including problem focus, research goal and the variables of the survey. After this, the research methodology will be elaborated in Chapter 6. This part is concluded with a description of the results of the field research with the adjustment of the energy saving behaviour model, the general factor levels of the respondents, the preferences for intervention strategies and the characteristics of the segments that are identified.

In the concluding Part 3, the results of the field research will be related to the contextual orientation of Part 1. The energy saving behaviour model, the intervention strategies, the need to focus the governmental strategy on segments and the effectiveness of the current governmental policy are elaborated in Chapter 8. At the end of this chapter (conclusion) the things that went wrong in the research are discussed.

In Chapter 9 the product and process of this research is evaluated about what is good about this research and what is not. The recommendation for further research is also elaborated in this chapter. The recommendation to the municipality of Eindhoven can be found in Chapter 10. In total, there are six recommendations discussed.

Part 1: Contextual orientation

Chapter 3: Energy neutral target municipality Eindhoven

In this chapter the governmental policy about the realization of energy neutral target will be elaborated. In the first paragraph the general aspect of energy policies on national and municipal level is elaborated. Paragraph 3.2 is about the actual strategy and roadmap of the municipality of Eindhoven to achieve the energy neutral target. In Paragraph 3.3 the currently executed projects are elaborated followed by reference projects in other municipalities in Paragraph 3.4. Paragraph 3.5 discusses the identified problems related to reducing energy consumption.

3.1 Governmental energy policy

The climate policy program of the municipality of Eindhoven is based on three aspects: quality in construction and living, sustainable entrepreneurship and climate policy (W/E adviseurs, 2009b). The municipality introduces the performance focused method GPR to enable quality in construction and living. The method gives insight in sustainability performances on five categories (energy, environment, health, quality of use and future value) of buildings for different parties such as renters, municipality and investors (gprgebouw.nl).

However, the GPR method is not a legal instrument like for example the EPC norms. For new houses the EPC drops from 0,8 nowadays to 0,6 in 2011, 0,4 in 2015 and to 0,0 in 2020. However, there are no legal agreements yet for the existing housing stock. According to a senior policy advisor at the ministry of VROM, it is impossible to urge residential energy saving voluntary at the national level (Ramsoender-de Klerk, 2010). The ministry of Housing, Spatial Planning and the Environment (VROM) is therefore exploring the possibilities for a comparable norm for energy performance in the existing housing stock (VROM, 2007). The notes of the interview with the senior policy advisor of VROM can be found in Appendix 1.

Local governments have much more insight in the different parties that are involved in their municipalities. As a result, they are more capable to attract residents in the energy transition. The support by the national government with legal regulations facilitates a faster adoption process of the new energy regime. This enables the participation of the ‘majority’ of the market besides the ‘innovators’ and ‘early adaptors’ to participate in the transition. In Figure 3.1 the diffusion curve of innovations is shown.

Collaboration with other municipalities is desired. In this way experiences on sustainability can be shared and agreements like the covenant ‘Naar een Duurzame Voorraad’ (Realizing a Sustainable Stock) have more strength. The main target of this project is to give insight in and improve the sustainability of the existing real estate stock (housing, educational buildings and utility buildings). 37 parties in total (municipalities, housing associations and school boards) collaborated in this project. The general conclusion of its final report (W/E adviseurs, 2009a) is that broad governmental support for sustainability is not obvious in many organizations.

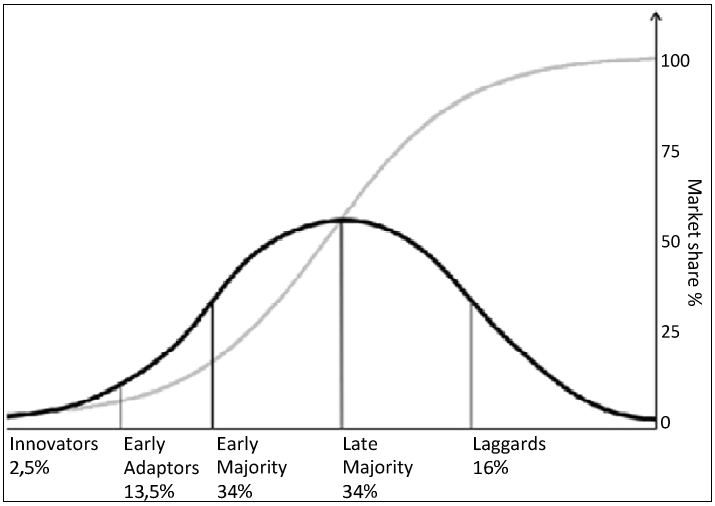


Figure 3.1: Diffusion curve of innovations (Rogers, 1962)

3.2 Energy strategy municipality Eindhoven

According to the Social-Economic Council (SER), the energy transition should be based on the Trias Energetica: reduce demand, use renewable sources, and efficiently use fossil fuels (SER, 2008). This model, pictured in Figure 3.2, is also used by the municipality of Eindhoven. The strategy of the municipality of Eindhoven is based on the energy consumption cutback (90% in the housing stock compared to the current energy consumption) and the increase of sustainable energy supply (currently 0,6% bio energy and 0,4% WKO to 70% solar energy, 25% earth warmth, and 5% bio energy).

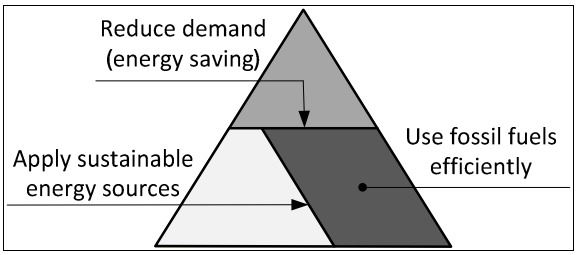


Figure 3.2: Trias Energetica strategy for energy consumption (Telos, 2008)

Houses utilized 33% of the total energy consumption in Eindhoven in 2008 (BuildDesk, 2009a). For a great deal this amount is dependent on energy behaviour. The municipality wants to collaborate with interest groups of residents to realise great reductions in energy use. The targets to reduce the energy consumption in the existing housing stock are (Gemeente Eindhoven, 2008; W/E adviseurs, 2009b):

- Improve the energy-quality of the existing housing stock with 4% per year;
- Realise energy saving behaviour at 20% of the households.

In the roadmap to realise energy neutrality, two policy scenarios are suggested with a different amount of projects and investments and a different timeframe to realise the target. In February 2010 the town council of Eindhoven chose the 'extra' scenarios with the shortest timeframe. However, no extra means (finance and labour) were made available. This is caused by the election in March and the planned budget cutting.

Table 3.1: Contribution sectors to energy neutrality (BuildDesk, 2009b)

	Sector	Saving energy	Sustainable energy	Total
1	Municipality	5%	4%	9%
2	Company buildings	18%	9%	26%
3	Company processes	10%	0%	10%
4	Existing housing	25%	18%	43%
5	New housing	2%	1%	3%
6	Traffic	8%	0%	8%
	Total	**68%**	**32%**	**100%**

In Table 3.1 the contribution to the energy neutral target of different sectors are listed, divided into saving energy and sustainable energy supply. The intersection of 'saving energy' and 'existing housing' is marked since this is the main focus of this research. Insulation, implementation of high efficiency heating, micro WKK, energy efficient lightning (LED) and heat recovery are the most important measures to realise the energy neutral target. In Table 3.2 the energy savings per measure are given.

Table 3.2: Contribution measures to energy neutrality (BuildDesk, 2009b)

Measure existing housing	Energy saving
Insulation	6,89%
High efficient heating	6,46%
Micro WKK	0,45%
Efficient lightning	1,54%
Heat recovery	9,89%
Total	**25,2%**

3.3 Currently executed projects in Eindhoven

Currently the municipality of Eindhoven already executes and supports certain projects that have a positive influence on the reduction of energy use in the existing housing stock (Gemeente Eindhoven, 2008; BuildDesk, 2009a). However, there are not many projects that have great effects already. Below the most striking projects are elaborated:

'Haal energie uit je wijk'

This project is executed by the municipality of Eindhoven together with the program 'Meer met Minder' (MMM) of the national government. The project started in 2009 in the city district Kronehoef. A CO_2 reduction-opportunity-map has been developed giving insight in the energy performance of about 250 houses with use of energy labels. The target of the project is that about 25 private house owners eventually take action (Gemeente Eindhoven, 2009c). To realise

the participation of the residents of Kronehoef multiple meetings were planned and an information brochure supported the activities.

Despite the effort taken by the organization of this project the interest of the residents was extremely low. The company Motivaction executed a research to discover the reason of this low interest. The respondents were generally satisfied with the communication about the project. The general opinion was that the letters and the articles in the local newsletters were sufficient. However, the residents indicate that energy saving is not a priority for them. Most of the respondents of their qualitative research were aged (above the age of 50). Besides these reasons there is not a large involvement in the district. Therefore the community focus of the project approach does not perfectly fit the district characteristics (Motivaction, 2009).

Information meetings 'Energie besparen en subsidies'
In 2009 three information meetings were organized for residents of Eindhoven. These meetings were highly visited (de Bruijne, 2010). This is likely caused by the invitation letters that each household received in Eindhoven. De Bruijne indicated three important activities that stimulate residents to save energy, namely:

- Personal and direct informing;
- Relieving people from effort and complexity;
- Financial stimulation.

These 3 steps were also named in the presentation of the program manager sustainability of the municipality of Eindhoven (Silvertand, 2010).

Caféin 1 'Eindhoven duurzaam 2045'
In this project artist professionals function as catalysts for innovation and changes. The target of the project is to link the problem owners (municipality Eindhoven) to technical knowledge (DHV and Arteconomy) and the creative sector (MAD, VERS, CHEOPS) to develop answers for public issues.

The first project of Caféin started in November 2009 and was about the energy neutral target of the municipality of Eindhoven. Since all energy that is used in Eindhoven has to be generated sustainable, all stakeholders in Eindhoven (residents, companies, other organizations) need to contribute in this target. In the project different types of solutions to urge residents to participate were developed. Two solutions that create awareness ('Energie-eten' and play object 'Kunstmatige energie') were chosen by a jury for further elaboration (Caféin, 2009).

3.4 Reference projects other municipalities

During interviews the project manager of the climate policy indicated that more knowledge about reference projects of other municipalities is desirable (Ketelaers, 2010). In this paragraph some reference projects are listed.

Wonen ++
The target of this project was to enable healthy and energy efficient houses without the increase of costs. This project started in 2007 and is an initiative of the province of Groningen

and its municipalities. In this project people can make their own properties energy efficient with measures such as double glazing. The project focused on private house owners with houses that were built before 1985. In the municipality of Groningen (Gemeente Groningen, 2007) the project resulted in information evenings in 11 neighbourhoods, 217 EPA advices, 65 assignments and about 55 tonne CO_2 reduction yearly.
Keywords: privately owned houses, improvement energy-quality of houses.
Success factors: financing concept reducing energy costs covers investments; limited investment threshold since provincial governance support Energy-Performance-Advice financially.

Waterzijdig inregelen Piccardthof
In this project the heating systems in houses in the neighborhood Piccardthof in the municipality of Groningen were improved (Gemeente Groningen, 2007). In this project the heating system in houses are tuned in collaboration with the residents and installation companies for optimal and evenly heating. This will increase the comfort of the houses and reduce the energy consumption.
Keywords: existing houses, improvement energy-quality of houses.

Energy saving behaviour social housing
This project is about helping low income households to reduce their energy costs. The municipality of Utrecht initiated this project in 2006 in which 13.000 households received an energy box (insulation foil, draft strips, energy saving lights) and personal energy advice from an EPA adviser (VNG, 2007). The project also offered employment to people with social assistance. The total costs of the municipality of Utrecht were €250.000 and the ministry of VROM invested €400.000 (see Tender *Energiebesparing Lage Inkomens*). The municipality of Groningen executed a similar project in 2007 in which 6.000 low income households received energy boxes from a reintegrated EPA adviser (Gemeente Groningen, 2007).
Keywords: existing houses, improvement energy-quality of houses, change energy behaviour.
Success factors: free tailored direct advices.

Energy market Veldhoven
The target of this project was to provide residents with information about saving energy and sustainable energy sources. Advises were given on topics as energy saving in general, local and provincial subsidies, insulation and other energy efficiency possibilities, and sustainable energy supply sources. Besides this people could watch a climate change movie and listen to different presentations. About 350 people visited the energy market. The energy market was promoted in the local newspaper and people were attracted to the energy market with gadgets such as the exchange possibility of light bulbs for LED lights.
Keywords: privately owned houses, improvement energy-quality of houses, sustainable energy supply, change energy behaviour.
Success factors: Free gadgets available (LED lights); broad offering of services.

Energy agreements with housing corporations
From 2000 the municipality of Tilburg, housing corporations Breburg, TIWOS, TBV Wonen and St. Lambertus and energy company Essent make energy agreements (VNG, 2007). The second

agreement led to 16.000 EPA advices and concrete activities in renovation and sustainable energy supply (installation solar systems). The third agreement is based on a project structure. Costs related to this agreement are €8.690 for the municipality and €16.310 for the housing corporations.
Keywords: housing corporations, improvement energy-quality houses, sustainable energy supply.
Success factors: small scaled, feasible ambitions; commitment of housing corporations.

Wijkgerichte energiebesparing in 's Hertogenbosch
Stimulate (at least 200) private house owners to invest in energy saving measures to improve the energy-quality of the houses. Besides this also energy saving through behavioural changes is a target of the communication activities (information evenings, energy paper). Since this project is not finished yet no results are available.
Keywords: private house owners, improvement energy-quality houses, sustainable energy supply.

3.5 Problem identification reducing energy demand

By means of the former paragraph the problems of reducing energy demand are identified. The problem analysis diagram can be found in Figure 3.3. Below the most striking problems are elaborated.

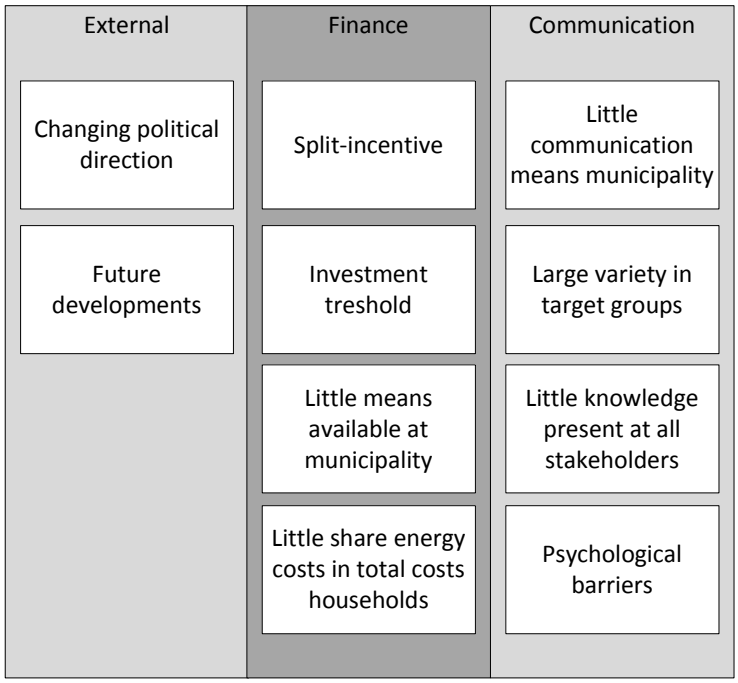


Figure 3.3: Problem analysis diagram

Finance
- *Split-incentive*: this is a typical rental problem. Ownership of benefits and costs is divided, and investments are mainly recharged in the basic rent (which is limited for social rent).
- *Investment threshold*: this problem is for example caused by the fact that there are no scale advantages since a generic approach is not possible in the private habitation.
- *Little means available at municipality*: this problem is caused by the economical crisis, and the budget cutting at the municipality.

Communication
- *Little communication means municipality*: this problem includes the lack of structural contact moments with stakeholders and the fact that there is no legal basis to claim agreements.
- *Large variety in target groups*: this problem complicates the communication in the energy transition process. The splintered ownership of real estate is an important component of this problem.
- *Little knowledge present at all stakeholders*: components of this problem are the fact that the advantages of energy neutrality are unknown, the possible sustainable energy sources in Eindhoven are unidentified, and there are no reference projects of other municipalities to urge residents known.
- *Psychological barriers*: there is little willingness to participate of residents, different sectors at the municipality, and market parties (Too much trouble, image facilities don't work, low perception of output).

External
- *Changing political direction*: the uncertainty of this problem proposes actual execution of activities.
- *Future developments*: the uncertainty of future developments (for example prices fossil fuels) discourages stakeholders to participate in the energy transition.

3.6 Conclusion

The municipality of Eindhoven wants to become energy neutral in 2035-2045. The Trias Energetica model has been used as basis for the strategy to realise the energy neutral target. Reducing energy consumption with 90% in comparison to the current use in the existing housing stock is an ambitious target that will contribute 25% to the energy neutrality of the municipality Eindhoven.

The importance of investigation how residents can be urged to participate in the energy transition is tangible. The voluntary participation of residents to reduce energy consumption is required since the introduction of oblige measures such as energy performance norms for existing houses is a very complex process and causes large political discussions.

In this chapter the aim of the governmental energy policy is discussed. In the next chapter the energy saving behaviour of households will be addressed.

Chapter 4: Energy saving behaviour households

Individuals can contribute significantly in saving energy by adopting pro-environmental behaviour patterns. In this chapter the behaviour of energy consumers, the many aspects that influence behaviour and the natural of these causal relations are described. The energy saving behaviour model will also be discussed.

4.1 Energy use of households

Households use energy directly in forms of natural gas and electricity and indirectly through the energy that is used to develop the products and foods that households consume. The amounts of electricity- and natural gas use per household are comparable to a total energy of about 73,4 GJ. The amount of electricity- and natural gas use per household slightly changed over the past ten years. In comparison to former years more electricity and less gas is used per household.

Van Arkel et al. (van Arkel et. Al, 1999) distinguish energy use in two categories, namely house related energy use and appliances related (or user bound) energy use. The house related energy use consists of house heating, ventilation and the heating of tap water. They discuss whether or not lightning is also part of this category and conclude that since lightning is conditioned by the design of the house together with the lifestyle of the residents it is both part of house related energy use and user bound energy use. The user bound energy use consists of energy use related to cleaning, cooling and preparation of food and audio-, video- and telecommunication. In Figure 4.1 total energy use per household for new and existing housing according to PeGO is pictured.

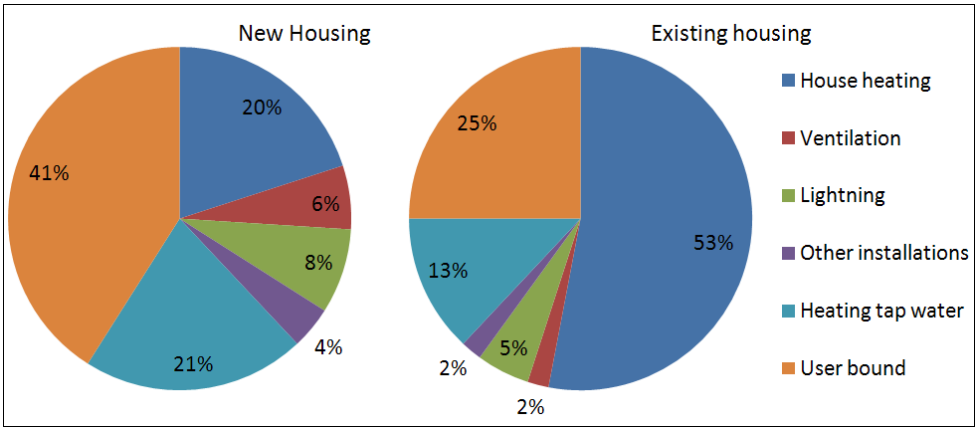


Figure 4.1: Distribution energy use new and existing housing (PeGO, 2002)

Average natural gas use is strongly related to housing characteristics since a large share is used for house related energy use. Hence there are substantial differences in the average gas use per type of housing. Flat housing in general is much more natural gas use efficient than detached housing.

4.2 Habitual behaviour of people

People need to make decisions continually. However, our metal capacity to foresee all consequences is limited and the use of only reasoned decision processes is not possible. Therefore, bounded rationality is used to manage the complexity of everyday life (CE Delft, 2006). Bounded rationality consists of automated behaviour (routines or habitual behaviour and imitation) and the use of rules of thumb. Habitual behaviour is guided by automated cognitive processes. The behaviour is likely to be repeated when outcomes are satisfactory. Habits are triggered by a structure of learning, storing in, and retrieving from memory when individuals perceive a particular situation (Aarts et al., 1998). Habitual behaviour may involve misperceptions and selective attention: people tend to focus on information that confirms their choices, and neglect information that is not in line with their habitual behaviour (Steg; Vlek, 2009). People only accept a change in this information when there is a sufficient deviation.

Bounded rationality results in 'satisfaction' (Simon, 1957). According to this phenomenon not all costs and benefits are included in the decision process. Besides this people take their perception of costs and benefits into account and do not use objective data. In this way consequences of decisions are sufficient instead of optimal. In addition, costs and benefits are often expressed in money. However, a lot of decisions differ from economic costs-benefits-analysis since factors like risks; organizational commotion and effort are not included.

4.3 Influence factors energy saving behaviour

There are two different types of energy saving behaviours resulting from certain influencing factors. Investment behaviour is about the increase of energy-quality of houses and the purchase of energy-efficient appliances. Curtailment behaviour (consuminderen) is about the decrease of energy usage by behavioural changes. With the energy saving behaviour there is a sufficient risk for compensation and rebound behaviour.

Macro-level or contextual factors shape individual (micro-level) factors such as motivations and abilities (Abrahamse et al., 2005). Contextual factors are technological developments, economic growth (increase of household incomes), institutional factors (governmental policies), cultural developments (emancipation), and demographic factors. There are certain demographic developments that cause an increase in the energy use of households (Heijs, 1999):

- General increase of the population;
- General decrease in size of households;
- General increase of incomes per household;
- General technical developments on consumer markets.

Knowledge, motivations and ability are the most important micro-level factors that influence energy saving behaviour of households (Steg, 2008). Knowledge about problems related to household energy use is present in general. However, there is often confusion about the causal processes involved. For example, a limited number of people think global warming is caused by heating and cooling homes. In addition, people know little about the energy use related to their behaviour.

Besides this, many people are not motivated to reduce their energy use. Individual motivations to engage in environmental behaviour are perceived costs and benefits, concerns about environmental- and energy problems, and affect (Steg; Vlek, 2009). Other factors such as status, comfort and effort are also important (Stern, 2000). The motivation factor is influencing the acceptability of energy policies. Energy policies are more acceptable when they increase (purchase energy-efficient appliances) rather that limit (curtailment behaviour) the freedom of choice (Steg, 2008).

The ability factor is highly dependent on contextual factors, and the facilitation of pro-environmental actions by these contextual factors rule out psychological motivations. Examples of contextual factors are the availability of products and services, the available infrastructure, cultural norms and economic factors (Steg, 2000). Contextual factors can affect behaviour directly (availability products and services), through the mediation of motivational factors such as attitudes, by moderation of the relationship between motivational factors and behaviour, and by the determination of which type of motivations most strongly affects behaviour (Steg; Vlek, 2009).

Besides these micro-level factors, saving energy is also dependent on socio-demographic factors. These factors serve as barriers or opportunities for saving energy such as income. Other socio-demographic factors are: age, gender, household size and ownership/renting of houses. Direct energy use appeared to be strongly related to household size and indirect energy use to income and household size (Abrahamse; Steg, 2009).

4.4 Intervention strategies

There are different types of strategies to urge people to save energy: antecedent, consequence and structural interventions.

Antecedent interventions manipulate one or more determinants that influence behaviour. For example, they increase people's knowledge and strengthening their concern with energy problems. There are different types of antecedent interventions such as providing information, demonstration, commitment, goal setting and free products. Information campaigns are commonly used to promote energy saving. Providing information aims to increase people's awareness about energy problems and their knowledge about how to reduce these problems. There are different possibilities to provide people with information like workshops, mass media campaigns, and tailored information (Abrahamse et al., 2005). In contradiction to the general opinion, mass media campaigns appeared not to be effective (Abrahamse, 2007). Providing specific information that is tailored on a household is essential and seems to be effective. Demonstration provides examples of recommended behaviour. In general, people will follow these examples when they are understandable, relevant, meaningful and rewarding to people (Abrahamse et al., 2005).

Commitment strategies contain a promise to change behaviour, in this case to save energy. If the promise is pledged to oneself it may activate a personal norm. When the promise is made public (by leaflets for example), social norms influence the saving behaviour (Abrahamse et al.,

2005). The promise to save energy can be linked to a specific goal such as reduce energy use by 5%. The goal setting strategy is often used in combination with other interventions (besides commitment) such as feedback. Feedback is an incentive of the consequence strategy.

Consequence interventions are based on the assumption that the presence of positive or negative consequences will influence behaviour. Feedback and rewards are two incentives that manipulate the positive or negative outcomes. Abrahamse (Abrahamse, 2007) states that providing feedback about the reached saving rate is very effective, and appeared to be more effective when the feedback was given more often and related to a saving goal. Although rewards seem to have a positive effect on reducing energy usage; it appeared that effects of rewards are short-lived (Abrahamse et al., 2005).

Structural strategies are aimed at changing the context to facilitate behaviour changes (Steg, 2008). Changes in the circumstances under which behavioural choices are made may be needed so as to make pro-environmental behaviour more attractive. The costs and benefits of behavioural alternatives may be changed in various ways (Steg; Vlek, 2009). Changes in physical, technical and organizational systems can alter the availability in products and services. High energy consuming products and services can be made less attractive or even unavailable and energy saving behaviour options may be provided (LED lights and other energy efficient appliances). Secondly, legal regulations can be implemented (to prevent split-incentive for example). Third, pricing policies can decrease prices of energy saving behaviour options in comparison to other energy behaviour (higher tax for fossil fuel energy).

The tree structure in Figure 4.2 shows the different types of intervention strategies. This structure has been developed with use of the previous paragraphs of this chapter. Besides this the owner-residents-panel (Vereniging Eigen Huis, 2009) has been used to complete the structure.

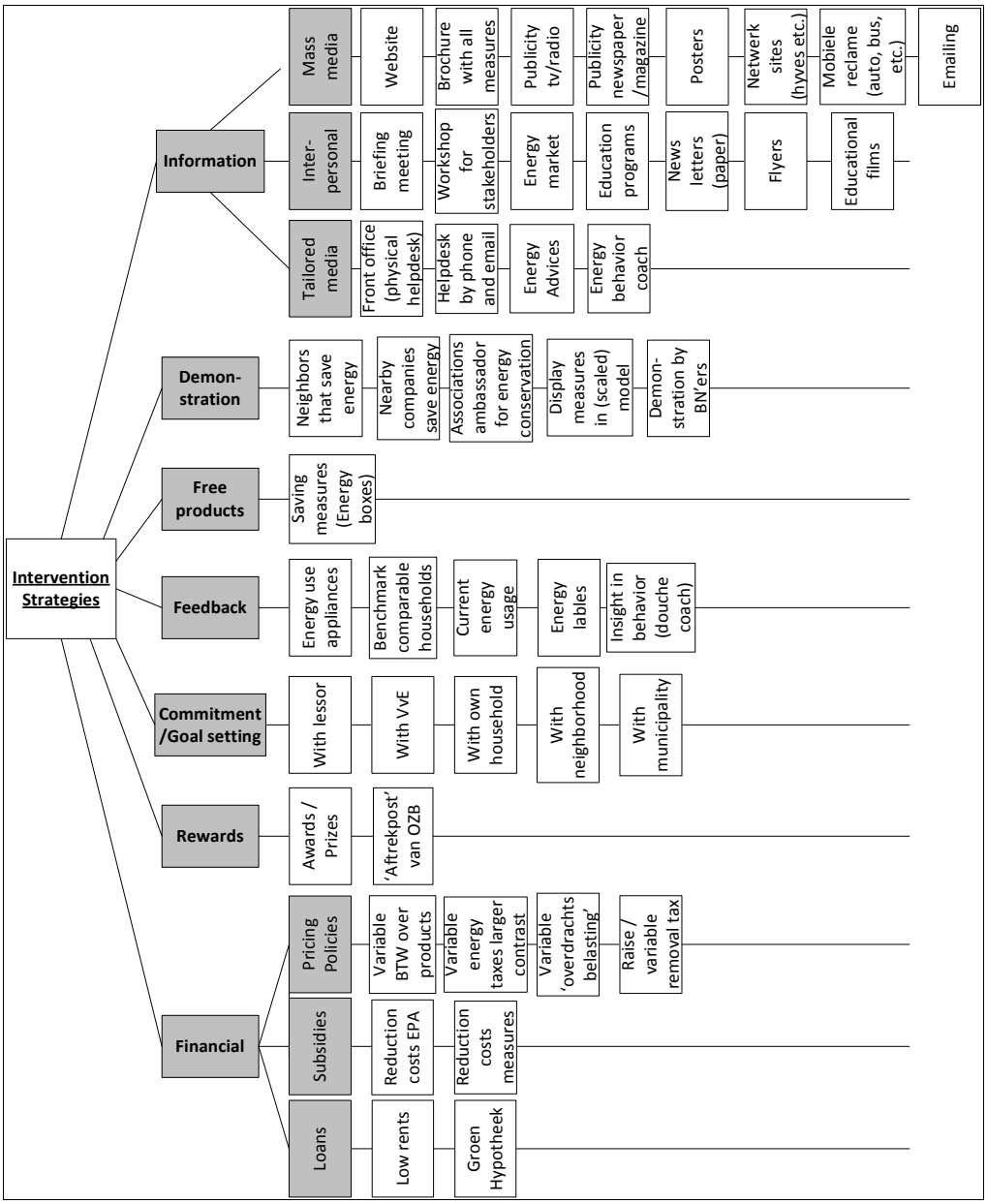


Figure 4.2: Tree structure of all possible intervention strategies

4.5 Energy saving behaviour model

There are multiple papers about behaviour models with causal relations between factors and behaviour. The MOA-model is often used and it visualizes the theory of reasoned action (Ajzen and Fishbein, 1980). According to this model, behaviour is caused by three main influence factors (motivation, ability and opportunity). Motivation includes beliefs, attitudes, intention and social norms. Habits and knowledge are part of the ability factor. Another behaviour model concentrates on the behaviour of energy consumers in houses. This model includes socio-demographic factors and housing characteristics as individual influence factors on the energy aware behaviour and the energy consumption (van de Maele-Vaernewijck et al., 1980). Certain aspects of this model overlap with the Value-Belief-Norm (VBN) theory model. The VBN theory is a causal chain leading to different types of environmental behaviour. The model consists of different variables (Stern, 2000):

- Personal values (altruistic, egoistic and traditional);
- Three types of beliefs (ecological worldview about human-environmental relation, the consequences for individuals caused by this human-environmental relation, and the perceived ability to reduce the threats);
- Personal norms for pro-environmental action.

These variables lead to different types of environmental behaviour. The most relevant type of behaviour in this research is the 'Private-Sphere Behaviour'. Private-Sphere Environmentalism is about the purchase, use and disposal of personal and household products that have environmental impact. According to Stern this type of behaviour is mainly caused by personal capabilities such as literacy, social status, and financial resources.

The simplest and most obvious model is a socio-psychological framework including a flowchart with four phases of behaviour: to know, to want, to be able to, and to do (Nationale DenkTank, 2009). This flowchart is based on the AIDA funnel model developed by E. St. Elmo Lewis in 1898 (www.provenmodels.com, 2010). Visualizations of both models can be found in Appendix 2. It seems like the flowchart indicates causality between the earlier and later phases. However, it appeared that there is only a faint correlation between the phases 'to know' and 'to do' (Uitdenbogerd, 2007).

Since no perfect fit of existing behaviour models for this research is found, the various existing models that are described above are merged to create the energy saving behaviour model in Figure 4.3. The model consist of both macro-level or contextual factors and micro-level factors. Because of its clearness the socio-psychological framework by the 'Nationale DenkTank' will be followed to show the micro-level factors. However, the model should not be visualized as a strict flowchart since the phases are not strictly passed through. In addition, also the socio-demographic factors and housing characteristics should be included in the model like in the behaviour model of van de Maele-Vaernewijck et al. To have a good oversight in the different possibilities to intervene in the energy behaviour process the intervention strategies as described in the previous paragraph are included in the model.

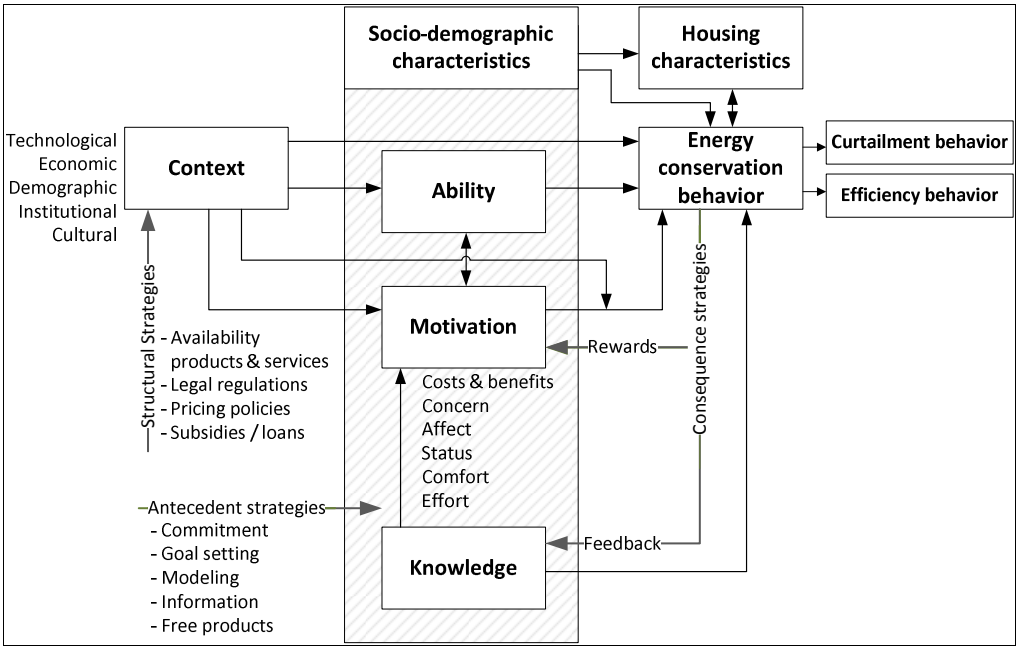


Figure 4.3: Energy saving behaviour model

In the energy saving behaviour model the influence factors of energy saving behaviour and the intervention strategies are shown. The relations between different factors are indicated by arrows. There is no beginning in this model since behaviour does not result from one particular process through successive phases. Therefore a factor can have different arrows (and relations with different other factors). Since socio-demographic characteristics influence all three psychological variables it is shown as a layer below the factors knowledge, motivation and ability. These characteristics form the restrictions of the box in which the psychological factors can develop. The antecedent strategies intervene in this box and influence the psychological factors.

4.6 Conclusion

Two categories of energy use can be distinguished, namely house related energy use and appliances related (or user bound) energy use. There are also two different types of energy saving behaviours. Investment behaviour is about the increase of energy-quality of houses. Curtailment behaviour is about the decrease of energy usage by behavioural changes.

Knowledge, motivations and ability are the most important factors that influence household energy saving. Besides these micro-level factors, energy savings are also dependent on socio-demographic factors such as income. These factors serve as barriers or opportunities for saving energy. There are seven types of intervention strategies that can be used to urge people to save energy. These intervention strategies seize on the different influence factors.

Part 2: Field research

Chapter 5: Focus field research

In this chapter the subject of the research, its expected output and the variables that determine this output are discussed.

5.1 Problem focus

The participation of residents is required to save energy to realise the energy neutral target. Although 82% of the Dutch energy consumers are convinced that it is important to save energy, the current yearly saving rate of 0,01% is far below the desired and required rate of saving of 2% to meet the energy targets (Nationale DenkTank 2009). Therefore the problem focus can be stated as follows:

In spite of all efforts currently taken to urge residents to save energy, the energy saving rate is still far below the required rate.

This problem can be investigated by executing field research. The main research question is:

How can residents in the existing housing stock in Eindhoven be urged to save energy?

In my opinion diverse groups of residents should be approached differently. The hypothesis is that:

Multiple segments of residents should be distinguished that have different preferences for intervention strategies to be urged to save energy.

5.2 Research Goal

The output of the field research enables the assessment of different methods to urge residents in the existing housing stock of Eindhoven to reduce their energy usage. The goal of the field research is to investigate what kind of policy (combination of intervention strategies) is sufficient to urge residents to save energy.

Besides the assessment of the intervention strategies the relations between different factors in the energy saving behaviour model will be investigated. The following relations are important:

- Relation between micro-level factors and energy saving behaviour;
- Relation between ability, motivation, knowledge and socio-demographic factors;
- Relation between socio-demographic factors, housing characteristics and energy saving behaviour.

5.3 Variables for the survey

The quality of the assessment is dependent on the completeness of the variables of the field research. Five types of variables derived from the previous chapter. These variables are visualized in the energy saving behaviour model in Figure 4.3. Below the variables that need to be examined are listed:

- *Socio-demographic factors* (age, education, income, household composition, activities daytime);
- *Housing characteristics* (ownership, type, year of construction, settlement time, insulation, energy label);

- *Micro-level factors*:
    - *Ability* (financial ability);
    - *Motivation* (concern, effort, comfort, attitude);
    - *Knowledge* (energy problems, saving measures, advantages saving, people that have taken measures to save energy);
- *Context* (financial, technological, institutional, and cultural aspects);
- *Intervention strategies* (see Figure 4.2);
- *Energy saving behaviour* (see Table 5.1).

Table 5.1: Categories of saving energy (VROM, 2009a; Arkel et al., 1999; Nuon 2010)

	Investment behaviour	**Curtailment behaviour**
House related energy use	Constructional measures Method of heating Efficient lightning	Heating behaviour Method and degree of ventilation Use of heated water
Appliances related energy use	Purchase appliances with high energy efficient labels	Degree of stand-by usage Location appliances (refrigerator not directly next to heating system) Efficient usage appliances

5.4 Conclusion

In spite of all efforts currently taken to urge residents to reduce their energy usage, the energy saving is still far below the required saving rate. The main question in the field research is therefore: How can residents in the existing housing stock in Eindhoven be urged to save energy? The hypothesis is that multiple segments of residents can be distinguished with different preferences for intervention strategies to be urged to save energy.

Chapter 6: Research methodology

The previous chapter attended to the problem that in spite of all efforts currently taken, the energy saving rate is still limited and that research about intervention strategies is required. To enable the assessment of different intervention strategies the execution of a survey is required to get the data about the preferences for specific intervention strategies of the residents of Eindhoven. In this chapter the design of the survey is elaborated.

6.1 Questionnaire

A survey-research is the best method to investigate the many required aspects. In this research a one-moment survey is sufficient to explore relations between the different aspects. The survey consist of a choice experiment to assess the main intervention strategies (see Figure 4.2), and other questions that are related to the aspects of the energy saving behaviour model (see Figure 4.3).

The questions deal with the topics as described in Paragraph 5.3 (variables of the survey). The questionnaire is quite extensive. In total the questionnaire contains 45 questions. Therefore, each question is carefully rated for its importance in this research. For example, questions about gender, health, nationality, amount of gas and electricity use per year are excluded. In Figure 6.1 an example of how questions are presented to respondents.

Knowledge

Hoe vaak komt u de volgende zaken tegen (in gesprekken met kennissen, in de media, op uw werk / studie, etc.)?

	Nooit	Soms	Vaak
Milieuproblemen door winnen, verwerken en transporteren van fossiele brandstoffen (olie, gas, kolen etc.)	◯	◯	◯
Schaarser worden van fossiele brandstoffen	◯	◯	◯
(politieke) Onzekerheid rondom de levering van fossiele brandstoffen	◯	◯	◯
Klimaatverandering	◯	◯	◯
Maatregelen om energie te besparen	◯	◯	◯
Voordelen energiebesparing voor de samenleving	◯	◯	◯
Voordelen energiebesparing voor individuele huishoudens	◯	◯	◯

Figure 6.1: Layout of knowledge questions in the questionnaire

To test the questionnaire for its clarity and ambiguity the questionnaire was presented to about 20 test respondents. Due to their comments unclear questions were excluded from the survey, for example the questions about lifestyle. Other questions were adjusted to be less ambiguous. Also the presentation of the choice sets of the experiment is improved with help of the test respondents.

The questionnaire is made in de program Surveymonkey. This program is quite adequate for the development of such large questionnaires. An important advantage of this program is the opportunity to select how the output should be generated. One can choose whether the output should be generated as numeric values or as actual text of the values.

6.2 Conjoint choice experiment

In the survey a choice experiment is included to assess the intervention strategies. As stated in Paragraph 4.4 the main intervention strategies are:

- Information
- Demonstration
- Free products
- Feedback
- Commitment with goal
- Rewards
- Financial support

With use of an experiment the demand for these methods by the residents of Eindhoven can be investigated.

6.2.1 Conjoint choice experiment method

A stated a conjoint choice experiment is a suitable method to use to assess the intervention strategies. A stated choice experiment is an integration of the conventional conjoint analysis method and the probabilistic discrete choice demonstration method. In this way the best features of both methods are combined and the shortcomings removed (Oppewal; Timmermans, 1993).

Conjoint choice experiments are based on the assumption that preferences can be defined by presenting alternatives according to certain 'profiles' (Meys, 2008). These profiles consist of certain attributes, in this case the intervention strategies. The respondents make actual choices between the alternatives and select a profile that best reflects their preferences. Respondents can also choose a base alternative when none of the other choice sets is attractive enough to be selected (Kemperman, 2000).

There are certain important motives to use a stated choice experiment instead of using self-explicated methods or revealed choice methods for example. Using surveys to collect data is much more efficient than revealed choice methods since only one choice per respondent is observed in revealed choice methods. In stated choice experiments much more choices can be observed per respondent.

In self-explicated methods respondents indicate with use of a rating scale how attractive specific alternatives are. Although this method has practical advantages the respondents' judgment for alternatives turned out to be unreliable. The main cause for this is the fact that people are not forced to weigh the alternatives against one another (Oppewal; Timmermans, 1993). Besides this it appears to be easier for respondents to choose between alternatives than to judge each alternative separately.

6.2.2 Experiment design

The design of the experiment is constructed with attributes; in this case the seven intervention strategies. Each attribute has two levels about whether or not it is present in the choice set. A full factorial design contains descriptions of all possible combinations of attribute levels. Therefore, it enables to estimate all main effects and all interaction effects of each attribute. Interaction effects occur when the combined occurrence of attributes gives an extra positive or negative effect to an alternative's utility. The size of a full factorial design in this experiment is 2^7 alternatives. The full amount of possibilities (128) is too large to entirely include in the survey. Therefore the design is created more efficiently with use of fractional factorial designs (Montgomery, 1984).

In this research a design with 64 trials has been used. These trials are combined in choice sets with two alternatives to make the choice as clear and uncomplicated as possible for the respondents. In addition, there are many other questions in the survey besides the choice sets. Therefore the experiment is split and each respondent makes four choices. Hence, there are eight questionnaires that differ from one another in choice sets. In Appendix 3 the actual design of the conjoint choice experiment can be found. The profiles are randomly distributed over the questionnaires. In the design in Appendix 3 the attributes that are in a curtain profile are marked with a one. The attributes that are not in that curtain profile are marked with a zero.

In the questionnaire the profiles are presented to respondents as in Figure 6.2.

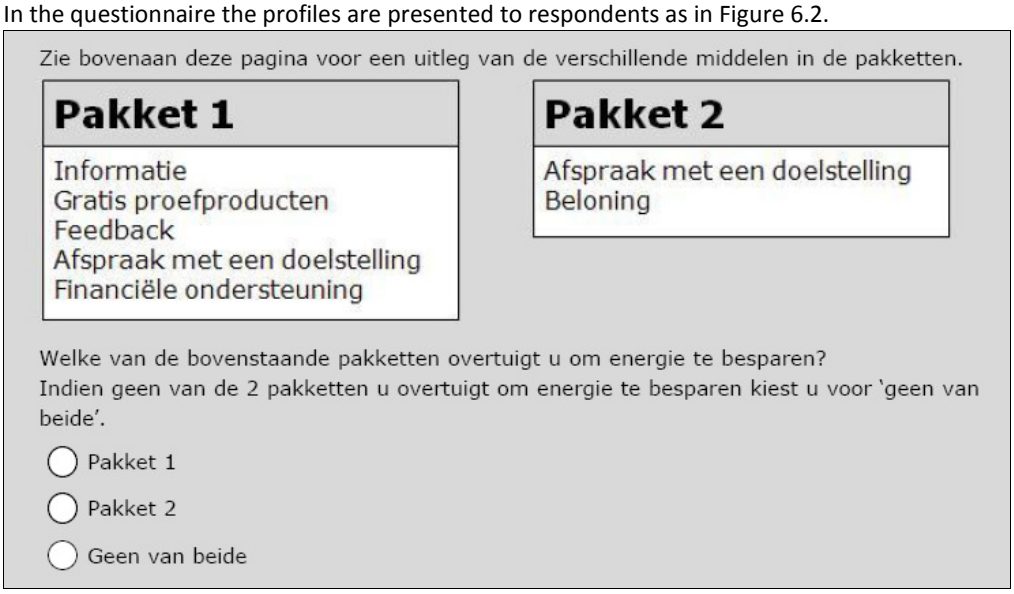


Figure 6.2: Layout of the choice experiment in the questionnaire

6.2.3 Analysis techniques experiment

To obtain the best manageable data from the internet survey program the response is downloaded in a spreadsheet with numeric values. The data that is collected in the survey enables the discovering of relations between preferences for intervention strategies and personal characteristics. Besides this the relations between the aspects in the energy saving behaviour model can be analysed. There are certain analysis methods to evaluate the output of the conjoint choice experiment.

Random utility theory

The choice behaviour of the respondents for the attributes can be analysed with help of the random utility theory. This theory assumes that the utility (U_i) for a profile consists of a systematic component (V_i) and a random error component (ε_i). The utility for a certain alternative *i* is expressed as follows (Kemperman, 2000):

$$U_i = V_i + \varepsilon_i$$

Each alternative is based on different attributes. Therefore, the utility for an alternative is the summation of the utilities of the attributes. In this research the formula for the utility of a certain profile can be expressed as follows:

$$U_i = \beta_0 + \beta_{\inf} \cdot \chi_{\inf} + \beta_{dem} \cdot \chi_{dem} + \beta_{prod} \cdot \chi_{prod} + \beta_{feedb} \cdot \chi_{feedb} + \beta_{comm} \cdot \chi_{comm} + \beta_{rew} \cdot \chi_{rew} + \beta_{fin} \cdot \chi_{fin} + \varepsilon_i$$

In this formula the β_i coefficients are the parameter values of the attributes. The X_i values in the formula are the levels of the attributes (whether or not the attribute is included in the profile or not). In this research the X_i can get 0 or 1.

Multinomial logit model

The multinomial logit model elaborates the random utility theory and is the most widely applied model to predict the probability that a choice alternative will be chosen. This model is based on the assumption that respondents choose the alternative with the highest utility (Ortúzar and Willumsen, 2001). This model takes into account that a natural fluctuation can occur when respondents make choices. The probability that an alternative will be chosen can be calculated with the following formula:

$$P(i \setminus A) = \frac{e^{(\mu \cdot V_i)}}{\sum_{j \in A} e^{\left(\mu \cdot V_j\right)}}$$

In this formula the μ is a scalar quantity known as the Gumbel scale factor (Kemperman, 2000).

Latent class model

With help of the latent class model, the difference in preferences for intervention strategies of the respondents can be investigated. This model enables the assessment of the hypothesis as stated in Paragraph 5.1.

Goodness of fit
The likelihood ratio (ρ^2) is a common measurement to calculate the goodness of fit of choice models. ρ^2 indicates how well the used model the observed choices estimates in comparison with a 'zero' model. The formula to calculate the value of ρ^2 is:

$$\rho^2 = 1 - \frac{\log(\beta_i)}{\log(\beta_0)}$$

In this formula LogL is the loglikelihood. This value indicates the conformity between the observed and the predicted choice behaviour. The LogL(β_0) is based on a model in which the probability that an alternative is chosen is equal. LogL(β_i) is based on a model that calculates the choice probabilities of alternatives dependent on parameters (Meys, 2008). In general, a model with a ρ^2 value above 0,2 is considered well fit (Meys, 2008).

Program LIMDEP
The choice behaviour of respondents can be calculated with use of the program LIMDEP, also known as NLogit. LIMDEP is a specialized program for econometric analysis, written by Professor William H. Greene (Yaffee, 2002). The program automatically calculates performance values (Rho^2) aside the coefficients of the attributes.

6.3 Sample

To enable the most valid data the surveys were distributed with help from the department of information and research (Bureau Informatie en Onderzoek) of the municipality of Eindhoven. Since the research is about saving energy in households, the survey has been distributed to a sample of all households in Eindhoven that suit the sample frame. Every head of a household in this sample received a letter with a request to participate in the research. An example of this letter can be found in Appendix 5. The boundaries of the sample frame are:

- Head of household is between 19 and 79 years old;
- Household is settled in a house (houseboats, caravans and institutions are excluded);
- Less than nine persons on one address;
- Secret addresses are excluded.

Almost 86.000 households remained when these boundaries were put on the data set with information about all households in Eindhoven. Since it is likely that not all responses are usable as output of the survey for analysis the sample size aims for 500 respondents. The department of information and research usually obtain about 30% response in a timeframe of three weeks. Therefore the sample size is about 1.500 households. The sample is randomly chosen and more information about the sample can be found in Appendix 5.

In Table A5.2 in Appendix 5 can be found that in total 1.515 households were selected. This sample was selected from addresses that were listed in 2000 in Eindhoven. Since 2000 some residents in this sample moved to other addresses or died. Hence, 1.480 letters were actually sent to residents.

6.4 Data collection

The questionnaire is presented online to respondents since this method is administrative and cost efficient. Residents that were selected in the sample received a postal invitation letter. It was not possible to send the residents in the sample an email with a direct link to the survey on the internet. Therefore, residents had to fill in the link on the internet. Since the response of the first sample was about 10%, a request for participation in this research was send by email to 99 acquaintances in Eindhoven. These emails contained a direct link to the surveys.

6.4.1 Response

In Table 6.1 the response characteristics per questionnaire are given. The average valid amount of response per questionnaire is about 21. However, there is a gap between the response on questionnaire six (15) and seven (27). And the percentage of 'email' responses on questionnaire 8 (62%) differs a lot from questionnaire five (10%).

Table 6.1: Respondents per questionnaire

Questionnaire	Total	Total valid	# email	% email	# letter	% letter
1	20	19	4	21%	15	79%
2	21	20	8	40%	12	60%
3	26	25	6	24%	19	76%
4	21	18	3	17%	15	83%
5	21	20	2	10%	18	90%
6	20	15	2	13%	13	87%
7	27	27	5	19%	22	81%
8	28	26	16	62%	10	38%
Total	**184**	**170**	**46**	**27%**	**124**	**73%**

In Table 6.2 the characteristics of the response is listed. In total 184 respondents filled in the questionnaires. 170 responses were valid to use in the choice experiment. 46 of these responses were delivered by respondents that received an invitation to participate in the research by email. 83% of all respondents filled in the total survey (152 of 184). More information and characteristics of the respondents such as income, age, degree of education type of housing can be found in Appendix 5.

Table 6.2: Characteristics of respondents

Respondents that:	Amount	Percentage
Received postal invitation	1.480	-
Received invitation per email	99	-
Started a questionnaire	184	11,7%
Delivered valid response for experiment	170	10,8%
Answered total survey	152	9,6%

6.5 Conclusion

In this research a one-moment survey with an online questionnaire has been used including a conjoint choice experiment to assess the preferences for specific intervention strategies. Conjoint choice experiments are based on the assumption that preferences can be defined by presenting alternatives according to certain 'profiles'. These profiles consist of attributes, in this research the seven intervention strategies. The response rate of the online survey was about 11%. Both participation invitations by letter and email are included in this rate. 9% of all responses were fully answered.

The random utility theory has been used to analyze the output of the conjoint choice experiment. The multinomial logit model is an elaboration of the random utility theory. This model predicts the probability that a choice alternative will be chosen. The latent class model can be used to investigate the difference in preferences for intervention strategies of respondents. To validate these models the likelihood ratio, ρ^2, has been used. The program LIMDEP calculates both the coefficients of the attributes (intervention strategies) according to the used models and the performance values (Rho^2 of these models).

In this chapter the design of the survey, the data collection and the analysis methods are elaborated. In the next chapter the output of the survey are investigated and the results are presented.

Chapter 7: Results field research

This chapter elaborates the results of the field research. The adjustment of the energy saving behaviour model is discussed and the general levels of respondents on certain factors in this model are discussed as well. People's preferences for the intervention strategies and the characteristics of the different segments of residents are also elaborated in this chapter.

7.1 Adjustment energy saving behaviour model

The energy saving behaviour model (see Figure 4.3) can be tested with the output of the survey. Since the questionnaire in this research was very large, the first step to analyze the output of the survey is to reduce the amount of data variables. In SPSS the factor analysis tool constructs new factors based on correlations between the original data variables. Using the rotation method the factors are profiled against each other to provide the clearest differentiation between the factors (Nooij, 1995). There are five types of variables in the energy saving behaviour model in Figure 4.3 that can be investigated with factor analysis (context, knowledge, motivation, investment behaviour and curtailment behaviour).

In the questionnaire, respondents answered to what extent they experience obstruction by contextual aspects. Two contextual factors are found using factor analysis. The first factor is about governmental regulation and public opinion and the second factor is about the experienced possibility (money and technological possibilities of products) to save energy.

Context, knowledge and motivation appeared to consist of two factors each. The two types of energy saving behaviour (curtailment behaviour and investment behaviour) both consist of five factors. In Figure 7.1 the adjusted energy saving behaviour model is shown including these factors. In Appendix 6 more detailed information of the factor analysis can be found.

Besides the refinement of the influence factors in the model, the relations between these factors can also be tested with the output of the survey. In Appendix 7 a model with all significant relations can be found.

Comparing Figure 7.1 and the model in Appendix 7 some remarks can be made. Firstly, the output of the survey confirms all relations between the factors as pictured in Figure 7.1. Extra relations are found between the factors of context and knowledge and context and socio-demographic characteristics of respondents. These relations were not expected since the context (governmental regulation etc.) is equal for everyone. However, respondents were asked about how they experience the obstruction by contextual aspects. Apparently, how people experience their context is related to their knowledge and socio-demographic characteristics.

As shown in Figure 7.1 the contextual factors also influence the relation between motivation and energy saving behaviour. However, only relations between factors can be tested with the output of the survey. Therefore, the influence on a relation between factors cannot be tested.

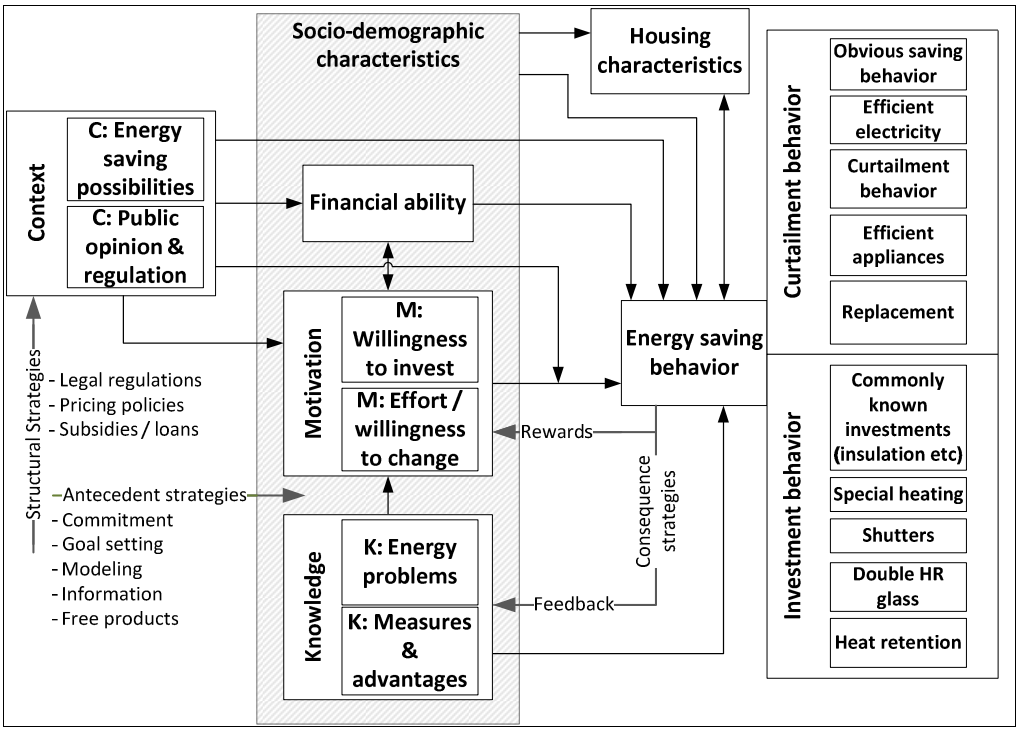


Figure 7.1: Adjusted energy saving behaviour model

7.2 General factor levels of respondents

Using the output of the survey the levels of the factors that influence the energy saving behaviour of residents can be calculated. In Figure 7.2 the current levels on the following factors can be found:

- Knowledge of energy problems;
- Knowledge of measures and advantages;
- Willingness to invest in saving energy;
- Willingness to change behaviour;
- Experienced contextual obstruction in terms of money and technology;
- Experienced contextual obstruction by governmental regulation and public opinion.

These levels indicate the current level of residents on these factors. For example, only 20% of the respondents claim to have a very high level of knowledge about energy problems. In addition, 20% of the residents claim to have a very low knowledge level of the advantages and measures of saving energy. Respondents do not have a very high motivation at all to invest or put more effort to save energy. The level of current energy saving behaviour of respondents can also be calculated using the output of the survey (see Figure 7.3). In general none of the curtailment behaviour factors are currently done to a very high level.

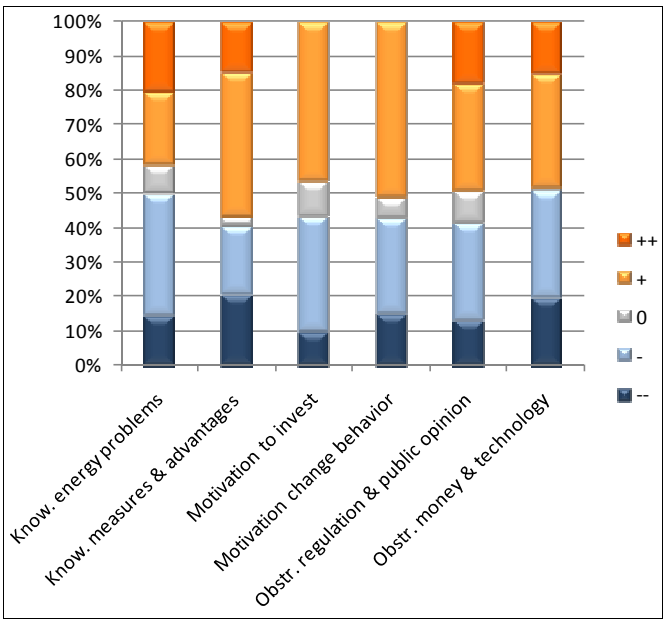


Figure 7.2: Factor levels of respondents

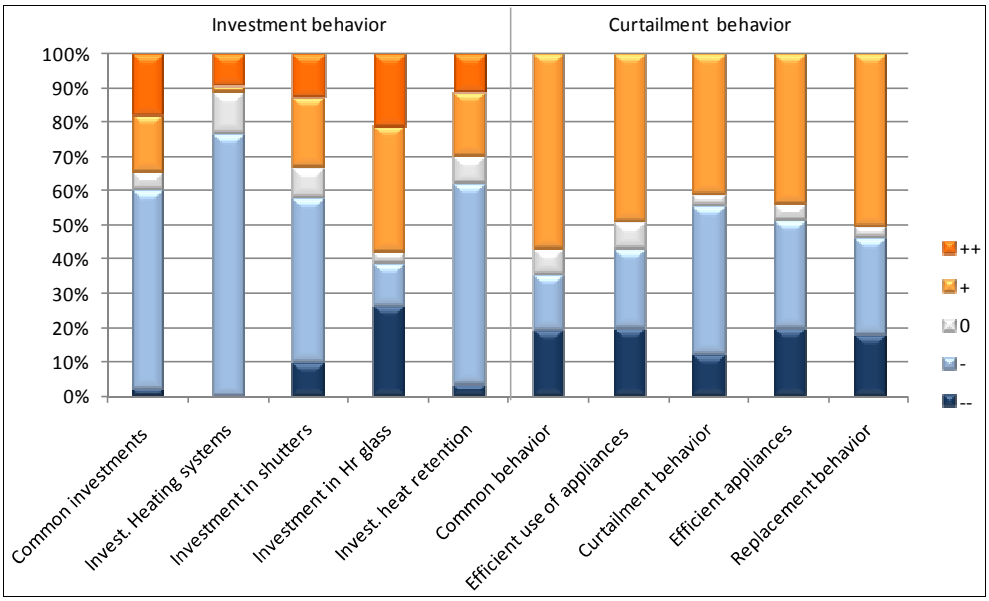


Figure 7.3: Level of current energy saving behaviour respondents

7.3 Preferences for intervention strategies

In Figure 7.1 the intervention strategies are pictured as well. These intervention strategies are assessed with the program LIMDEP in which the respondents' choices for specific packages of intervention strategies are imported.

In Figure 7.4 the average preference of residents in the sample for the intervention strategies according to the multinomial logit model is pictured. The figure shows that rewarding energy saving behaviour is preferred, directly followed by financial support like subsidies. Not all intervention strategies are in demand. Averagely residents have a slight dislike for commitment for example.

As shown in Figure 4.2 there are a lot of subtypes of the seven main intervention strategies. In Appendix 8 the preference for subtypes of intervention strategies are shown. Subsidies and variable tax over added value (VAT) are preferred as financial methods. Regarding demonstration residents prefer demonstration by neighbours the most followed by a model house that displays possible measures. Residents prefer feedback about their actual energy use the most and the averagely most preferred information method is a website. Residents averagely dislike making commitments in general, and commitments with their own households are therefore preferred the most in this category.

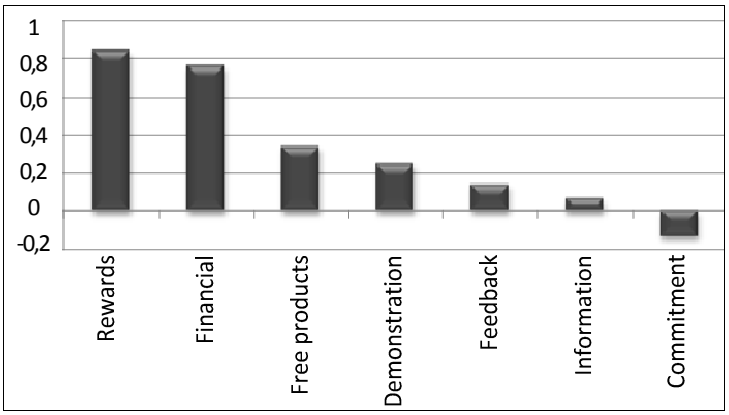


Figure 7.4: Preference according to multinomial logit model

As discussed in Paragraph 6.2.3 the likelihood ratio (Rho^2) indicates the goodness of fit of a model. The ρ^2 of the multinomial logit model (0,108) is below 0,2. Therefore, the multinomial model is not optimally suitable to represent the preferences for the intervention strategies. This low goodness of fit value can be caused by:

- Respondents do not have high preferences for the alternatives;
- Respondents have conflicting preferences for the alternatives;
- Respondents cannot picture the alternatives to oneself;
- It is too difficult for the respondents to recognize the differences between the alternatives.

The second cause corresponds with the hypothesis at the start of this research that not all residents have the same needs regarding support for energy saving. Analysis with the latent class model will enable further elaboration of the preferences for intervention strategies of residents.

7.4 Segments of residents

In Appendix 9 the output of the latent class model can be found. It appeared that three segments of respondents can be distinguished. Segment one covers about 65%, segment two covers about 15% and segment three covers about 20% of the total respondents. The likelihood ratio of the latent class model is 0,2533. Therefore, using different segments of people is much better to represent the preferences of residents for the intervention strategies.

In Figure 7.5 the importance of the intervention strategies for the three segments is pictured. The residents in segment one prefer the intervention strategies free products, rewards and financial support. Although the residents in segment two prefer financial support as well, information and demonstration are more important to them. Feedback is the 4th intervention strategy that is important to segment two. However, residents in segment two dislike the other intervention strategies. Residents in segment three do not have a clear preference or dislike for any of the intervention strategies. Rewarding energy saving behaviour is the most important intervention strategy for them and they dislike demonstration the most.

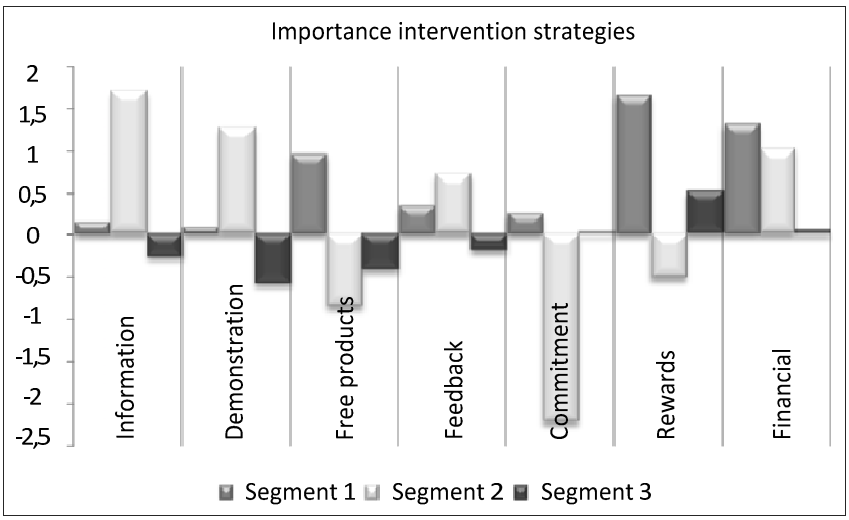


Figure 7.5: Importance intervention strategies per segment

Since the groups differ in their preferences for intervention strategies it is important to investigate whether or not the groups possess different characteristics. This is tested in the program SPSS. The significant characteristics are listed in Table 7.1.

	Segment 1	Segment 2	Segment 3
Age groups	27-46	27-35 and 47-59	47-59 and > 59
Knowledge of energy problems	Not low or high	High	Low
Experienced obstruction by regulation and opinions of acquaintances	Not low or high	Low	High
Current time of settlement	Many 2-5 Little > 10	Many <2	Many > 10 Little < 2
Investment in HR glass	High	Low	Very low
Daytime activities: Work ≥ 12 hours per week	Many do	-	Many do not

Table 7.1: Characteristics of three segments of respondents

In Figure 7.6 the importance for the segments of significant subtypes of intervention strategies are pictured.

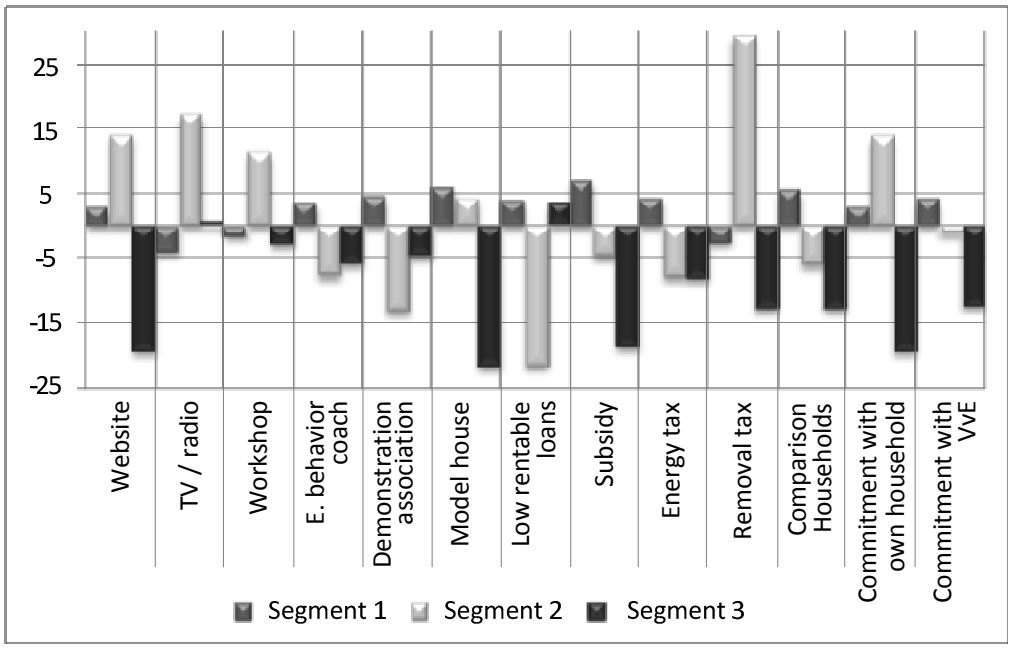


Figure 7.6: Preference intervention strategies per segment

7.4.1 Segment one: Financially focused residents

Residents in this segment are mainly about 30 till 40 years old and do not have low or high knowledge about energy problems. The degree of education in this group is averagely distributed in this segment and the main daytime activity of the residents is work for more than 12 hours per week. Residents in this segment do not experience high or low obstruction by governmental regulation and public opinion to save energy. These residents mainly live in their

houses for about two till five years and very little residents in this segment live in their houses for more than 10 years. They basically invest in energy efficiency to save money. This segment scores high on the investment in HR glass while the other segments score low. This probably has to do with the fact that there is a lot of financial support like the subsidy on investment in double glass (subsidie-dubbel-glas.nl).

This group can best be informed through a website and advices from an energy behaviour coach (see Figure 7.6). These residents dislike information through TV and radio publicity and workshops. Residents in this group favour the demonstration of saving energy by model houses and (sport) associations that invest in energy saving. This group favours feedback in terms of the comparison to similar households. According to residents in this segment, agreements about energy saving can best be made with the association of owners and peoples' own households. The financial support by low rentable loans and subsidies is desired by the residents in this group. These residents dislike raising the removal tax on energy inefficient appliances.

7.4.2 Segment two: Conscious residents

Averagely people in segment two have a high level of knowledge about the energy problems and do not experience obstruction by governmental regulation and public opinion. It seems as if this segment represents the 'innovators' and 'early adopters' of the diffusion curve in Figure 3.1.

Furthermore, this segment is more focused on their own energy use. For example, feedback is listed as an effective incentive for this segment. However, feedback in terms of comparison with other households is not favoured in this segment. The residents in this group are both younger than 35 and older than 59. The main settlement time is very short (less than two years). Residents in segment two save energy mainly to save money. Residents in segment two prefer websites, publicity by TV and radio and workshops as methods to get informed. A higher removal tax on energy inefficient appliances is highly preferred by residents in segment two.

7.4.3 Segment three: Older residents

Averagely residents in this segment are older than in the other segments. The weight in this segment is on the age group older than 59 years old. Their knowledge of energy problems is low and they experience a high degree of obstruction by governmental regulation and public opinion. There are many residents in this group that live in their houses for more than 10 years. Many residents in this segment do not work for more than 12 hours per week. The score for investment in HR glass in this segment is very low.

Residents in this segment averagely dislike almost all intervention strategies that are pictured in Figure 7.6. Only the low rent loan scores slightly positive. Mostly due to the high average age in this group these residents cannot be urged to save energy.

7.5 Conclusion

The output of the survey generally confirms the energy saving behaviour model as developed in Figure 4.3. With use of factor analysis the influence factors of the model are refined and the relations between the factors are tested and confirmed. Only 20% of the respondents claim to have a very high level of level of knowledge about energy problems. These residents do not have a very high motivation at all to invest or put more effort to save energy. In general none of the curtailment behaviour factors are currently executed to a very high level.

Using multiple groups is better to represent the preferences of residents for the intervention strategies. Residents in each segment have other preferences for intervention strategies and other personal characteristics such as age, knowledge of energy problems and experienced obstruction by legal regulation and public opinion. The strategy to urge residents to save energy should be focused on the segments.

Part 3: Conclusion

Chapter 8: Conclusion

In this chapter the results of the research will be reviewed for its fit for answering the main research question:

How can residents of Eindhoven be urged to save energy?

The conclusions are based on the governmental framework, literature on energy saving behaviour and the survey.

8.1 Energy saving behaviour model

The energy saving behaviour model in Figure 4.3 derived from the literature about energy saving behaviour. Currently, there are various behaviour models developed in other researches. However, it appeared that none of the models combine macro and micro level aspects, personal characteristics and a description of relations between these factors. The adjusted model in Figure 7.1 is a refinement of the model derived from the literature and consists of more detailed factors. The output of the survey confirms the relations between the factors in the model (see Appendix 7).

In this way the developed model (Figure 7.1) merges multiple existing behaviour models to enable more insight in the specific energy saving behaviour of people. In the developed model the socio-demographic characteristics of people are identified as a layer for the micro level factors (knowledge, motivation and financial ability). This layer of socio-demographic characteristics functions to set the boundaries for the micro level factors such as knowledge, motivation and the ability of people.

In the literature, some models are pictured as flowcharts. However, since the factors in the model are not sequentially related it is obvious that the model should not look like a sequential flowchart. This is the most striking difference with some of the existing behaviour models (for example the AIDA model by E. St. Lewis, developed in 1898). Although these models are pictured as flowcharts, they agree with the statement that the factors are not sequentially related.

Therefore, the energy saving behaviour model developed in this research (Figure 7.1) adds a clear and specific oversight in the energy saving behaviour of people to the existing literature on this topic. With this model stakeholders like municipalities can easily get insight in the energy saving behaviour process of people.

8.2 Intervention strategies

In the literature, different types of intervention strategies are distinguished. The tree structure in Figure 4.2 contains certain intervention strategies. The seven main intervention strategies are derived from the literature:

- Information
- Demonstration
- Free products

- Feedback
- Commitment with goal
- Rewards
- Financial support

These main intervention strategies are the possible strategies to intervene in a behaviour process. The tree structure in Figure 4.2 has been developed since an oversight of all possible intervention strategies did not exist yet in the literature. The results of the survey indicate that financial focused incentives are preferred in general. This is consistent with the statement in the literature that policy is accepted better when freedom of choice is enlarged instead of limited. The financially focused incentives such as rewards, financial support and free products rather enlarge people's freedom of choice.

8.3 Focus intervention policy on segments

As discussed in Paragraph 7.2 it is best to distinguish three different segments of residents to represent the preferences for intervention strategies. Therefore, the municipality of Eindhoven should focus their policy to urge residents to save energy on these different segments. Besides different preferences for intervention strategies, the residents in these segments also possess different characteristics. The largest segment consists of residents that are highly financial focused. The second segment consists of residents that are aware of the need for saving energy. The residents in the last segment are averagely older and do not want to be bothered with energy saving.

The municipality of Eindhoven should focus their policy on two of the three groups. It is best not to focus on segment three since these people averagely cannot be urged to participate and save energy. Therefore, 80% of the residents of Eindhoven are sensitive for certain intervention strategies to save energy.

In Figures 7.4 and 7.5 the preferences of the different segments for intervention strategies and subtypes are pictured. These figures indicate that there are two methods that seem to be effective to some extent for both segments (feedback and providing information). Feedback on actual energy use, the use of appliances and energy behaviour is effective for these segments of residents. The effectiveness for providing energy consumers feedback on their energy use is confirmed by both literature and the output of this research. Additionally, the comparison with similar households is very useful for segment one, while segment two dislikes this type of feedback. Both segments one and two are also sensitive for receiving information through websites and energy performance advisers. Below the optimal policies for the segments are described.

8.3.1 Residents that are financially focused

Figure 7.5 indicates that segment one (65% of the residents) is highly sensitive for *rewards*. Rewarding people when they save energy positively influences their motivation to continue saving energy (see also Figure 7.1). However, as said before in Paragraph 4.5, effects on

motivation by rewarding are short-lived. Shortly after the rewards stop, the effect will fade away. This should be taken into account when residents are urged using this method.

A *subsidy is* a very good incentive to urge residents in segment one to invest in the energy-quality of their houses. Less VAT (BTW) for energy efficient products is also highly preferred in this segment. However, this is an incentive that can only be given by the national government. Derived from this, the municipality can urge residents in segment one using a discount on the real estate value (WOZ-waarde) for houses with a high quality in terms of energy.

Providing residents in segment one *free products* is another effective intervention strategy. This method influences both knowledge and motivation of people. Usually, these products are small test examples of different energy saving behaviour categories. Showering coaches (curtailment behaviour), sockets with on/off switches (efficient use of appliances), crack sealing material (commonly known investments) and heat reflection material for behind radiators (heat retention). Therefore, the method of providing residents free products is an incentive for energy saving behaviour in general instead of only the investment in commonly known measures.

Feedback is an additional intervention strategy that can be used to urge residents in segment one to invest in energy efficiency. Feedback is especially useful for residents in segment one when *similar households are compared* on their energy use. The ideas for Smart Meters (Slimme meters) in Eindhoven are very useful when both the actual use of households and the comparison to similar households can be provided.

8.3.2 Conscious residents

15% of the residents in Eindhoven cannot be urged with rewards, subsidies and free products. This segment of residents has a high knowledge level about energy problems (see Table 7.1). It seems as if they are eager for more information and examples about how other people save energy especially because they have more knowledge. These residents are aware of the energy problems and their own energy use but experience a lack of knowledge about their opportunities to save energy.

These residents are highly sensitive for information. The best methods to provide residents in this segment information are *websites*, *publicity on TV and radio* and through *workshops*. What should be taken into account with using websites and other communication tools is to adjust the information to the target group. Information should be provided very clear and unambiguous. It is remarkable that these subtypes of information do not agree with the assumption of the advisors of the municipality that residents are mainly in demand for tailored information.

Residents in segment two are also sensitive for demonstration of energy saving. *Demonstration by neighbours and acquaintances* and a *model house* with presented measures are good incentives. Demonstration by neighbours and acquaintances implies that residents present the measures they took in their houses to save energy to people they know. In a model house all

types of possible measures are presented and people can visit this house to get a real life experience with these measures.

Regarding the financial intervention strategy, residents in segment two highly prefer the adjustment of *removal tax* on appliances. In this way energy inefficient appliances will have higher removal taxes. Apparently these residents experience this incentive as a good opportunity to be urged to invest in energy efficient appliances.

Providing *feedback* to households is also a good incentive for residents in segment two. They prefer feedback on the actual energy use of households, their use of appliances and their energy behaviour. As can be seen in Figure 7.6 they do not prefer the comparison with similar households. This indicates that the conscious residents have an inward focus. This corresponds with the assumption that residents in segment two are the innovators and the early adopters (see Figure 3.1). The innovators mainly react on their own principles and the technological or other contextual innovations. One can expect that the majority is more outwardly focused and react on the behaviour of others.

8.3.3 Older residents

Averagely residents in this segment are older than in the other segments. Residents in this segment averagely dislike almost all intervention strategies. They do not want to be bothered with saving energy and they expect a loss of comfort with saving energy. In addition it is too much effort for them to save energy. However, housing corporations are perfect stakeholders to help these residents to be more energy efficient. Therefore, municipalities should focus to increase the quality of the houses of the older residents in terms of energy.

8.4 Effectiveness of current governmental policy

The strategy of the municipality of Eindhoven to realise the energy neutral target is based on the Trias Energetica. The first step of this strategy is to save energy. According to the roadmap of the strategy, saving energy in the existing housing stock contributes for 25% to the strategy (see Figure 3.2). Insulation and high efficient heating is 13,5% of this contribution and correspond to the commonly known investments in the survey. It appeared that only about 18% of the respondents highly invested in this type of improving the energy-quality of the houses (see Figure 7.3). The output of the survey indicates that this type of investments worth to focus the intervention policy on.

Special heating systems, that contribute for 9,9% to the strategy to realise the energy neutral target, are still rarely applied. Therefore, the relation model in Appendix 7 that has been developed in this research cannot be used to identify the most important influence factors for this type of investment. However, the preferences for intervention strategies of the different segments are expected to influence the investment in special heating systems as well.
Besides the current focus of the municipality to urge residents to invest in the energy-quality of their houses it is also possible to realise a significant reduction in energy use through curtailment behaviour. For example, 9% of the total gas usage can be saved through changes in heating behaviour (see Paragraph 3.3). From the results of the survey can be concluded that

residents do not save a lot of energy by changes in their behaviour yet. Therefore, it is interesting for the municipality of Eindhoven to add the focus on curtailment behaviour changes to the intervention policy for urging residents to save energy.

8.4.1 Review on current projects

Reviewing the projects that are currently executed in the municipality of Eindhoven to urge residents to save energy the following remarks can be made:
In the project 'Haal energie uit je wijk' the target group was averagely older than 50 years. Therefore, it can be expected that the project failed since these residents are part of segment three and do not want to be bothered with saving energy or any intervention strategies. Therefore, when projects are planned in the future, the personal characteristics of people should be taken into account (see Table 7.1).

The project 'Energie besparen en subsidies' was quite successful since a lot of residents visited the information meetings that were organized in this project. The output of the survey corresponds with this since information meetings are generally preferred. However, a refinement of the opinion about what residents desire (Paragraph 3.5) should be made. Certain advisers of the municipality indicated that there are three important activities that will urge residents to save energy (personal and direct informing, relieving effort and financial stimulation). However, this will only be effective for residents in segment one (see Figures 7.5 and 7.6). Residents in segment two prefer mass media tools such as websites and publicity by TV and radio more than advices from an energy behaviour coach for example. This is probably caused by the fact that these residents are more conscious of the problems and willing to put more effort in finding information about saving energy.

8.4.2 Support intervention policy municipality by national government

Despite all effort currently taken by the national government it appeared that the national government is not the right stakeholder to urge people to save energy. Local governments are more capable to urge residents since they have much more insight in the playing field of all stakeholders in their municipalities. However, the national government can support the intervention policy of municipalities with legal regulation. The output of the survey confirms this and suggests that the VAT (BTW) of products should be adjusted. Especially financial regulations that directly affect people, such as energy tax and BTW, are worth to be reconsidered. Although the current tax system is tremendously complex and that it is very complicated to adjust certain aspects in this system, this is the best opportunity for the national government to support the intervention policy of the local governments.

8.5 Discussion

Three different segments of residents are distinguished and each group requires its own intervention strategies. One of the segments (20%) is not sensitive for any incentives. Feedback on actual energy use, the use of appliances and energy behaviour is effective for both other segments of residents. In addition, these segments are sensitive for receiving information through websites and energy performance advisers as well.

The largest segment of people (65%) contains residents that are financially focused. These residents can be urged to save energy with rewards, subsidies and free products. The other segment (15%) consists of conscious residents that have a high knowledge level about the energy problems. These residents require information, demonstration and feedback.

Combining the governmental framework with the strategy of the municipality of Eindhoven, the literature analysis about energy saving behaviour and the output of the survey provides enough information to get a clear insight in the energy saving behaviour process and how people can be urged to save energy.

Remarkable is that different segments of residents were found in this research that are in demand for different intervention strategies. This adds knowledge to the current literature that urging strategies should be focused on specific target groups, and which intervention strategies are effective for each segment. Therefore the lack of clarity in how residents can be urged to save energy is solved.

The respondents made choices among the intervention strategies in the conjoint choice experiment. However, to enable the shortest questionnaire as possible, the respondents only received $1/8^{th}$ part of the total experimental design. It is likely that this makes the differentiation between the segments of people less clear. This is the weakness of the research. With the second sample that is taken at the end of this research this problem is overcome. Though the output of the second sample is not used in this research due to the short timeframe, it can be used for further research.

Chapter 9: Evaluation

9.1 Product

The product of this research consists of the energy saving behaviour model, and the advice how residents in the different segments can be urged to save energy. The most important value of the energy saving behaviour model for municipalities is that it creates a clear insight in the behaviour process of energy consumers and different strategies to intervene in this behaviour process. The advice how to urge residents in the segments makes the results of this research concrete and useful in practice. Unfortunately there are some weaker aspects in this research. The characteristics of the respondents are not equally distributed over the characteristics of residents in Eindhoven. For example, since about 80% of the respondents have a high degree of education this characteristic cannot be related properly to the different segments.

9.2 Process

In general I learned a lot about the actual execution of a large research. Starting from the general theme 'Eindhoven energy neutral', I choose the topic of saving energy by households.
This is very important since the strategy of the municipality of Eindhoven depends for such a great deal on it. With this topic I learned a lot about behaviour processes that broadened the knowledge I gained during my study. I sometimes wondered whether or not students from psychology related studies are more qualified for executing this research. However, many articles about the energy saving behaviour called for integration with experts from the work field of construction. In addition, I learned a lot about this type of research. It was very interesting to use conjoint choice experiments and now I know better which type of experimental design I can use for which type of research. Besides this I have more insight in how the municipality of Eindhoven is organized and I have more feeling with how things are done in such organizations.

The largest problem I run into during this research is the relative long timeframe of executing a quantitative field research. Without the samples that are done with help from the municipality the results of the research would not be as clear as they are. However, it lasted five weeks between the first contact with the municipality to set out the assignment for the sample and the actual distribution of letters to the residents in the sample. After this in three weeks all responses of the first sample were collected. Since the amount of respondents was far less than what the experts from the department of the municipality expected a request to fill in my questionnaire was send by email to 99 acquaintances in Eindhoven. In the same time, I requested for another sample at the municipality. Due to activities for the election in June it took another four weeks until the residents in this sample received an invitation letter to participate in the research. By then it was no longer possible to add and use these respondents in the analysis.

9.3 Recommendation for further research

This research can be seen as a basis for further research. In further research the segments as found in this research can be distinguished clearer using the output of the second sample. Perhaps even more segments can be found. In addition future researches can be focused on one

of the three types of ownership (private ownership, private rental housing and rental housing by housing corporations). Besides that it would be interesting to investigate whether or not differences can be found between municipalities. I can imagine that municipalities in urban areas should focus their strategies to urge residents to save energy differently than municipalities in rural areas. Finally, it would be interesting to execute a survey to investigate whether or not residents actually save energy when the incentives are focused on the target groups.

9.4 Recommendation to municipality Eindhoven

Based on this research six recommendations can be given to the municipality of Eindhoven:

1. Know your energy savers
2. Give households feedback
3. Provide residents knowledge
4. Focus intervention projects on segments
5. Adjust projects to segments using characteristics
6. Add curtailment behaviour in the roadmap

Especially for the municipality of Eindhoven a brochure is made in which these recommendations are elaborated in Dutch. In Appendix 10 the text of this brochure can be found.

List of Abbreviations

VNG	Vereniging van Nederlandse Gemeentes	Association of Dutch Municipalities	5
VROM	Ministerie van Verkeer, Ruimtelijke Ordening & Milieu	Ministry of Housing, Spatial Planning and the Environment	13
SER	Sociaal-Economische Raad	Social-Economic Counsil	14
MMM	Meer Met Minder	More with Less	15
PeGO	Platform energietransitie Gebouwde Omgeving	Platform energy transition build environment	21
VBN	Value-Belief-Norm		26
SPSS	Statistical Package for the Social Sciences (Analysis software)		41
VAT	Value Added Tax	Belasting Toegevoegde Waarde (BTW)	44

List of Figures

List of Tables

References

Publications:

Aarts, H.; Verplanken, B.; van Knippenberg, A. (1998) Predicting behaviour from actions in the past: repeated decision making or a matter of habit?, Journal of Applied Social Psychology, 28, 1355-1374

Abrahamse, W. (2007) Energy saving through behavioural change: Examining the effectiveness of a tailor-made approach, State University Groningen

Abrahamse, W.; Steg, L.; Vlek, C.; Rothengatter, T. (2005) A review of intervention studies aimed at household energy saving, Journal of Environmental Psychology 25 (273-291)

Abrahamse; W., Steg, L. (2009) How do socio-demographic and psychological factors relate to households' direct and indirect energy use and savings?, Journal of Economic Psychology 30 (711-720)

Ajzen, I.; Fishbein, M. (1980) Understanding attitudes and predicting social behaviour, Englewood Cliffs, NJ: Prentice-Hall in Ölander, F.; Thøgersen, J. (1995) Understanding of Consumer Behaviour as a prerequisite for Environmental Protection, Journal of Consumer Policy 18: 345-385

Ajzen, I. (1999) The Theory of Planned Behaviour, organizational behaviour and human decision processes 50, 179-211

van Arkel, W.G.; Jeeninga, H.; Menkveld, M.; Ruig, G.J. (1999) Energieverbruik van gebouwgebonden energiefuncties in woningen en utiliteitsgebouwen

Baarda, D.B.; de Goede, P.M. (2006) Basisboek methoden en technieken, Noordhoff Uitgevers B.V.

de Bruijne, B. (2010) Adviseur Communicatie, Gemeente Eindhoven, interview at March 11th 2010

BuildDesk Benelux B.V. (2009a) Routekaart naar een energieneutraal Eindhoven: Gemeente Eindhoven op weg naar energieneutraliteit

BuildDesk Benelux B.V. (2009b) Notitie kostenindicatie energieneutraliteit

Caféin (2009) Caféin Projectplan

CE Delft (2009) Energieprestatie-eisen bestaande woningen: verkenning van economische en juridische haalbaarheid

CE Delft (2006) Energiebesparingsgedrag: verkenning t.b.v. Algemene Energie Raad

Gemeente Eindhoven (2002) Eindrapportage Klimaatbeleid, Beleidsnota klimaat "van energiebesparing naar klimaat beleid" 2003-2007

Gemeente Eindhoven (2008a) Uitvoeringsprogramma klimaatbeleid 2009-2012: Van succesvolle projecten naar structurele uitvoering, 2008

Gemeente Eindhoven (2009a) Sector Control-Internal control, Een energieneutrale gemeente kost nog veel energie

Gemeente Eindhoven (2009b) Sector Gebiedsontwikkeling, Programma Wonen 2010-2015, met een doorkijk naar 2020

Gemeente Eindhoven (2009c) Plan van aanpak communicatie Meer met Minder Pilot 'Energie besparen in je wijk'

Gemeente Groningen (2007) Routekaart Groningen Energieneutraal+ 2025

Heijs, W. (1999) Huishoudelijk energiegebruik: gewoontegedrag en interventiemogelijkheden, i.o.v. Novem b.v., Faculteit Technologie Management, Technische Universiteit Eindhoven

van der Klauw; M. (2009) W/E adviseurs, Handreikingen voor duurzaam bouwen aan gemeenten

Ketelaers, J. (2010) interview with Adviseur Duurzaam Bouwen, Afdeling Milieu, gemeente Eindhoven, interview at March 3th 2010

Kemperman, A.D.A.M. (2000) Temporal aspects of theme park choice behaviour: modelling variety seeking, seasonality and diversification to support theme park planning, Eindhoven: Technische Universiteit Eindhoven

van de Maele-Vaernewijck, M.C.L.; van Raaij, W.F.; Verhallen, Th.M.M. (1980) Energiegedrag in de woning: literatuuroverzicht en gedragsmodel, i.o.v. Ministerie van VROM

Meys, F. (2008) Particulier opdrachtgeverschap in beeld, beeldregie bij particulier opdrachtgeverschap in de woningbouw, afstudeerverslag, Technische Universiteit Eindhoven

Motivaction (2009) Topline onderzoeksplan Kronehoef Eindhoven

Montgomery, D.C. (1984) Design and Analysis of Experiments, 2nd edition, John Wiley and Sons, New York in Kemperman, A.D.A.M. (2000) Temporal aspects of theme park choice behaviour: modelling variety seeking, seasonality and diversification to support theme park planning, Eindhoven: Technische Universiteit Eindhoven

Nationale DenkTank (2009) Energie in beweging, Adviezen om consumenten aan te zetten tot energiebesparing

Nooij, A.T.J. (1995) Variabelen en modellen: Multivariate analyse in het sociaal-wetenschappelijk onderzoek, Amsterdam: Boom

Nuon (2010) Energie besparen: Tips voor een lagere energierekening, at www.nuonenergiebesparen.nl consulted in March 2010

Oppewal, H.; Timmermans, H.J.P. (1993) Conjuncte keuze experimenten: achtergronden, theorie, toepassingen en ontwikkelingen

Ortúzar, J.; Willumsen, L. (2001) Modelling transport, John Wiley & Sons Ltd, Chichester in Meys, F. (2008) Particulier opdrachtgeverschap in beeld, beeldregie bij particulier opdrachtgeverschap in de woningbouw, afstudeerverslag, Technische Universiteit Eindhoven

Ossokina, I.; Verkade, E. (2006) Demografische ontwikkelingen en de woningmarkt in de grote steden, Centraal Plan Bureau

PeGO (2002) Een innovatieplan energie-efficiency nieuwbouw en renovatie, basisonderzoek elektriciteitsverbruik kleinverbruikers 2000, rapport EnergieNed

PeGO; EnergieNed; Bouwend Nederland; UNETO-VNI; Aedes (2007) Meer met Minder

Provincie Noord-Brabant (2009) Masterplan energie 2009-2020: Energiebeleid als economische en ecologische kans

Ramsoender-de Klerk, K. (2010) interview with Senior Adviseur Beleid, Wonen Wijken & Integratie, Ministerie van Volkshuisvesting, Ruimtelijke Ordening & Milieu, interview on April 7th 2010, see Appendix 1

Rogers, E.M. (1962) Diffusion of Innovations, New York, 1962 at http://en.wikipedia.org/wiki/Diffusion_of_innovations consulted in May 2010

SER (2008) Advies Energie & Innovatie: Brabant Energieneutraal als economische kans, aanbevelingen voor de regionale agenda

Silvertand, V. (2010) Political spearhead of the city of Eindhoven: Sustainablility and Climate Policy, Presentation, March 27th 2010

Simon, H. (2006) Models of man: social and rational, Wiley New York, 1957 in CE Delft, Energiebesparingsgedrag: verkenning t.b.v. Algemene Energie Raad

Steg, L. (2008) Promoting household energy saving, Energy Policy 36 (4449-4453)

Steg, L.; Vlek, C. (2009) Encouraging pro-enviornmental behaviour: An integrative review and research agenda, Journal of Enviornmental Psychology 29 (309-317)

Stern, P.C. (1999) Information, Incentives, and Proenvironmental Consumer Behaviour, Journal of Consumer Policy 22, pp. 461-478

Stern, P.C. (2000) Toward a Coherent Theory of Environmentally Significant Behaviour, Journal of Social Issues, Vol. 56, No. 3, pp. 407-424

Stern, P.C.; Dietz, T.; Abel, T.; Guagnano, G.A.; Kalof, L. (1999) A Value-Belief-Norm Theory of support for social movements: the case of envirionmentalism, Human Ecology Review, Vol. 6, No. 2

Telos (2008) Energiek Brabant

Uitdenbogerd, D. (2007) Energy and Households: the acceptance of energy reduction options in relation to the performance and organization of household activities, Maastricht: Dossertation in Nationale DenkTank (2009) Energie in beweging, Adviezen om consumenten aan te zetten tot energiebesparing

Vereniging Eigen Huis (2009) EigenHuisPanel, VROM – energie

VNG; SenterNovem (2007) Klimaat op de Kaart: 30 voorbeelden van gemeentelijk klimaatbeleid om zo toe te passen

VROM (2007) Schoon en Zuinig: Nieuwe energie voor het klimaat

VROM (2009a) Energiegedrag in de woning: Aanknopingspunten voor de vermindering van het energiegebruik in de woningvoorraad

VROM (2009b) Kernpublicatie WoON Energie 2006

W/E adviseurs (2009a) Eindrapport Implementatietraject “Naar een duurzame voorraad”

W/E adviseurs (2009b) Kwaliteit in bouwen en wonen: Plan van Aanpak – periode 2009-2012

W/E adviseurs (2009c) Stevige ambities, Klare taal! Definiëring van doelstellingen en middelen bij energieneutrale, CO2-neutrale of Klimaatneutrale projecten in de gebouwde omgeving, i.o.v. Platform energietransitie Gebouwde Omgeving

Yaffe, R.A. (2002) An Introduction to LIMDEP, Statistics, Social Science, and Mapping Group, Information Techonology Services, New York University

Consulted websites:

http://www.eindhoven.nl/inwonersplein/leefomgeving/milieu/duurzaam-eindhoven.html consulted in March 2010

www.energievergelijker.nl/energiebesparing-tips.html consulted in March 2010

www.kieskeurig.nl/cv-ketel/informatie consulted in April 2010

www.klimaatstraatfeest.nl/ consulted in March 2010

http://www.meermetminder.nl/ consulted in Februari - March 2010

http://www.milieucentraal.nl/pagina?onderwerp=Apparaten consulted in March 2010

http://www.provenmodels.com/547/aida-sales-funnel/elias-st.-elmo-lewis/ consulted in April/May 2010

www.stichtingmilieunet.nl/energiebespaartip.php consulted in March 2010

http://subsidie-dubbel-glas.nl/

Consulted experts:

Prof. dr. ir. B. (Bauke) de Vries, TU/e

Dr. ir. E.J.G. (Erik) Blokhuis, TU/e

Ir. I. (Ienke) de Vrieze, HetEnergieBureau B.V.

Drs. M. (Marianne) Gloudemans, HetEnergieBureau B.V.

Ing. F.L. (Floor) Ambachtsheer, HetEnergieBureau B.V.

J. (Jan) Bekkering, HetEnergieBureau B.V.

Drs. S. (Serge) van de Berg, HetEnergieBureau B.V.

B. (Birgit) de Bruijne, Adviseur communicatie, gemeente Eindhoven

M. (Marjorie) van Dooren, HetEnergieBureau B.V.

J. (Jeroen) van Gestel, HetEnergieBureau B.V.

Dr. Ir. A.D.A.M (Astrid) Kemperman, TU/e

J. (Joop) Ketelaers, Adviseur Duurzaam Bouwen, afdeling milieu, gemeente Eindhoven

Ing. M. (Miriam) van Oostveen, DGM, VROM

Ir. K.W. (Karen) Ramsoender-de Klerk, WWI, VROM

Ing. J.P.M. (Jan) van Rijen MSc., HetEnergieBureau B.V.

Drs. ir. J.M.P. (Jessie) van Rooij MBA MRICS, programmamanager woningbouwproductie, sector stadsontwikkeling, gemeente Eindhoven

Drs. V. (Vanessa) Silvertand, Programmamanager Duurzaamheid en Klimaatbeleid, gemeente Eindhoven

Ir. H. (Hans) Spronken, HetEnergieBureau B.V.

Drs. M.J.H. (Martijn) Teuwen, Bureau Beleidsinformatie en Onderzoek, gemeente Eindhoven

A. (Alfredo) Verboom, Duurzaamheid en bodemenergie, afdeling milieu, gemeente Eindhoven

Appendices

Appendix 1: Interview senior advisor policy VROM/WWI

Karen Ramsoender-de Klerk
Locatie Ministerie van VROM, Den Haag
Woensdag 7 april 2010
Doel van het interview is meer inzicht krijgen in wat er speelt bij het ministerie van VROM en de nationale overheid m.b.t. energie transitie en de energie neutraal ambities van gemeentes.

Wat houdt de functie van adviseur beleid in?
Als adviseur beleid maak je de vertaalslag van de huidige stand van zaken in de gebouwde omgeving naar de doelstellingen in beleidsprogramma's zoals 'Schoon en Zuinig'.

Hoe gaat het met de uitvoering van 'Schoon en Zuinig'?
Toen het beleid van 'Schoon en Zuinig' werd opgesteld was er sprake van een economische hoog conjunctuur. Hierdoor was er al een maatschappelijke beweging op gang gekomen. Door de crisis stagneerde deze maatschappelijke beweging en werden er middelen ingezet door de nationale overheid als het programma 'Meer met Minder'.

Wat zijn de resultaten van dit programma?
De laatste evaluatie van 'Meer met Minder' laat zien dat de gebouwde omgeving niet de doelen gaat halen zoals die in 'Schoon en Zuinig' staan. Dit komt doordat investeringen niet of nauwelijks meer gedaan worden. Op dit moment zijn het vooral de woningcorporaties die veel aan hun bezit kunnen doen omdat deze woningen vaak van erg slechte kwaliteit zijn. Maar daarna zullen de particuliere woningbezitters mee moeten gaan doen in de transitie en dat gebeurd nu maar met mondjesmaat.
Daarom zijn wij van mening dat een verplichtende norm noodzakelijk is de energetische kwaliteit van de woningvoorraad te verbeteren. De nationale overheid moet een voorwaarde scheppen voor verbetering, net zoals bij de 40 wijken aanpak.

Is verplichting noodzakelijk en heeft energie besparing stimuleren geen zin?
De nationale overheid heeft allerlei activiteiten uitgeprobeerd en is tot de conclusie gekomen dat ze nooit op dat schaalniveau kunnen komen wat nodig is om mensen te verleiden tot energiebesparing. Dat wil niet zeggen dat lokale overheden dit ook niet kunnen doen. Lokale overheden hebben veel meer overzicht wat er in hun gemeentes speelt en wie ze kunnen inzetten om mensen te verleiden tot energie besparing.

Welke verleidingsmethoden vindt u zelf een goed idee?
Ik heb ooit een boek gelezen van Marcel Burgers, Klanten zijn net mensen. Daarin werd de informatie driehoek besproken waarbij iemand als persoon bovenaan de piramide staat en daaronder allerlei niveaus van informatie middelen. Hoe lager het middel, hoe groter het schaalniveau waarop het werd ingezet maar hoe lager het effect van het middel. Het ambassadeurschap stond in dat model vlak onder de persoon boven aan de piramide. Dit is naar mijn mening een erg goed middel om mensen te verleiden om iets te doen. In de 40 wijken aanpak werden er op een gegeven moment allochtone vrouwen uit die wijken ingezet om met de inwoners te praten etc. Dit werkte erg goed.

Appendix 2: Experiment design

Quest.	Choice set	Profile	Inform	Demon-stration	Free products	Feedback	Commitment / Goal	Rewards	Financial support
1	1	52	1	1	1	0	0	1	0
1	1	17	0	1	0	0	0	0	0
1	1	Base	0	0	0	0	0	0	0
1	2	3	0	0	0	0	0	1	1
1	2	26	0	1	1	1	0	0	0
1	2	Base	0	0	0	0	0	0	0
1	3	47	1	0	0	1	1	1	1
1	3	58	1	1	1	1	0	0	0
1	3	Base	0	0	0	0	0	0	0
1	4	23	0	1	0	0	1	1	0
1	4	22	0	1	1	0	1	0	0
1	4	Base	0	0	0	0	0	0	0
2	5	46	1	0	1	1	1	0	1
2	5	7	0	0	0	0	1	1	0
2	5	Base	0	0	0	0	0	0	0
2	6	14	0	0	1	1	1	0	1
2	6	62	1	1	1	1	1	0	1
2	6	Base	0	0	0	0	0	0	0
2	7	42	1	0	1	1	0	0	0
2	7	44	1	0	1	1	0	1	1
2	7	Base	0	0	0	0	0	0	0
2	8	61	1	1	0	1	1	0	0
2	8	5	0	0	0	0	1	0	1
2	8	Base	0	0	0	0	0	0	0
3	9	50	1	1	1	0	0	0	1
3	9	31	0	1	0	1	1	1	1
3	9	Base	0	0	0	0	0	0	0
3	10	38	1	0	1	0	1	0	0
3	10	41	1	0	0	1	0	0	1
3	10	Base	0	0	0	0	0	0	0
3	11	13	0	0	0	1	1	0	0
3	11	11	0	0	0	1	0	1	0
3	11	Base	0	0	0	0	0	0	0
3	12	16	0	0	1	1	1	1	0
3	12	56	1	1	1	0	1	1	1
3	12	Base	0	0	0	0	0	0	0
4	13	15	0	0	0	1	1	1	1
4	13	48	1	0	1	1	1	1	0
4	13	Base	0	0	0	0	0	0	0
4	14	54	1	1	1	0	1	0	0
4	14	45	1	0	0	1	1	0	0
4	14	Base	0	0	0	0	0	0	0
4	15	34	1	0	1	0	0	0	1
4	15	24	0	1	1	0	1	1	1
4	15	Base	0	0	0	0	0	0	0
4	16	28	0	1	1	1	0	1	1
4	16	6	0	0	1	0	1	0	0

4	16	Base	0	0	0	0	0	0	0
5	17	18	0	1	1	0	0	0	1
5	17	1	0	0	0	0	0	0	0
5	17	Base	0	0	0	0	0	0	0
5	18	57	1	1	0	1	0	0	1
5	18	53	1	1	0	0	1	0	1
5	18	Base	0	0	0	0	0	0	0
5	19	59	1	1	0	1	0	1	0
5	19	63	1	1	0	1	1	1	1
5	19	Base	0	0	0	0	0	0	0
5	20	25	0	1	0	1	0	0	1
5	20	10	0	0	1	1	0	0	0
5	20	Base	0	0	0	0	0	0	0
6	21	19	0	1	0	0	0	1	1
6	21	55	1	1	0	0	1	1	0
6	21	Base	0	0	0	0	0	0	0
6	22	12	0	0	1	1	0	1	1
6	22	49	1	1	0	0	0	0	0
6	22	Base	0	0	0	0	0	0	0
6	23	29	0	1	0	1	1	0	0
6	23	40	1	0	1	0	1	1	1
6	23	Base	0	0	0	0	0	0	0
6	24	21	0	1	0	0	1	0	1
6	24	27	0	1	0	1	0	1	0
6	24	Base	0	0	0	0	0	0	0
7	25	2	0	0	1	0	0	0	1
7	25	33	1	0	0	0	0	0	0
7	25	Base	0	0	0	0	0	0	0
7	26	51	1	1	0	0	0	1	1
7	26	8	0	0	1	0	1	1	1
7	26	Base	0	0	0	0	0	0	0
7	27	30	0	1	1	1	1	0	1
7	27	39	1	0	0	0	1	1	0
7	27	Base	0	0	0	0	0	0	0
7	28	32	0	1	1	1	1	1	0
7	28	9	0	0	0	1	0	0	1
7	28	Base	0	0	0	0	0	0	0
8	29	64	1	1	1	1	1	1	0
8	29	60	1	1	1	1	0	1	1
8	29	Base	0	0	0	0	0	0	0
8	30	37	1	0	0	0	1	0	1
8	30	20	0	1	1	0	0	1	0
8	30	Base	0	0	0	0	0	0	0
8	31	4	0	0	1	0	0	1	0
8	31	35	1	0	0	0	0	1	1
8	31	Base	0	0	0	0	0	0	0
8	32	36	1	0	1	0	0	1	0
8	32	43	1	0	0	1	0	1	0
8	32	Base	0	0	0	0	0	0	0

Appendix 3: Invitation letter to participate in research

Geachte heer/mevrouw,

Gemeente Eindhoven is in samenwerking met de TU/e een onderzoek gestart naar de mogelijkheden om als gemeente energieneutraal te worden.

Gemeente Eindhoven heeft de ambitie uitgesproken om een energieneutrale stad te worden. Deze ambitie draagt eraan bij dat generaties na ons nog steeds prettig kunnen wonen, werken en leven in Eindhoven. Energieneutraal betekent dat alle energie die verbruikt wordt in de stad op een duurzame manier geproduceerd wordt. Het totale energiegebruik binnen de gemeente zal verminderd moeten worden om deze ambitie mogelijk te maken. In Eindhoven wordt 33% van het totaal aan energie gebruikt in woningen. Er valt dus heel veel winst te behalen wat betreft energiebesparing bij Eindhovense huishoudens.

Er zijn tal van mogelijkheden om energie te besparen. Gemeente Eindhoven is benieuwd waaraan inwoners het meest behoefte hebben en wat de gemeente het beste kan doen om inwoners te helpen.

Graag wil ik u uitnodigen om deel te nemen aan het onderzoek naar energiebesparing. U kunt de vragenlijst invullen door op internet naar de volgende site te gaan: **http://www.surveymonkey.com/s/energiebesparen6** en het volgende wachtwoord te gebruiken: **Energie 6**

Het beantwoorden van de vragen zal ongeveer 20 minuten in beslag nemen. Uiteraard zal uw privacy gewaarborgd blijven. Uw antwoorden zullen alleen gebruikt worden voor dit onderzoek. Tevens worden er geen gegevens verstrekt aan derden.

Als u de vragenlijst voor 1 juni 2010 invult dan maakt u kans op 1 van de 5 prijzenpakketten.

Bij voorbaat hartelijk dank voor uw medewerking.

Bezoekadres Stadhuisplein 10 Eindhoven
Openingstijden ma 9.00-19.00 uur
di t/m vr 9.00-16.00 uur
Bereikbaar per openbaar vervoer
met bus 1

Postadres Postbus 90150
5600 RB Eindhoven
Telefonisch bereikbaar
9.00-12.30 en 13.30-16.00 uur
Fax (040) 243 35 85

Appendix 4: Sample characteristics

City districts

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Stadsdeel Centrum	2807	3,3	3,3	3,3
	2 Stadsdeel Stratum	12748	14,8	14,8	18,1
	3 Stadsdeel Tongelre	8037	9,4	9,4	27,5
	4 Stadsdeel Woensel-Zuid	15122	17,6	17,6	45,1
	5 Stadsdeel Woensel-Noord	25315	29,5	29,5	74,5
	6 Stadsdeel Strijp	10927	12,7	12,7	87,2
	7 Stadsdeel Gestel	10961	12,8	12,8	100,0
	Total	85917	100,0	100,0	

Composition of Household

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Hoofd gezin (man/vrouw)	17238	20,1	20,1	20,1
	Hoofd gezin (man/vrouw/kind)	17259	20,1	20,1	40,2
	Ouder met kind(eren)	10120	11,8	11,8	51,9
	Alleenstaande	40611	47,3	47,3	99,2
	Hoofd partnerrelatie	499	0,6	0,6	99,8
	Hoofd huwelijk gelijk geslacht	190	0,2	0,2	100,0
	Total	85917	100,0	100,0	

Age groups

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18 - 24	2567	3,0	3,0	3,0
	25 - 39	26496	30,8	30,8	33,8
	40 - 54	25907	30,2	30,2	64,0
	55 - 64	14558	16,9	16,9	80,9
	65 - 74	11382	13,2	13,2	94,2
	75 - 84	5007	5,8	5,8	100,0
	Total	85917	100,0	100,0	

Amount of people per household

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	40611	47,3	47,3	47,3
	2	23393	27,2	27,2	74,5
	3	9887	11,5	11,5	86,0
	4	8966	10,4	10,4	96,4
	5	2485	2,9	2,9	99,3
	6	471	0,5	0,5	99,9
	7	87	0,1	0,1	100,0
	8	17	0,0	0,0	100,0
	Total	85917	100,0	100,0	

Tables A4.1: Characteristics population of Eindhoven (sample frame)

City districts

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Stadsdeel Centrum	49	3,2	3,2	3,2
	2 Stadsdeel Stratum	231	15,2	15,2	18,5
	3 Stadsdeel Tongelre	146	9,6	9,6	28,1
	4 Stadsdeel Woensel-Zuid	284	18,7	18,7	46,9
	5 Stadsdeel Woensel-Noord	435	28,7	28,7	75,6
	6 Stadsdeel Strijp	185	12,2	12,2	87,8
	7 Stadsdeel Gestel	185	12,2	12,2	100,0
	Total	1515	100,0	100,0	

Composition of households

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Hoofd gezin (man/vrouw)	293	19,3	19,3	19,3
	Hoofd gezin (man/vrouw/kind)	325	21,5	21,5	40,8
	Ouder met kind(eren)	173	11,4	11,4	52,2
	Alleenstaande	716	47,3	47,3	99,5
	Hoofd partnerrelatie	5	0,3	0,3	99,8
	Hoofd huwelijk gelijk geslacht	3	0,2	0,2	100,0
	Total	1515	100,0	100,0	

Age groups

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18 - 24	37	2,4	2,4	2,4
	25 - 39	486	32,1	32,1	34,5
	40 - 54	464	30,6	30,6	65,1
	55 - 64	258	17,0	17,0	82,2
	65 - 74	196	12,9	12,9	95,1
	75 - 84	74	4,9	4,9	100,0
	Total	1515	100,0	100,0	

Amount of people per household

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	716	47,3	47,3	47,3
	2	402	26,5	26,5	73,8
	3	178	11,7	11,7	85,5
	4	165	10,9	10,9	96,4
	5	42	2,8	2,8	99,2
	6	7	0,5	0,5	99,7
	7	4	0,3	0,3	99,9
	8	1	0,1	0,1	100,0
	Total	1515	100,0	100,0	

Tables A4.2: Characteristics actual sample

Appendix 5: Characteristics of respondents

Table A5.1: Age of respondents

Age groups (years)	Population (%)	Sample (%)	Respondents incl. mail (#)	Respondents incl. mail (%)	Respondents excl. mail (#)	Respondents excl. mail (%)
18 - 24	3,0%	2,4%	12	8,6%	3	2,7%
25 - 39	30,8%	32,1%	56	40,0%	38	27,1%
40 - 54	30,2%	30,6%	33	23,6%	31	22,1%
55 - 64	16,9%	17,0%	24	17,1%	24	17,1%
65 - 74	13,2%	12,9%	12	8,6%	12	8,6%
75 - 84	5,8%	4,9%	3	2,1%	3	2,1%
Total	100%	100%	140	100%	111	100%

Table A5.2: Composition of respondents' households

Composition households	Population (%)	Respondents incl. mail (#)	Respondents incl. mail (%)	Respondents excl. mail (#)	Respondents excl. mail (%)
1 person household	36%	33	24%	25	23%
1 parent family	6%	4	3%	4	4%
2 adults with children	22%	40	29%	35	32%
2 adults without childr	30%	54	39%	45	41%
Other	6%	9	6%	2	2%
Total	100%	140	100%	111	100%

Table A5.3: Respondents' degree of education

Degree of education	Respondents incl. mail (#)	Respondents incl. mail (%)	Respondents excl. mail (#)	Respondents excl. mail (%)
Geen	2	2%	2	1%
Basisonderwijs / lagere school	1	1%	1	1%
Lager/middelbaar voortgezet onderwijs	11	9%	10	7%
Hoger alg. voortgezet onderwijs	10	8%	9	6%
Lager beroepsonderwijs LBO	2	2%	2	1%
Middelbaar beroepsonderwijs MBO	17	14%	17	12%
HBO / WO	97	81%	70	50%
Total	140	100%	111	79%

Table A5.4: Income of respondents

Income	Respondents incl. mail (#)	Respondents incl. mail (%)	Respondents excl. mail (#)	Respondents excl. mail (%)
Less than €2.500,-	43	30,7%	27	24,3%
Between €2.500,- and €3.750,-	32	22,9%	27	24,3%
Between €3.750,- and €5.000,-	26	18,6%	25	22,5%
More than €5.000,-	25	17,9%	21	18,9%
No answer	14	10,0%	11	9,9%
Total	140	100%	111	100%

Table A5.5: Housing type of respondents

Housing type	Population (%)	Respondents incl. mail (#)	Respondents incl. mail (%)	Respondents excl. mail (#)	Respondents excl. mail (%)
Private owned house	43%	82	58,6%	72	64,9%
Privately rented house	57%	15	10,7%	5	4,5%
Rental house from housing corporation		43	30,7%	34	30,6%
Total	100%	140	100%	111	100%

Appendix 6: Factor analysis

Table A6.1: Factor analysis knowledge

	Energy problems	Measures & advantages
Knowing people that save energy	0,349	0,174
Climate change	0,610	0,420
Measures to save energy	0,879	0,081
Advantages for society	0,818	0,276
Advantages for individual households	0,865	0,140
Knowledge environmental problems caused by mining, moving and use fossil fuels	0,035	0,808
Knowledge of depletion of fossil fuels	0,423	0,684
Knowledge of uncertainty delivery fossil fuels	0,266	0,774

Table A6.2: Factor analysis motivation

	Importance, willingness to invest & change	Comfort, effort, willingness to change, use appliances efficient
Level of concern of environmental problems	0,406	0,406
Importance energy saving households	0,640	0,421
Willingness invest in energy-quality houses	0,697	-0,054
Willingness to change buying behaviour	0,756	0,107
Willingness to change behaviour in the house	0,475	0,514
Willingness to use appliances more efficient	0,244	0,692
Comfort	-0,311	0,667
Experienced effort to save energy	0,118	0,463

Table A6.3: Factor analysis context

	Public opinion & regulation	Possibilities saving
Obstruction by governmental regulation	0,787	0,039
Obstruction by opinion of acquaintances	0,792	-0,058
Obstruction by money	-0,264	0,751
Obstruction by technological possibilities	0,230	0,784

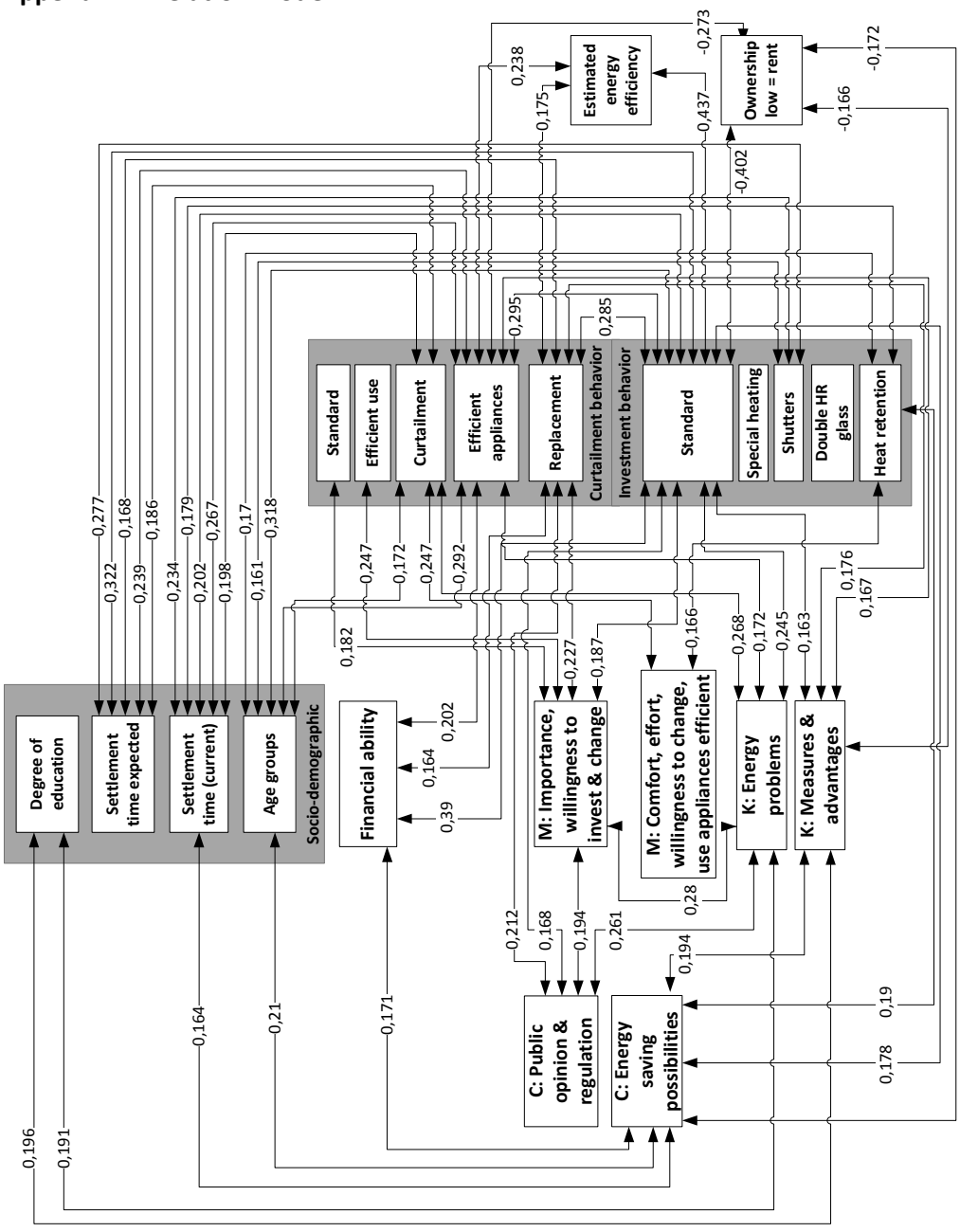
Table A6.4: Factor analysis investments energy-quality

	Standard	Special heating	Shutters	Double HR glass	Heat retention
Double glass	,243	-,020	,134	-,882	,057
Crack sealing	,414	-,076	,254	-,040	,396
Double glass HR	,459	,051	,298	,652	-,057
Façade insulation	,799	,086	,074	,043	-,175
Roof insulation	,693	-,009	,362	,072	-,143
Floor insulation	,852	,008	-,098	,063	-,031
Pipes insulation	,738	-,011	,101	-,136	,210
HR heating system	,588	,037	,358	-,122	,081
Low temp heating	,476	,246	-,413	,231	,109
Heat recovery system	,266	,667	-,169	,233	-,033
Solar heating system	-,062	,766	,088	-,067	-,049
Heating pump	-,028	,798	,012	-,026	,008
Shutters	,178	,104	,661	-,132	-,022
Cowl flap	,131	-,096	,649	,243	,179
Conversion windows	-,114	,004	,160	,027	,704
Heat reflection behind radiators	,036	-,034	-,124	-,078	,728

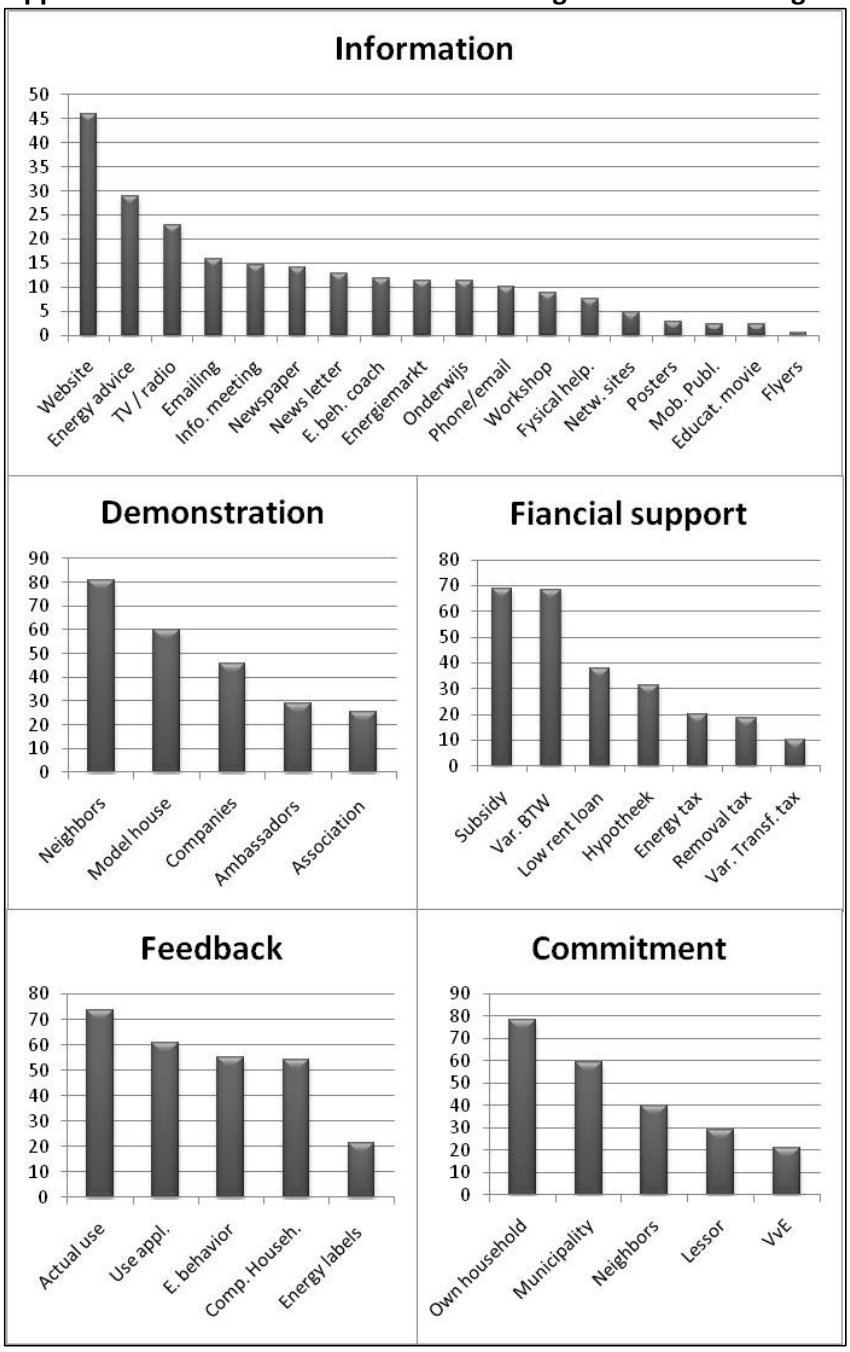
Table A6.5: Factor analysis curtailment behaviour

	Standard	Efficient use	Curtailment	Efficient appliances	Replacement
Lower temperature	,636	,049	,360	-,049	,101
Lights out when leaving room	,723	,084	,011	-,008	,129
Cooking with lid on pan	,560	,343	,037	,353	-,060
Dry laundry outside	,698	,134	,030	,201	-,043
Washing low temp, full drum	,469	,339	,099	,059	,263
Efficient location appliances	,166	,607	,186	,267	-,097
Socket with on/off switch	,019	,651	,390	-,271	,106
Removing adaptors from socket	,337	,516	-,017	-,092	,354
Thawing in fridge	,134	,669	-,041	,206	,058
Shower shorter	,023	,084	,830	,000	,068
Fridge/ freezer 1 degree warmer	,159	,121	,697	,256	,193
Water saving showerhead	,050	-,016	-,009	,819	,234
Thawing fridge and freezer	,243	,251	,298	,555	-,216
Replacement light bulbs	,284	-,131	,113	-,010	,734
Replacement energy inefficient appliances	-,120	,345	,161	,193	,672
Appliances out i.o. on standby	,203	,408	,363	-,075	-,011

Appendix 7: Relation model



Appendix 8: Preferences intervention strategies multinomial logit model



Appendix 9: Output latent class model

```
+---------------------------------------------+
| Latent Class Logit Model                    |
| Log likelihood function       -557.8123     |
| Number of parameters                26      |
| Restricted log likelihood     -747.0564     |
| McFadden Pseudo R-squared      .2533197     |
| Chi squared                    378.4881     |
| Prob[ChiSqd > value] =         .0000000     |
| R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj |
| No coefficients   -747.0564  .25332  .23877 |
| Constants only    -719.8082  .22505  .20995 |
| At start values   -666.4106  .16296  .14665 |
| Response data are given as ind. choice.     |
+---------------------------------------------+
| Number of latent classes =    3             |
| Average Class Probabilities .643 .149 .208  |
| ------------------------------------------- |
| LCM model with panel has 170 groups.        |
| Fixed number of obsrvs./group= 4            |
| Number of obs.=   680, skipped   0 bad obs. |
+---------------------------------------------+
+--------+--------------+----------------+--------+--------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]|
+--------+--------------+----------------+--------+--------+
---------+Utility parameters in latent class -->> 1
 CONST|1 |      .38784599       .43341959      .895   .3709
 INFORM|1|      .16636483       .20398949      .816   .4148
 VOORBE|1|      .09731492       .19271999      .505   .6136
 PROEFP|1|      .95574234       .19905547     4.801   .0000
 FEEDBA|1|      .34079261       .20564000     1.657   .0975
 AFSPRA|1|      .25262536       .20167425     1.253   .2103
 BELONI|1|     1.65362573       .22558986     7.330   .0000
 FINANC|1|     1.31340994       .18595453     7.063   .0000
---------+Utility parameters in latent class -->> 2
 CONST|2 |     -.03398940       .52217043     -.065   .9481
 INFORM|2|     1.69936526       .34036588     4.993   .0000
 VOORBE|2|     1.26934719       .42562468     2.982   .0029
 PROEFP|2|     -.85125291       .33175102    -2.566   .0103
 FEEDBA|2|      .72389646       .34544792     2.096   .0361
 AFSPRA|2|    -2.21805800       .39565008    -5.606   .0000
 BELONI|2|     -.50989460       .30508406    -1.671   .0947
 FINANC|2|     1.01977595       .29306912     3.480   .0005
---------+Utility parameters in latent class -->> 3
 CONST|3 |    -1.50795455       .40923640    -3.685   .0002
 INFORM|3|     -.25322857       .28054019     -.903   .3667
 VOORBE|3|     -.57343587       .31238931    -1.836   .0664
 PROEFP|3|     -.40952088       .29340661    -1.396   .1628
 FEEDBA|3|     -.18788681       .28946238     -.649   .5163
 AFSPRA|3|      .02533569       .26306355      .096   .9233
 BELONI|3|      .51560003       .29440051     1.751   .0799
 FINANC|3|      .05668434       .26352840      .215   .8297
---------+Estimated latent class probabilities
 PrbCls_1|      .64270989       .05926195    10.845   .0000
 PrbCls_2|      .14922987       .03736285     3.994   .0001
 PrbCls_3|      .20806024       .03372119     6.170   .0000
```

Appendix 10: Aanbevelingen aan gemeente Eindhoven

Energie besparende inwoners in gemeente Eindhoven

Veel gemeentes hebben energieambities uitgesproken. Het blijkt echter lastig om de ambities om te zetten naar concrete, succesvolle projecten en de ambities te realiseren. In deze folder staan enkele aanbevelingen op een rij die voortgekomen zijn uit een uitgebreid onderzoek naar hoe inwoners in Eindhoven aangezet kunnen worden tot meer energiebesparing.

1. Weet wie al energie bespaart

Het is essentieel dat de inwoners die al goed bezig zijn op het gebied van energiebesparing, bekend zijn bij de gemeente. Deze mensen kunnen ingezet worden als goede voorbeelden voor andere inwoners. Geef dus publiciteit aan wat deze mensen al doen aan energiebesparing en wat het hen oplevert.

2. Geef huishoudens inzicht in hun energieverbruik

Mensen hebben nu veel te weinig inzicht in hun energieverbruik. Maar ook bij de hoeveelheid energie die apparaten gebruiken en hun eigen 'energiegedrag' wordt niet stilgestaan. Daarom is de invoer van een feedbackmiddel als de 'slimme meter' een goede mogelijkheid om mensen te stimuleren om meer energie te besparen. Hierbij geldt dat hoe vaker feedback gegeven wordt, hoe meer effect het zal hebben. Van belang is dat op elk gewenst moment inzicht gegeven kan worden in zowel het totale energieverbruik van het huishouden; de hoeveelheid energie die verschillende apparaten gebruiken en het 'energiegedrag' van mensen. Tevens wil ongeveer 65% van de mensen erg graag een vergelijking kunnen maken met andere huishoudens wat betreft energiegebruik.

3. Voorzie mensen van voldoende kennis

Het kennisniveau van inwoners over de energieproblemen, voordelen van energiebesparing en de mogelijkheden die zij hebben om energie te besparen is niet erg hoog. Het verstrekken van informatie over deze onderwerpen is daarom belangrijk. 80% van de mensen geeft de voorkeur aan een website om meer informatie te verkrijgen. Zorg er wel voor dat deze website zeer duidelijk is. Vaak is een website inefficiënt door de kwantiteit van de informatie. Informatie over de volgende onderwerpen is nodig:

- Energieproblemen:
  - Milieuproblemen door winning, verwerking en vervoer van fossiele brandstoffen;
  - Onzekerheid van de levering van energie en afhankelijkheid van energieleveranciers);
  - Uitputting van fossiele brandstoffen;
  - Klimaatverandering;
- Voordelen van energiebesparing:
  - Voor de samenleving (verminderen van energieproblemen);
  - Voor individuele huishoudens (verlaging energiekosten);
- Maatregelen om energie te besparen:

- Investeringsgedrag (verbeteren van de energetische kwaliteit van de woning) zoals HR++ glas, gevelisolatie en reflectiemateriaal achter radiatoren;
- Energiebesparing door het aanpassen van eigen gedrag zoals vervanging van energie onzuinige apparaten, gebruik van standby-killers en een waterbesparende douchekop.

Op dit moment is de website van de gemeente Eindhoven erg gefragmenteerd. Het is aan te bevelen om alle onderwerpen te verzamelen en naar elkaar te verwijzen. Het is echter ook mogelijk om explicieter te verwijzen naar een andere website waar de onderwerpen wel goed besproken worden, zoals www.milieucentraal.nl. Deze website is erg bruikbaar om mensen te voorzien van informatie. Naast websites heeft 80% van de inwoners ook behoefte aan adviezen over de energieprestatie van hun woningen. Het al uitgevoerde project 'Haal energie uit je wijk' gaat hierop in. Jammer genoeg was dit project niet goed afgestemd op de doelgroep. De volgende aanbeveling gaat verder in op doelgroepen.

4. Focus energiebesparing stimuleringsprojecten op doelgroepen

Niet alle inwoners hebben dezelfde behoeftes en voorkeuren voor stimuleringsmiddelen voor energiebesparing. Globaal kan onderscheid gemaakt worden tussen drie groepen inwoners. De mensen in deze groepen hebben niet alleen verschillende voorkeuren voor stimuleringsmiddelen maar bezitten ook verschillende karakteristieken.

Mensen gericht op financiële aspecten

65% van alle inwoners hecht erg veel waarde aan financiële aspecten. Deze mensen zijn vooral gevoelig voor beloningen (als mensen daadwerkelijk energie besparen), subsidies en gratis proefproducten. De stimuleringsmiddelen beïnvloeden voornamelijk de motivatie van mensen om energie te besparen. Gratis proefproducten beïnvloeden zowel de motivatie als het kennisniveau van mensen. Normaal gesproken zijn het kleine testproducten van verschillende mogelijkheden voor energiebesparing zoals douchecoaches, stand-by killers, kierdichting materiaal en reflectiemateriaal voor achter radiatoren. Het uitdelen van gratis proefproducten is dan ook een stimuleringsmiddel dat niet alleen mensen stimuleert om te investeren in de energetische kwaliteit van hun woning maar ook om hun gedrag aan te passen.

Een goed voorbeeldproject om de financieel gerichte groep mensen aan te zetten tot energiebesparing is: 'Energiebesparing huishoudens' van de gemeente Utrecht. In dit project werden energieboxen uitgedeeld in combinatie met persoonlijke energie prestatie adviezen. De doelgroep in dit project bestond uit huishoudens met een laag inkomensniveau. Tegelijkertijd creëerde dit project re-integratie banen. Een vergelijkbaar project is later ook uitgevoerd in de gemeente Groningen.

Bewuste mensen

Ongeveer 15% van de mensen is zich meer bewust van het belang van energiebesparing. Ze hebben over het algemeen iets meer kennis van energieproblemen dan de vorige groep mensen. Deze mensen geven aan dat ze een erg grote behoefte hebben aan informatie over mogelijkheden om energie te besparen, het liefst met behulp van een duidelijke website, TV of radiopubliciteit en workshops. Daarnaast zijn ze gevoelig voor goede voorbeelden van hoe

anderen (kennissen, buren of familie) energie besparen. Daarnaast is een voorbeeldwoning een goed middel om deze mensen te stimuleren tot energiebesparing. De groep bewuste mensen wil ook erg graag meer inzicht krijgen in hun eigen energiegebruik, het verbruik van apparaten en hun energiegedrag (zoals stookgedrag). Echter, deze mensen zijn niet echt geïnteresseerd in een vergelijking met andere soortgelijke huishoudens. Financiële prikkels zoals subsidies en leningen met lage rentes lijken niet veel invloed te hebben op deze groep mensen.

Oudere mensen
Ongeveer 20% van de mensen wil liever niet lastig gevallen worden met het besparen van energie. Het is voor hen te veel moeite om hun gedrag aan te passen of hun woningen te gaan verbouwen. Om bij deze groep mensen toch energiebesparing te realiseren kunnen afspraken over energiebesparing gemaakt worden met de woningcorporaties gericht op de oudere huurders. De woningcorporaties kunnen de investeringen in de energetische kwaliteit van de woningen van deze huurders uitvoeren terwijl de mensen ontzorgd worden.

5. Gebruik doelgroep eigenschappen voor projectfocus

Bij het organiseren van projecten om mensen te stimuleren energie te besparen moet in de toekomst rekening gehouden worden met de verschillende doelgroepen. Deze doelgroepen kunnen aan de hand van de eigenschappen die in tabel 1 omschreven staan onderscheiden worden.

	Financiële focus	**Bewuste mensen**	**Oudere mensen**
Leeftijden	27-46	27-35 and 47-59	47-59 and > 59
Kennis van energieproblemen	Niet hoog of laag	Hoog	Laag
Ervaren belemmering door regelgeving en publieke opinie	Niet hoog of laag	Laag	Hoog
Huidige vestigingstijd (in jaren)	Veel 2-5 Weinig > 10	Veel <2	Veel > 10 Weinig < 2
Investeringen in HR++ glas tot nu toe	Veel	Weinig	Extreem weinig
Dagbesteding: Werk voor meer dan 12 uur per week	Veel wel	-	Veel niet

Tabel 1: Eigenschappen van groepen mensen

6. Voeg energiebesparing door gedragsverandering toe aan strategie

Op dit moment is de strategie van gemeente Eindhoven om het energieverbruik in de bestaande woningen met 90% te verminderen vooral gericht op de algemeen bekende investeringen in de woning (isolatie en HR verwarming). Het blijkt echter dat er nog een relatief groot besparingspotentieel is te halen door gedragsveranderingen. Zo blijkt dat 9% van het totaal aan gasgebruik verminderd kan worden door veranderingen in het stookgedrag. Het is daarom aan te bevelen dat energiebesparing door aanpassingen in gedrag toegevoegd wordt aan de strategie van gemeente Eindhoven om energiebesparing te realiseren bij huishoudens. Deze gedragsveranderingen kunnen gestimuleerd worden door bijvoorbeeld het verschaffen van informatie, feedback en op doelgroepen gerichte projecten.

Deze folder is voortgekomen uit het afstudeeronderzoek van Ingrid Nieuwenhuijsen MSc. Zij deed onderzoek naar hoe de inwoners van Eindhoven aangezet kunnen worden tot meer energiebesparing. Het onderzoek is uitgevoerd in samenwerking met faculteit Construction Management & Engineering aan de Technische Universiteit Eindhoven en HetEnergieBureau B.V. Meer informatie is te vinden in het afstudeerverslag 'Urging residents in Eindhoven to save energy' van Ingrid Nieuwenhuijsen.

Acknowledgements

There are many people that contributed to this research with their experiences, time and knowledge to make it as successful as it is. Primarily I would like to express my sincere thanks to my graduation committee Bauke de Vries, Erik Blokhuis, Marianne Gloudemans and Ienke de Vrieze for their support during the project. In addition, I would like to thank all field experts of the municipality and the ministry of VROM for their collaboration and input. In addition, I learned a lot about conducting conjoint choice experiments from Astrid Kemperman. It was great that everyone made time for me and shared their opinions and knowledge. I also would like to thank everyone at HetEnergieBureau for the opportunity for this graduation traineeship and for providing all input for this research.

I am also grateful to my fellow students, friends, family and Daan Bolier for their patience, smart ideas and helping me validate to the research and sending almost 3.000 survey invitations. Your help prevented a lot of stress during this research.

URGING RESIDENTS IN EINDHOVEN TO SAVE ENERGY

Author: Ingrid Nieuwenhuijsen

Graduation program:
Construction Management and Urban Development 2009-2010

Graduation committee:
Prof. dr. ir. B. de Vries
Dr. ir. E.G.J. Blokhuis
Ir. I. de Vrieze
Drs. M. Gloudemans

Date of graduation:
23-08-2010

ABSTRACT
This paper is about the research that has been done to investigate how residents can be urged to save energy. There are two different types of energy-saving behaviours: investment behaviour and curtailment behaviour. There are certain intervention strategies to urge residents to change their investment and curtailment behaviour. With use of the latent class model, three segments of residents are distinguished with different preferences and dislikes for the intervention strategies. Therefore, the municipality of Eindhoven should focus their strategy to urge residents to save energy based on these different segments.

Keywords: reducing energy demand, energy-saving behaviour, intervention strategies, segments of residents

INTRODUCTION

The national government is aiming to achieve ambitious climate targets to become one of the most efficient countries in the world in terms of energy. Municipalities in the Netherlands join in with the national policy and determine their own environmental policies. The municipality of Eindhoven wants to become energy-neutral in 2035-2045. This implies that the energy that will still be used by then will be supplied sustainably within the area limits of Eindhoven. The strategy of the municipality of Eindhoven to realise the energy-neutral target is based on the Trias Energetica: reduce energy demand, use renewable energy resources and use fossil fuels efficiently. The reduction of energy demand in the existing housing stock contributes for 25% to the energy-neutral strategy (BuildDesk, 2009a). Insulation and implementing high efficiency heating are the most important measures for the reduction of energy demand. Since the government has too few (financial and legal) means to push the energy neutral target forward in the public sphere, the municipality is dependent on the voluntary participation of residents. Despite all efforts currently being undertaken, the energy-saving rate is still very low. In addition to this there is no clarity in the jungle of possibilities for municipalities to urge residents to save energy. In short, reducing the energy demand is a problem because there is no clarity in how

residents can be urged to save energy. Therefore, it is important to investigate how residents can be urged to save energy.

ENERGY-SAVING BEHAVIOR OF HOUSEHOLDS

Governmental policy to reduce energy consumption is mainly focused on financial incentives. However, household energy use keeps rising and the governmental financial incentives appear to be inadequate (Abrahamse, 2007). There are two different types of energy saving behaviours: investment behaviour and curtailment behaviour. Investment behaviour is about the increase of quality of houses in terms of energy and the purchase of energy-efficient appliances. Curtailment behaviour is about the decrease of energy usage by behavioural changes.

Influence factors energy saving behaviour

Contextual factors contribute to this increase in energy consumption and shape micro-level factors (Abrahamse et al., 2005). Examples of contextual factors are the availability of products and services, the available infrastructure, cultural norms and economic factors (Steg, 2000). Contextual factors can affect behaviour directly (availability products and services), through the mediation of motivational factors such as attitudes, by moderation of the relationship between motivational factors and behaviour, and by the determination of which type of motivations most strongly affect behaviour (Steg; Vlek, 2009).

Knowledge, motivations and ability are the most important micro-level factors that influence household energy saving (Steg, 2008). The ability factor is highly dependent on contextual factors, and the facilitation of pro-environmental actions by these contextual factors rule out psychological motivations. Knowledge about problems related to household energy use is present in general. However, there is often confusion about the causal processes involved. For example, a limited number of people think global warming is caused by heating and cooling homes. In addition, people know little about the energy use related to their behaviour. Individual motivations to engage in pro-environmental behaviour are perceived costs and benefits and concerns about environmental and energy problems (Steg; Vlek, 2009). Other factors such as status, comfort and effort are also important (Stern, 2000). The motivation factor is influencing the acceptability of energy policies. Energy policies are more acceptable when they increase (purchase energy-efficient appliances) rather that limit (curtailment behaviour) the freedom of choice (Steg, 2008). Besides these micro-level psychological variables, saving energy is also dependent on socio-demographic variables. These variables, such as income, serve as barriers or opportunities for saving energy.

Intervention strategies

There are seven main intervention strategies identified in the literature: information; demonstration; free products; feedback; commitment with goal; rewards and financial support. Providing information aims to increase people's awareness about energy problems and their knowledge about the way to reduce these problems. Mass media campaigns appeared not to be effective (Abrahamse, 2007). Providing specific information that is tailored on a household is essential and seems to be most effective. Demonstration provides examples of recommended behaviour. In general, people will follow these examples when they are understandable, relevant, meaningful and rewarding to people (Abrahamse et al., 2005). Free products influence

people's knowledge and strengthen their concern for saving energy. Commitment strategies contain a promise to change behaviour, in this case to save energy. The promise to save energy can be linked to a specific goal such as reducing energy use by 5%. Feedback and rewards are two incentives that manipulate the positive or negative outcomes. Abrahamse (Abrahamse, 2007) states that providing feedback about the saving rate reached is very effective, and appeared to be more effective when the feedback was given more often and related to a saving goal. Although rewards seem to have a positive effect on reducing energy usage; it appeared that effects of rewards are short-lived (Abrahamse et al., 2005). Financial support facilitates saving energy by making this behaviour more attractive. Highly energy efficient products and services can be made attractive and pricing policies can increase prices of conventional energy behaviour options (higher tax for fossil fuel energy).

Energy saving behaviour model

There are many different papers that show behaviour models with causal relations between influence factors and behaviour. The MOA-model is often used and it visualizes their theory of reasoned action (Ajzen and Fishbein, 1980). According to this model, behaviour is caused by three main influence factors (motivation, ability and opportunity). Another behaviour model concentrates on the behaviour of energy consumers in houses. This model includes socio-demographic factors and housing characteristics as individual factors influencing the behaviour in terms of energy awareness and the energy consumption (van de Maele-Vaernewijck et al., 1980). An overlap with the VBN theory model (Stern, 2000) can be found because 'acceptance of responsibility' is included in this model. The simplest and most obvious model is a socio-psychological framework modelled as a flowchart with 4 phases of behaviour: to know, to want, to be able, and to do (Nationale DenkTank, 2009). This flowchart is based on the AIDA model developed by E. St. Elmo Lewis in 1898 (www.provenmodels.com, 2010). Since no perfect fit of existing behaviour models for this research was found, multiple existing models were combined to create the energy saving behaviour model that has been developed in this research.

METHODOLOGY FIELD RESEARCH

To enable the assessment of different intervention strategies, the execution of a survey is required to get data about residents' preferences for specific intervention strategies. The quality of the assessment is dependent on the completeness of the variables of the field research. These variables are pictured in the energy-saving behaviour model in Figure 1. Research in the form of a survey is the best method to investigate all variables. The survey consists of a choice experiment to assess the main intervention strategies and questions that are related to the other factors in the energy-saving behaviour model.

Conjoint choice experiment

A stated or conjoint choice experiment is a suitable method to use to assess the intervention strategies. Conjoint choice experiments are based on the assumption that preferences can be defined by presenting alternatives according to certain 'profiles'. These profiles consist of certain attributes, in this case the intervention strategies. The respondents make actual choices between the alternatives and select a profile that best reflects their preferences. Respondents

can also choose a base alternative when none of the other choice sets is attractive enough to be selected (Kemperman, 2000).

Design experiment
The design of the experiment is constructed with the seven intervention strategies. Each attribute has two levels about whether or not it is present in the choice set. The full factorial design is too large (2^7 alternatives) to be included in the survey in its entirety. Therefore the design is created more efficiently with use of fractional factorial designs (Montgomery, 1984). In this research a design with 64 trials is used, combined in choice sets with two alternatives.

Analysis techniques experiment
The choice behaviour of the respondents for the attributes can be analysed with help of the random utility theory. This theory assumes that the utility for a profile consists of a systematic component and a random error component. Each alternative is based on different attributes. Therefore, the utility for an alternative is the summation of the utilities of the attributes. The multinomial logit model elaborates the random utility theory and is the most widely applied model to predict the probability that a choice alternative will be chosen. This model is based on the assumption that respondents choose the alternative with the highest utility (Ortúzar and Willumsen, 2001). This model takes into account that a natural fluctuation can occur when respondents make choices. With help of the latent class model, the difference in preferences for intervention strategies of the respondents can be investigated. This model enables the assessment of whether or not different groups of residents can be distinguished that prefer different intervention strategies. The likelihood ratio (Rho^2) is a common measurement to calculate the goodness of fit of choice models. In general, a model with a Rho^2 value above 0,2 is considered well fit (Meys, 2008).

Data collection
Since the research is about saving energy in households, the survey has been distributed to a sample of all households in Eindhoven. The questionnaire has been presented online to residents since this method is administratively and financially efficient. Residents that were selected in the sample received a postal invitation letter. It was not possible to send the residents in the sample an e-mail with a direct link to the survey on the internet. Therefore, residents had to fill in the link on the internet. In total 1.480 postal invitations to participate in the research were sent to residents in Eindhoven. Since the response of the first sample was about 10%, a request for participation in this research was sent by e-mail to 99 acquaintances in Eindhoven. These e-mails contained a direct link to the surveys. 170 responses were valid to use in the choice experiment.

RESULTS FIELD RESEARCH
Adjustment energy saving behaviour model
The energy-saving behaviour model can be tested with the output of the survey. Since the questionnaire in this research was very large, the first step to analyze the output of the survey is to reduce the data variables. In SPSS the factor analysis tool constructs new factors based on correlations between the original data variables. Context, knowledge and motivation appeared

to consist of two factors. The two types of energy saving behaviour (curtailment behaviour and investment behaviour) both consist of 5 factors. In Figure 1 the adjusted energy-saving behaviour model is shown including these factors. Besides the refinement of the influence factors in the model, the relations between these factors can also be tested with the output of the survey.

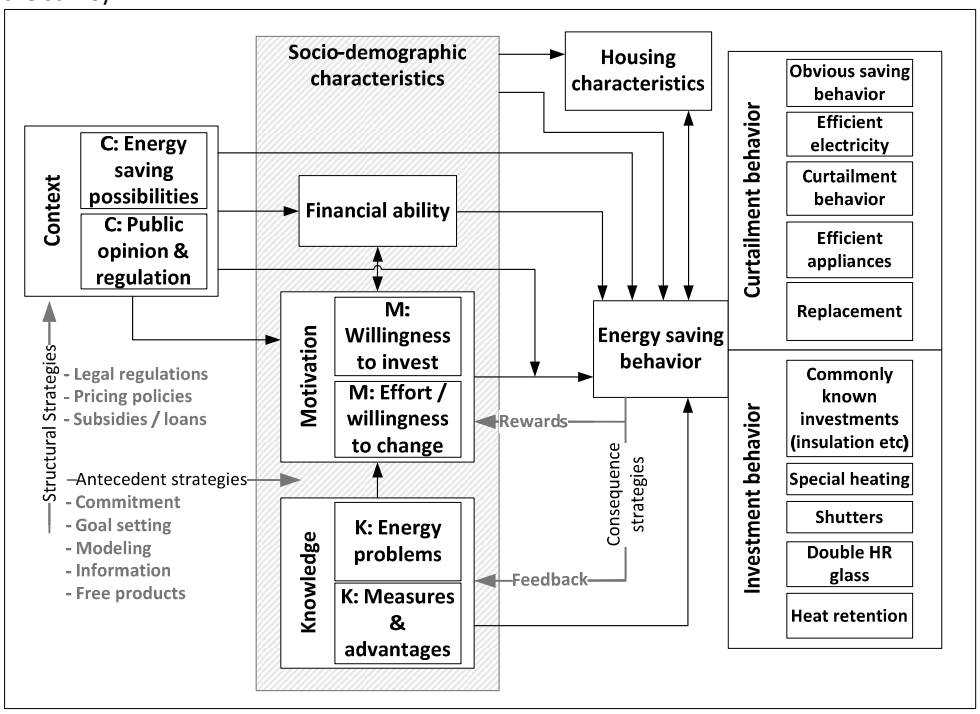


Figure 1: Adjusted energy-saving behaviour model

General factor levels respondents

Using the output of the survey, the levels of the factors that influence the energy-saving behaviour of residents can be calculated. Only 20% of the respondents claim to have a very high level of knowledge about energy problems. Residents do not have a very high motivation at all to invest or put in more effort to save energy. In general, none of the curtailment behaviour factors are currently done to a very high level.

Preferences for intervention strategies

In Figure 2 the average preference of residents in the sample for the intervention strategies according to the multinomial logit model is pictured. The figure shows that rewarding energy-saving behaviour is preferred, directly followed by financial support like subsidies. Not all intervention strategies are in demand. For example, on average residents have a slight dislike for commitment. However, the Rho^2 of the multinomial logit model (0,108) is below 0,2. Therefore, the multinomial model is not optimally fit to represent the preferences for the intervention strategies.

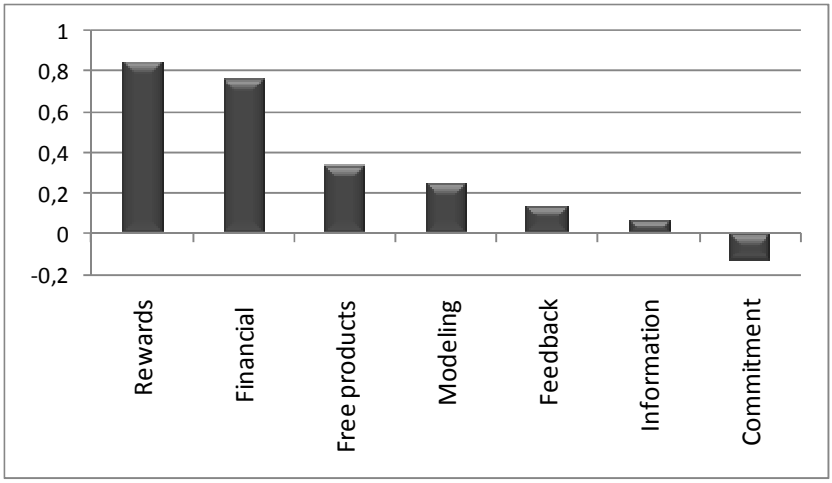


Figure 2: Preference according to multinomial logit model

Segments of residents

It appeared that three segments of respondents can be distinguished. Segment one covers about 65% of the total respondents, segment two covers about 15% and segment three covers about 20%. The likelihood ratio of the latent class model is 0,2533. Therefore, using different groups is better in order to represent the preferences for the intervention strategies. In Figure 3 the preferences and dislikes of residents in the segments for the seven main intervention strategies are pictured. In Figure 4 the preferences and dislikes of the segments for subtypes of intervention strategies are pictured.

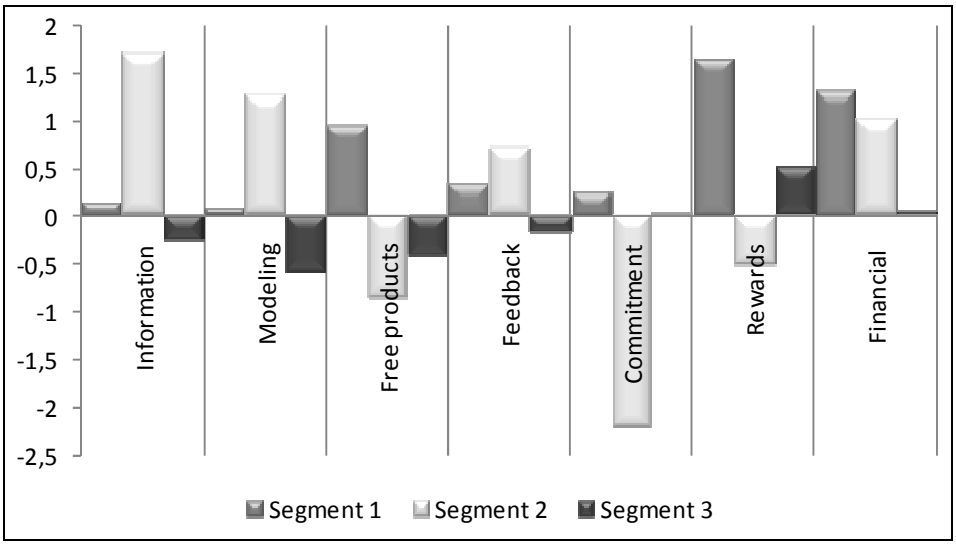


Figure 3: Importance intervention strategies per segment

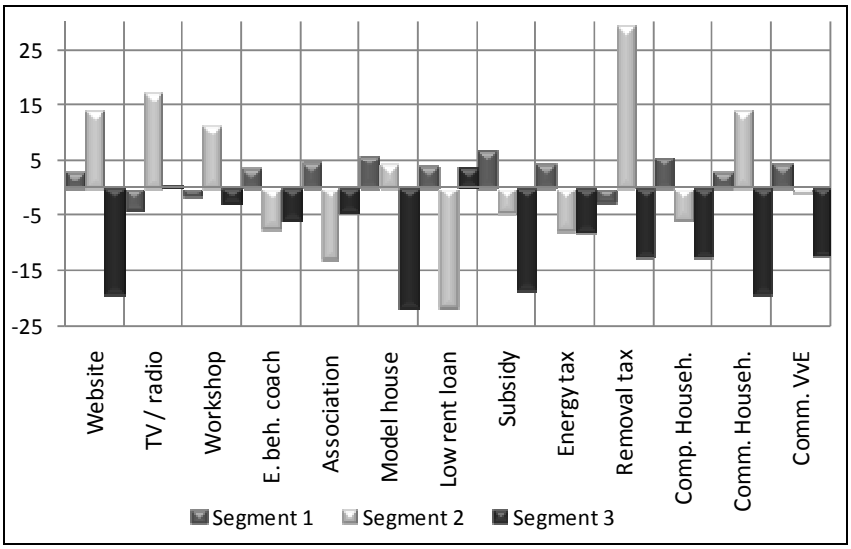


Figure 4: Preference intervention strategies per segment

CONCLUSION

Energy-saving behaviour model

The energy-saving behaviour model developed in this research is derived from literature about energy-saving behaviour and other existing behaviour models. However, it appeared that none of the models combine macro and micro level aspects, personal characteristics and a description of relations between these factors. The adjusted model in Figure 1 is a refinement of the model that has been derived from the literature and consists of more detailed factors. Therefore, the energy-saving behaviour model developed in this research (Figure 1) adds a clear and specific oversight in the energy-saving behaviour of residents to the existing literature on this topic. With this model, stakeholders like municipalities can easily gain insight into the energy-saving behaviour process of residents.

Intervention strategies

In the literature, different types of intervention strategies are distinguished. However, a clear oversight of all possible intervention strategies and its subtypes did not exist in the literature yet. Therefore, a tree structure is developed in this research.

Focus intervention strategy on segments

As discussed previously, it is best to distinguish three different segments of residents to represent the preferences for intervention strategies. Therefore, the municipality of Eindhoven should focus their strategy to urge residents to save energy on these different segments. Besides different preferences for intervention strategies, the residents in these segments also possess different characteristics.

Financially focused residents

Figure 4 indicates that segment one (65% of the residents) are highly sensitive for *rewards*. However, the short-lived effect of rewards should be taken into account when residents are urged using this method. *Subsidies* are a very good financial incentive to urge residents in segment one to invest in the quality of their houses in terms of energy. Providing residents in segment one *free products* is another good intervention strategy for this group. This method influences both knowledge and motivation of residents. Usually, these products are small test examples of different energy-saving behaviour categories. Therefore, the method of providing residents with free products is an incentive for energy-saving behaviour in general instead of only the investment in commonly known measures. Feedback is an additional intervention strategy that can be used to urge residents in segment one to invest in energy efficiency. Feedback is especially useful for residents in segment one when *similar households are compared* on their energy use. The ideas for smart metering in Eindhoven are very useful when both the actual use of households and the comparison to similar households can be provided.

Conscious residents

15% of the residents in Eindhoven cannot be urged with rewards, subsidies and free products. This segment of residents has a high knowledge level about energy problems. It seems as if they are eager for more information and examples about how others save energy especially because they have more knowledge. These residents are aware of their own energy use but experience a lack of knowledge about their opportunities to save energy. These residents are highly sensitive for information. The best methods to provide residents in this segment with information are through *websites*, *publicity on TV and radio* and *workshops*. The thing that should be taken into account with using websites is to adjust the information according to the target group. Information should be provided very clearly and unambiguously. It is remarkable that these subtypes of information do not match the assumption of the advisors of the municipality that residents are mainly in demand for tailored information. Residents in segment two are also sensitive for demonstration of energy saving. *Demonstration by neighbours and acquaintances* and a *model house* with presented measures are good incentives. Demonstration by neighbours and acquaintances implies that residents present the measures that they took to save energy in their houses to people they know. In a model house all types of measures that can be taken in houses are presented and residents can visit this house to get a real life experience with these measures. Regarding the financial intervention strategy, residents in segment two highly prefer the adjustment of *removal tax* on appliances. Apparently these residents experience this incentive as a good opportunity to be urged to invest in energy efficient appliances. Providing *feedback* to households is also a good incentive for residents in segment two. They prefer feedback on the actual energy use of households, their use of appliances and their energy behaviour. As can be seen in Figure 5 they do not prefer the comparison with similar households. This indicates that the conscious residents have an inward focus. This corresponds with the assumption that residents in segment two are the innovators and the early adopters. The innovators mainly react to their own principles and the technological or other contextual innovations. One can expect that the majority is more outwardly focused and react (on) to the behaviour of others.

Older residents
On average residents in this segment are older than in the other segments. Residents in this segment generally dislike almost all intervention strategies and do not want to be bothered with saving energy. They prefer high room temperatures and they expect a loss of comfort when saving energy. In addition it is too much effort for them to save energy. However, housing corporations are perfect stakeholders to help these residents to be more energy efficient. Therefore, municipalities should focus on increasing the quality of homes of these residents in terms of energy.

Effectiveness of current governmental policy
The strategy of the municipality of Eindhoven to realise the energy-neutral target is based on the Trias Energetica. The first step in this strategy is to save energy. Saving energy in the existing housing stock contributes to the strategy for 25% (mainly insulation and highly efficient heating, which correspond to the commonly known investments in the survey). It appeared that only a small amount of the respondents highly invested in this type of improvement to the quality of their homes in terms of energy. The output of the survey indicates that this type of investment is worth focussing the intervention policy on. Besides the current focus of the municipality urging residents to invest in the quality of their houses in terms of energy it is also possible to realise a significant reduction in energy use through curtailment behaviour. For example, 9% of the total gas usage can be saved through changes in heating behaviour. From the results of the survey it can be concluded that residents do not save a lot of energy by changes in behaviour yet. Therefore, it is interesting for the municipality of Eindhoven to add the focus on curtailment behaviour changes to the strategy for saving energy in households.

DISCUSSION
Remarkable is that different segments of residents were found in this research that are in demand for different intervention strategies. This adds knowledge to the current literature that municipal intervention policies should be focused on specific target groups, and which intervention strategies are effective for each target group. Therefore the lack of clarity in how residents can be urged to save energy is solved.

The respondents made choices among the intervention strategies in the conjoint choice experiment. However, to enable the shortest questionnaire as possible, the respondents only received 1/8th part of the total experimental design. It is likely that this makes the differentiation between the segments of residents less clear. With a second sample, taken at the end of this research this problem is overcome. Though the output of the second sample is not used in this research due to the short timeframe, it can be used for further research. In addition future research could focus on one of the three types of ownership (private ownership, private rental housing and rental housing by housing corporations). Besides that it would be interesting to investigate whether or not differences can be found between municipalities. I can imagine that municipalities in urban areas need to focus their strategies to urge residents to save energy differently than municipalities in rural areas.

REFERENCES

Abrahamse, W. (2007) Energy saving through behavioral change: Examining the effectiveness of a tailor-made approach, State University Groningen

Abrahamse, W.; Steg, L.; Vlek, C.; Rothengatter, T. (2005) A review of intervention studies aimed at household energy saving, Journal of Environmental Psychology 25 (273-291)

BuildDesk Benelux B.V. (2009a) Routekaart naar een energieneutraal Eindhoven: Gemeente Eindhoven op weg naar energieneutraliteit

Kemperman, A.D.A.M. (2000) Temporal aspects of theme park choice behaviour: modelling variety seeking, seasonality and diversification to support theme park planning, Eindhoven: Technische Universiteit Eindhoven

van de Maele-Vaernewijck, M.C.L.; van Raaij, W.F.; Verhallen, Th.M.M. (1980) Energiegedrag in de woning: literatuuroverzicht en gedragsmodel, i.o.v. Ministerie van VROM

Meys, F. (2008) Particulier opdrachtgeverschap in beeld, beeldregie bij particulier opdrachtgeverschap woningbouw, afstudeerverslag, Technische Universiteit Eindhoven

Montgomery, D.C. (1984) Design and Analysis of Experiments, 2nd edition, John Wiley and Sons, New York

Nationale DenkTank (2009) Energie in beweging, Adviezen om consumenten aan te zetten tot energiebesparing

Ortúzar, J.; Willumsen, L. (2001) Modelling transport, John Wiley & Sons Ltd, Chichester

Steg, L. (2008) Promoting household energy saving, Energy Policy 36 (4449-4453)

Steg, L.; Vlek, C. (2009) Encouraging pro-enviornmental behaviour: An integrative review and research agenda, Journal of Enviornmental Psychology 29 (309-317)

Stern, P.C. (2000) Toward a Coherent Theory of Environmentally Significant Behaviour, Journal of Social Issues, Vol. 56, No. 3, pp. 407-424

ACKNOWLEDGEMENTS

There are many people that contributed to this research with their experiences, time and knowledge to make it as successful as it is. Primarily I would like to express my sincere thanks to my graduation committee Bauke de Vries, Erik Blokhuis, Marianne Gloudemans and Ienke de Vrieze for their support during the project. In addition, I would like to thank all field experts for their collaboration and input. I also would like to thank my fellow students, friends, family and Daan Bolier for their patience, smart ideas and helping me to validate the survey and sending almost 3.000 survey invitations.

Ingrid Nieuwenhuijsen BSc.

Over the past 5 years I have learned a lot in both the bachelor program Architecture, Building and Planning as well as in the master program of Construction Management and Engineering with the focus on urban development. This graduation project was the perfect finish in which gaining knowledge, doing research and conducting a well-turned report came together.

Sept. 2005 – Aug. 2008 Bachelor of Science in Architecture, Building and Planning
Sept. 2008 – Aug. 2010 Master in Construction Management and Engineering
Feb. 2010 – Aug. 2010 Graduation internship at HetEnergieBureau B.V.