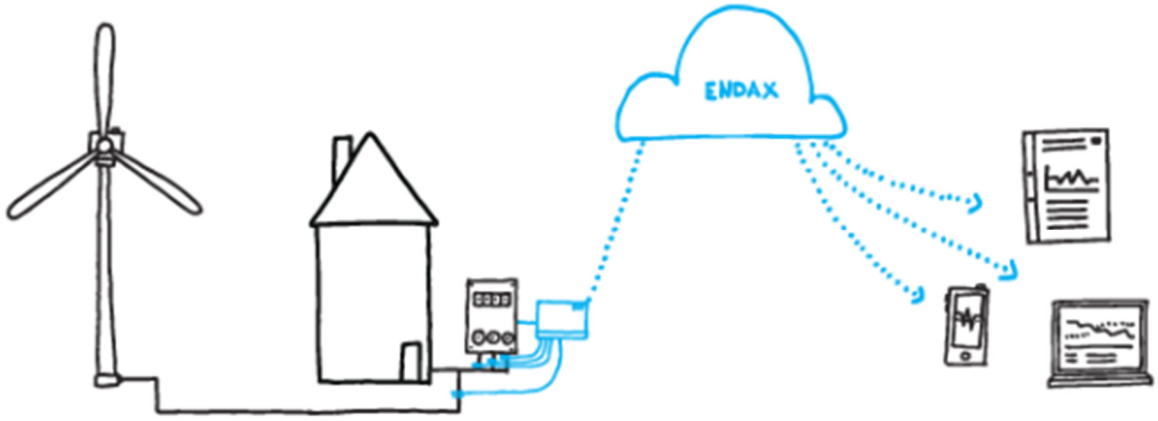
The flexibility of the consumers and their preferences regarding the energy bundles



Author: ing. M. Schut
Student number: 0774074
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Author Ing. M. Schut (Maaike)
Student number s118272 / 0774074
E-mail m.schut@student.tue.nl
maaike_schut@live.nl
Telephone 0031 6 23 56 99 87

Graduation program Construction Management and Engineering
Faculty Faculty of the Built Environment
Institute Eindhoven University of Technology

Graduation Committee:

Supervisors

Prof. Dr. Ir. W.F. Schaefer
w.f.schaefer@tue.nl
Dr. Ing. P.J.H.J. van der Waerden
p.j.h.j.v.d.waerden@tue.nl

Company

Stedin.net –
Dr. ir. E.G.J. Blokhuis
Ir. A. Rijneveld
Arnoud.Rijneveld@stedin.net

Knowlegde Cluster

Knowlegde Cluster KenW²ib
www.kenwib.nl

PREFACE

In your have hand, you have the report that presents my research on 'The preferences of the energy consumer concerning the energy bundle'. This research is the final part of the Master Construction Management and Engineering (CME), faculty of the Built Environment, at Eindhoven University of Technology (TU/e). This research is conducted under the supervision of Erik Blokhuis and Arnoud Rijneveld, Stedin, and Peter van der Waerden and Wim Schaefer, TU/e.

At this moment, the energy transition is going on, i.e., that changes are taking place at the side users, producers but also by the network operators. It is possible to absorb the changes by demand response. It is important that the consumer can and will use energy flexible. One way to help and to stimulate the flexibility of the energy consumer is the energy bundle. The energy bundle consist of several characteristics that may contribute to a flexible, durable and energy-saving behaviour of the consumers.

At the end, a business canvas is developed that will collect the conclusions and the results of this study and the ideas about the energy bundle and possibilities for the network operators.

Through this way, I want to think my supervisors Wim Schaefer, Peter van der Waerden, for their input and guidance during my graduation period. I am also grateful to Stedin, especially to Erik Blokhuis and Arnoud Rijneveld, for their valuable guidance from the practical side of the research. All other persons who have contributed during this study, I would like to thank.

Finally, of course I would like to thank my parents, brother and sisters, parents in law and my boyfriend because their big support throughout my academic career.

Maaike Schut,

Eindhoven, 25 February 2015

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CHAPTER 1. INTRODUCTION

This chapter will give a short overview about current energy systems, explain the problematic definition of this research, and describe the research questions and scope of this thesis.

1.1. Energy system in the Netherlands

The current energy systems in the Netherlands are demand-driven. Consumers can use energy every moment of the day for a fixed price. The current system consists of the network operator, the energy supplier, the energy consumer and the supervisor. APPENDIX 1 - THE PRESENT ENERGY SYSTEM present a clear overview of the situation.

Traditional energy usage behaviour is changing, and new energy systems have been and will be developed. The use of renewable energy will increase. Consumers, private initiatives, and other collective projects will produce their own energy and will have an impact on the energy grid. Simply explained, small new energy producers—often created by citizens—will appear on the current energy system. The rise of citizen initiative will have a major impact, but they are not considered in this research. (Schwencke, et al., 2013)

The increasing use of solar panels, heating pumps, and electric transport has major consequences for our current energy system. Generating energy from renewable sources means that the energy network has to deal with large variability in supply of energy through solar and wind energy. The current energy systems are not designed for large-scale variable supplies of electrical energy and variable increases in demand. Technological innovations in combination with new services should make energy affordable and reliable in the future. And the energy systems need to be resistant to transition of fluctuation of the sustainable produced energy. This requires interaction between the energy consumer (end user) and the management of the 'two-way' energy grids. The main challenge is to understand, and, where necessary, to stimulate and influence consumer behaviour. Social acceptance and a more active role of consumers are important for the success of the energy transition (Netbeheer Nederland, 2013)

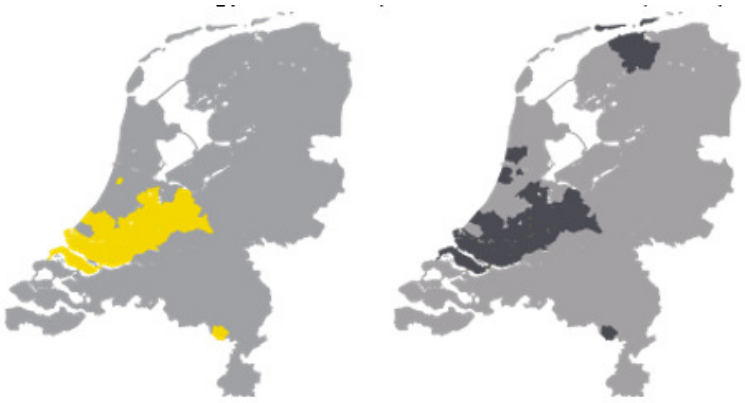


Figure 1 Work area of Stedin (Left Electricity and Right Gas) (Stedin, 2014)

Stedin is one of the 8 Network operators in the Netherlands with work in the province Utrecht and Zuid-Holland. See Figure 1 Work area of Stedin (Left Electricity and Right Gas). Stedin ensures that consumers of Stedin are always provided with energy. The network operator is responsible for the transportation of electricity and gas. Stedin is the owner of all the stations, cables and pipes required for energy distribution in its region. It is the owner and responsible party for the meters at the consumers' houses. They are responsible only up to the point of transportation in industrial connections (Stijl, 2013).

Stedin investigates opportunities to adapt to the advent of new developments—such as smart meters, smart thermostats etc.—and to changes in supply and demand due to wind and sun energy. Stedin is continuously searching for ways to improve their energy system and to investigate what the consumers want now and will want in the future. One of the pilot projects is Couperus Smart Grid. The purpose of this pilot is to investigate to better align demand and supply of energy from heat pump with the Power Matcher (Software technology). The flexibility of energy is demonstrate in this pilot, in an environment with many different households. Stedin is continuously searching for answers to the question of what consumers want and how Stedin as Network operator can contribute to the energy transition. In short, energy transition has to do with the behaviour change of the energy consumer, the advent of more and more renewable sources and the stimulation by the government to reach the target of the EU: to have 20% of the energy out renewable sources.

In addition to the network operators, suppliers and the government, the energy consumers also play an important role regarding energy consumption, as mentioned above. The consumers will have to adjust to new developments, partly due to the policies of the government. A good example of a policy approach is the energy label for houses introduced in 2008. In addition to this, solar panels have become more attractive for households. The electric car has become an affordable solution for more and more people. Through the advantage of new technologies, consumers can more efficiently control their energy consumption. By using insulation, solar panels, smart meters, electric cars and heat pumps, the consumer can reduce his/her energy consumption and thus contribute to a sustainable society (ECN, Energie-Nederland, Netbeheer Nederland, 2013). The advent of smart applications allows consumers to control the heating and lightning systems in their houses.

1.2. Problem identification

The previous section briefly sketched the background situation: i.e., what is going on at this moment in terms of energy. There is an important role to play for the consumer. In the future, the consumer may have to deal with interactive energy systems. However, at this moment, it is not known how consumers feel about it and how consumer will deal with the flexibility of energy supply. Is it possible to control consumption on the basis of energy supply, or do consumers want to change it themselves? Will the energy consumer change energy consumption based on the energye supply, or will they change their behavior to specific moments, or are they inflexible? By looking at behavioral patterns and setted conditions, it can be determined how households will respond to the future transition of energy. Which groups of households and what kind of conditions and requirements should be applied to change their flexibility in setted moments?

In the future, energy supply and demand will grow and be in greater flux than today. To prevent the network operators from reinforcing the energy grid, it is necessary to find new solutions; otherwise the energy systems will be unaffordable. One of the possible solutions is demand response. *Demand response* is defined as a customer's ability to alter electricity demand by reducing or shifting consumption in response to market prices or other market conditions (Chao, 2010). Demand response provides an opportunity for consumers to play a significant role in the operation of the electric grid by reducing or shifting electricity usage during peak periods in response to time-based rates or other forms of financial incentives (Energy Gov, sd). Demand response is an opportunity for consumers and network managers. But is the consumer willing to change, and, if so, under what kind conditions?

During this research an energy bundle will be developed and designed to investigate whether it can provide a solution to the energy transition. Chapter 2, IDENTIFYING THE ENERGY CONSUMER, will explain the energy bundle.

1.3. Research questions

An energy bundle will be developed to determine whether it could provide a solution to the energy transition. It is not known under what conditions consumers change their behaviour. This research will investigate the flexibility of the energy consumer by identifying activity patterns and willingness to change their activities. And there will be investigated what kind of recommendations in the concept of the energy bundle preference the energy consumer. The following research question will investigate if the energy bundle can be an solution for the energy transition.

Under what conditions are consumers willing to give up their flexibility in energy consumption in the concept of the energy bundle?

Sub-questions:

To provide an answer to the main question, the following sub-questions will be investigated:

1. What will be the desire of consumers regarding energy use in the future based on energy consumption, future home technology and innovations?
2. Which energy bundles and attributes can be developed to meet the requirements of the consumer, the requirements of the network operators and the expected innovations in the future?
3. Which energy bundles and attributes do the energy consumers prefer?
4. How can the conditions of different consumers be merged into one business plan for a particular group of consumers. And what are opportunities for Stedin regadering the energy bundle.

1.4. Research objective and relevance

At the moment, several studies are going on concerning the involvement of the consumer to save energy. There is also a lot of research being done on how consumers respond to smart meters and how they will behave in a smart grid. There is a need to know how consumers will behave in the future and how they will react to the energy transition. During this research, the researcher will investigate the behaviour of consumers, their activities, the needs and requirements in the field of energy and how consumers will react to changes in energy supply in the future. For the network operators and the suppliers, this research could be of major importance for investment for the future. The degree of consumer flexibility in combination with the energy consumption has not been previously investigated (ECN, Energie-Nederland en Netbeheer Nederland, 2014) (Netbeheer Nederland, 2014).

1.5. Thesis outline

This thesis consists of 8 chapters, in which the research questions as formulated in paragraph 1.3 will be answered. The outline is depicted in Figure 2 Thesis Outline.

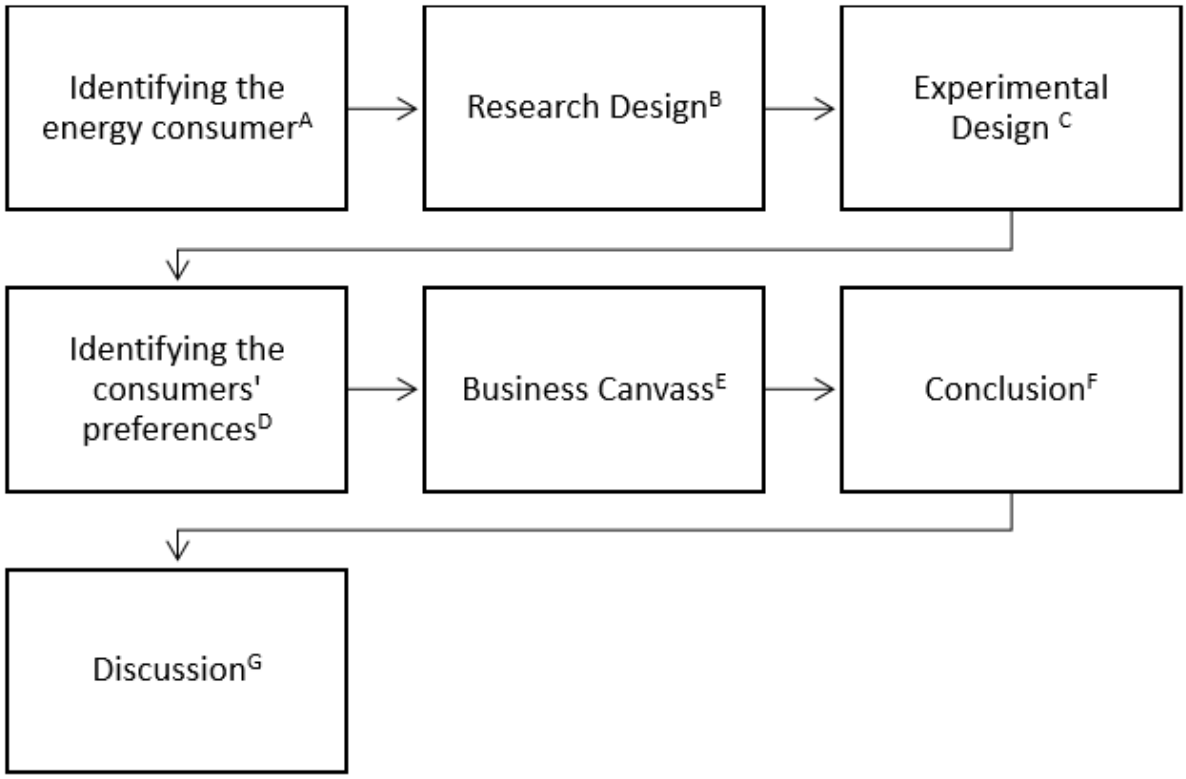


Figure 2 Thesis Outline

A. *Identifying the energy consumer*. This chapters explains the properties of the consumer. How much energy do households in the Netherlands consume, what are the activity patterns and what is the energy behaviour. The chapter will end by explaining one possible solution for the energy transition: the energy bundles. This chapter explains the theoretical framework of this research and provides the background for the development of the energy bundle.
   Will answer sub-questions 1 and 2.
B. *Research Design*. This chapter discusses the structure and the chosen models of this research, and will explain the theory behind the chosen models.
C. *Experimental Design*. This chapter shows how the Stated Preferences model has been constructed.
   Will answer sub-question 2.
D. *Identifying the consumers' preferences*. The data from the questionnaire will be analysed in this chapter. This part of the report will explain the sample description and will show the preferences of the energy consumer regarding the energy bundle.
   Will answer sub-question 3.
E. *Business model;* on the basis of the analysed data in chapter 5, a business canvas is filled in.
   Will answer sub-question 4.
F. *Conclusions and recommendations*. The conclusion will answer the main question of this research, and will explain the recommendations of this research.
G. *Discussion*. The results of this thesis will discussed in this chapter.

CHAPTER 2. IDENTIFYING THE ENERGY CONSUMER

Energy is one of the most important needs in the Netherlands; without energy, the consumer has no life. Consumers now use continuous energy, the heating of buildings, telephony, and, of course, the internet. It is hard to imagine what you would do if suddenly there was no power available. In that case, there remain few activities that would be considered normal nowadays.

This chapter will present an overview about consumers' energy consumption, their energy behaviour, their activity pattern related to energy, and the impact of the consumer on the current energy transition. This chapter provides the background for the development of the energy bundle. The chapter ends by defining energy bundles: one possible solution for the energy transition.

2.1. Energy consumption

For several years, households in the Netherlands have consumed less gas than they did during previous years. Electrical appliances have also become more and more efficient. The decline of gas consumption is caused by better insulation of houses, and heating boilers are becoming more efficient. However, a lot of energy is still consumed. The average household has an annual energy bill of approximately €1860.00 (for electricity and gas). Dutch households spend 14 billion euros for their energy annually (CBS, 2013) (RVO/NIBUD, 2014).

The energy consumption of the average household in 2012 can be divided into 4 different energy sources: natural gas, electricity, fossil fuel, and other sources. See Figure 3 Energy sources. This research investigates the energy consumption within the homes based on electricity and gas.

Paragraph 2.4 will explain the changes of the energy sources and the impact of those changes for the consumer and the network operator.

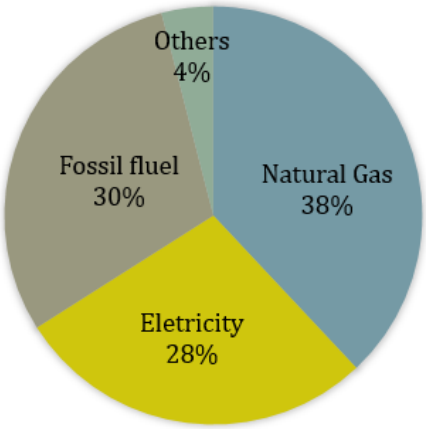


Figure 3 Energy sources

The consumption of energy in households can be divided by number of persons in households. To make clear how much energy households consume per person on average per month, see Figure 4 Overview of the energy costs per month for number of persons in households. (Rijksdienst voor Ondernemend Nederland .

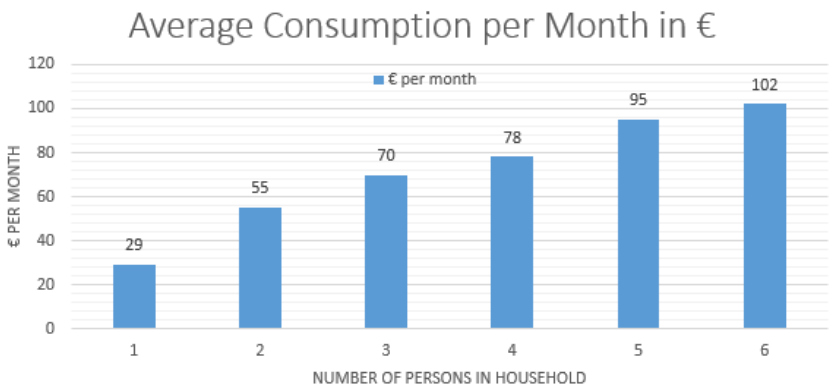


Figure 4 Overview of the energy costs per month for number of persons in households. (Rijksdienst voor Ondernemend Nederland (RVO/NIBUD, 2014)

We now know what kind of energy sources we use in the Netherlands, and how much households spend on average per month per person. (This study will not explain where the energy bill is composed, because it will focus on the use of devices that are related to activities.) But where is the money going? Which appliances use the most energy?

Previous research shows that consumption in households is due primarily to 10 devices. See Table 1 Top 10 Appliances in households compared to the energy consumption. The combi-boiler or heating boiler takes 46.1% of the total energy consumption in the households. This is of course one of the devices that uses gas instead of electricity. As mentioned before, total energy consumption based on electricity is approximately 28% of the total consumption of energy. The other 78% is this is gas consumption.

Energy consumers households Top 10	
1. Combi boiler	46.1%
2. Car	36.2%
3. Lighting	3.6%
4. TV	2.6%
5. Refrigerator	2.4%
6. Ventilation	2.0%
7. Heating	1.9%
8. Clothes dryer	1.8%
9. ICT	1.8%
10. Audio & Video devices	1.8%

Table 1 Top 10 Appliances in households compared to the energy consumption

This study looked at the devices and activities that use electricity instead of gas. The word *energy* is used below for the use of electricity. For a quick summary of which devices or activities consume electricity and how much they consume in proportion to the total electricity consumption, see Figure 5 division of electricity using devices .

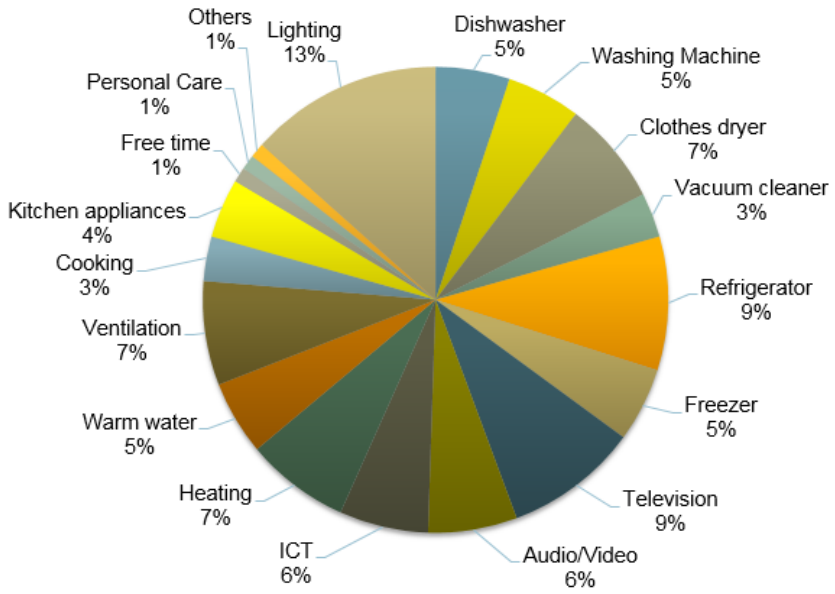


Figure 5 division of electricity using devices (ECN, Energie-Nederland en Netbeheer Nederland, 2014)

This section presented an overview of the consumption of households and their activities and devices. The consumption of electricity is highly fragmented. The next section will explain which activities people perform, and will investigate whether there is certain pattern.

2.2. Consumers and their activities

It is now known how much energy households consume and what the devices or applications are that consume the most energy. The question now is whether consumers have certain daily patterns in their energy use. The activities conducted by consumers will therefore be related to energy consumption to gain insights into patterns of energy consumption.

The pattern of activities can be based on one week divided into hours. The activities are categorized by mandatory activities, personal activities and leisure. Table 2 gives an overview of the average time consumers spend doing various activities.

Mandatory activities		**Personal activities**		**Leisure**	
	41.2 hours		77.7 hours		47.8 hours
Study	3.7 hours	Sleep	59.5 hours	Media use	20.9 hours
Paid Work	19.6 hours	Eat	11.9 hours	Social contacts	7.2 hours
Care for Children	17.9 hours	Personal Care	6.2 hours	Recreational leisure and social-participation	19.4 hours

Table 2 Overview of the spending hours by category

In addition, the moment when certain activities take place is investigated in more detail. This is done for two days of the week: Tuesday is elected as an average weekday, while Sunday represents a weekend day. It is clear that Saturday has its own properties. Figure 6 shows the subdivision of time over the day across the 3 categories as mentioned in Table 2 Overview of the spending hours by category.

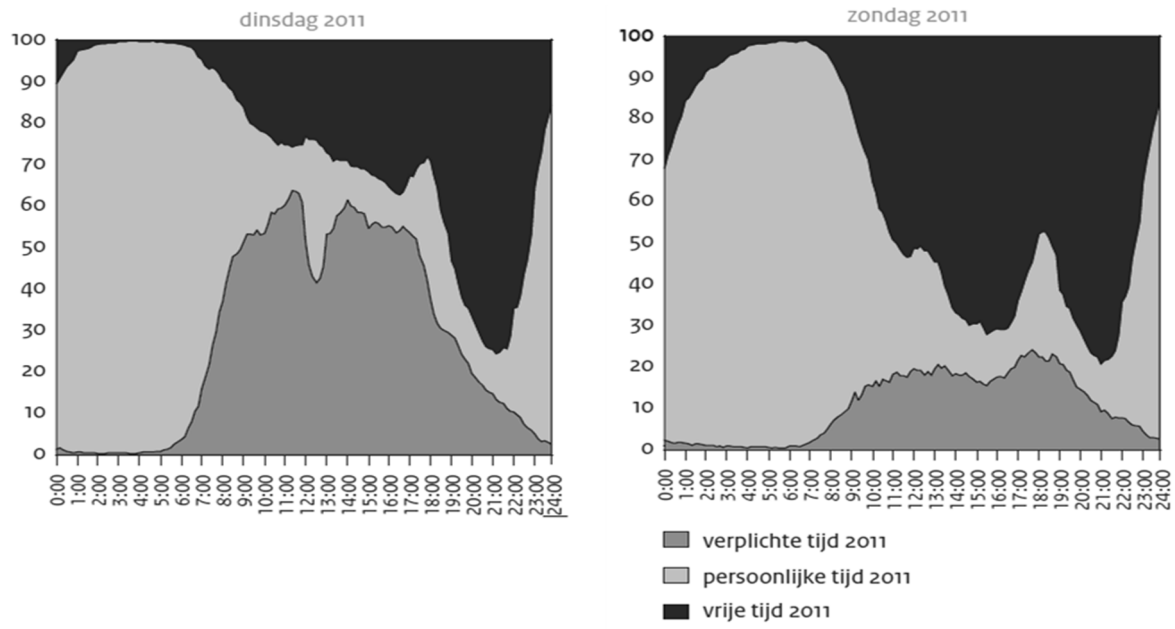


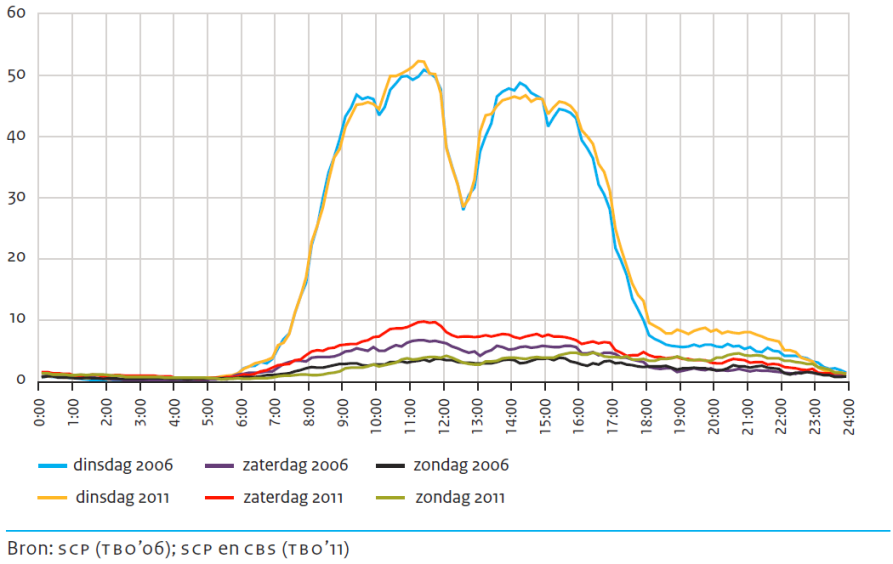
Figure 6 Activities divided over time for Tuesday and Sunday (Sociaal en Cultureel Planbureau , 2013)

Grey: Mandatory activities, light grey: Personal activities and dark grey: Leisure.
There is a clear pattern to the sleeping and eating behaviour of Dutch people. On the average day, Tuesday, everyone gets up between 6.00 and 8.00 hours. On Sunday, this is between 8.00 and 10.00 hours. The average person goes to bed around 23.00 hours. The moment for eating is on all days more or less the same: breakfast is between 6.30 hours and 9.00 hours, lunch is between 12.00 hours and 13.00 hours, and dinner is around 18.00 hours.

To gain insight into when people perform certain activities and which energy-consuming equipment can be related to those activities, the next figures shows when average Dutch people perform certain activities. Each time is examined for effects on energy consumption.

APPENDIX 2 - ACTIVITY PATTERNS FOR CERTAIN ACTIVITIES, presents an overview about the division of time for the following activities: work, household activities, childcare and eating. This shows how such activities are patterned. On the next page, one of the activities is analysed. Other activities will be explained in the appendix.

The first figure—Figure 7 Pattern of activity work see next page, indicates that most people work between 8:00 and 18:00. It can be said that the people who work at that time not be at home and thus consume no energy. One in three employees work from home. A growing number of employees work from home. In 2005, one quarter of employees reported working at home at least one hour a week as opposed to nearly one third in 2012. On average, employees work nearly 6 hours a week from home (CBS, 2013) .



Bron: SCP (TBO'06); SCP en CBS (TBO'11)

Figure 7 Pattern of activity work

2.3. Consumers and their energy behaviour

Meanwhile is explained how much households consume and when they are doing their activities. This section explains the behaviour of consumers in relation to their energy consumption. Several studies have investigated behavioural changes and attitudes and have included experiments by energy consumers with new technologies. It appears that attitudes and behaviour do change—and change quite radically—over time. Understand this process will be important in the area of energy consumption (Owens & Driffill, 2008). Research suggests that consumers often are not informed or are not sufficiently informed about their energy consumption and about energy saving possibilities in their houses.

Energy-saving behaviour is related to household energy conservation and can be divided into two categories: efficiency behaviour or investment behaviour and curtailment behaviour. *Investment behaviour* is about spending money on improving energy efficiency, such as on insulation. *Curtailment behaviour* involves repetitive efforts to reduce energy use, such as lowering thermostat settings. Contextual factors, knowledge, motivations, abilities and socio-demographic variables may influence energy-saving behaviour (Han, et al., 2013) (Abrahamse, et al., 2005).

Based on empirical studies, the factors influencing energy saving activities may generally be categorized as follows:

- Characteristics of the household (education, income, number of children, age, renter or owner);
- Characteristics of the residence (multi-family home, size);
- Economic factors (energy prices);
- Availability and quality of information;
- Weather and climate factors;
- Attitudes towards energy savings or towards the environment (Mills & Schleich, 2012).

There are certain interventions that promote energy-saving behaviour: e.g., providing information, demonstration, offering free products, commitment with goal setting, giving feedback, rewards, financial support, and legislation. Further research shows that some energy-saving theory provides greater benefit to the consumer than do other theories.
Furthermore, behavioural changes can sometimes be effected without explicit changes in attitudes, through regulation or through economic instruments such as pricing, taxation and incentives (Owens & Driffill, 2008).

2.3.1. Curtailment behaviour

In the literature (Abrahamse, et al., 2005), several types of interventions for stimulating energy-savings have been introduced. For example, Nieuwenhuisen examined the possible options for interventions and offered a clear overview of potential interventions (Han, et al., 2013) (Nieuwenhuisen, 2010). On the following pages, see Figure 8 Tree structure of all possible intervention strategies .

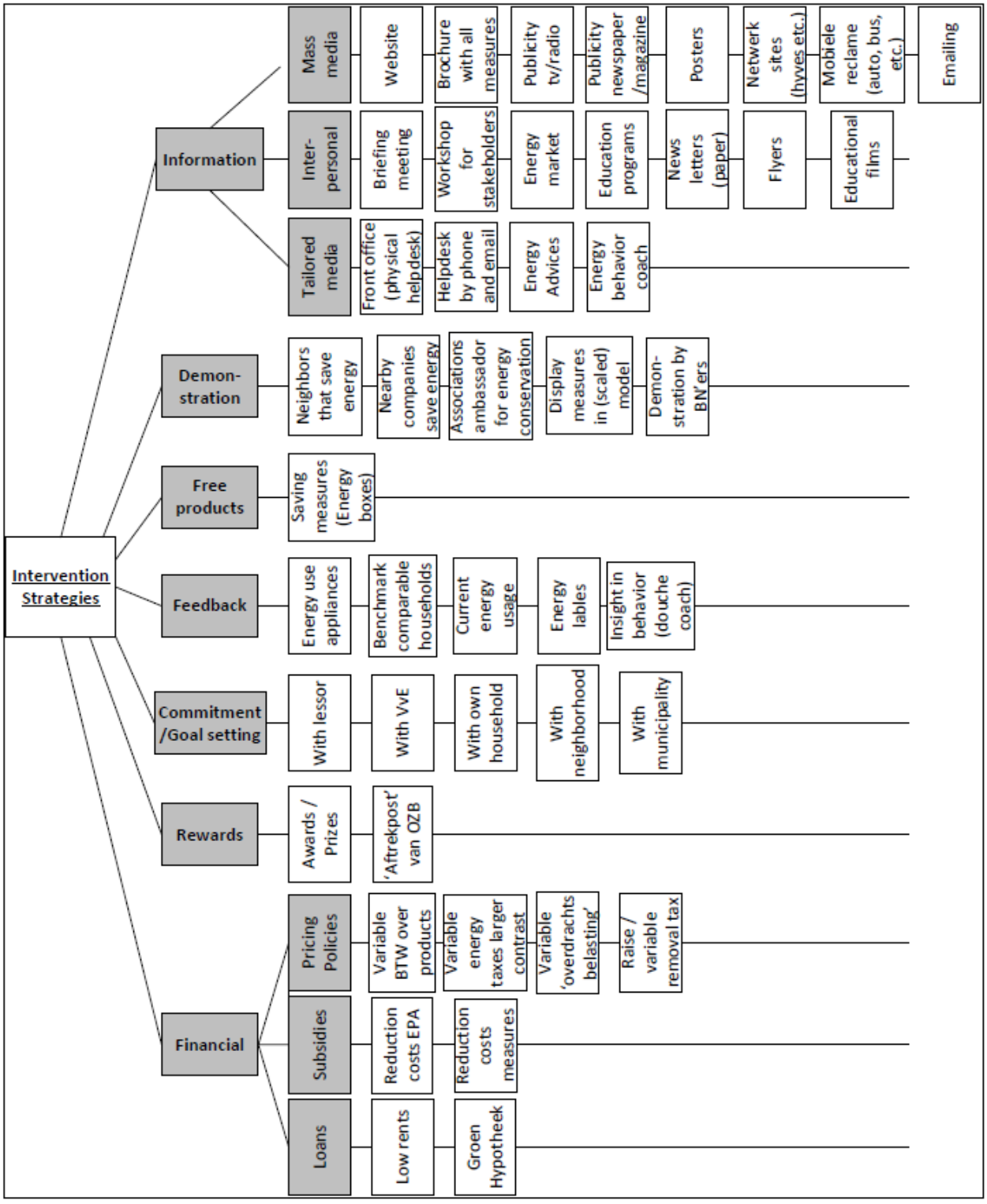


Figure 8 Tree structure of all possible intervention strategies (Han, et al., 2013)

The following pages explain what the different intervention strategies can do to change the behaviour of the consumer.

- **Information**

  Information is a commonly used strategy to promote energy-conservation behaviour. Providing information is aimed to increase people's awareness about energy problems and their knowledge about how to reduce these problems. There are different possibilities for providing people with information: e.g., workshops, mass media campaigns, and tailored information (Abrahamse, et al., 2005). Contrary to popular opinion, mass media campaigns appear not to be effective (e.g. Abrahmase, 2007 cited in (Nieuwenhuisen, 2010)).

- **Commitment and Goal setting**

  A *commitment* is an oral or written pledge or promise to change behaviour. More often than not, this promise is linked to a specific goal—for instance, to reduce energy use by 5%. This promise can be a pledge to oneself, in which case it may activate a personal norm to conserve energy. The promise can also be made public—by means of an announcement in the local newspaper, for example. Then, social norms may play a role as determinants of conservation behaviour. Goal setting entails giving households a reference point—for instance, to save 5% or 15% of energy. A goal can be set by experiments, or by households themselves. It is often used in combination with other interventions, such as feedback (to indicate how households are performing relative to the goal), or as part of a commitment to conserve a certain amount of energy. Commitment may be a successful strategy for reducing household energy use, especially in the view of the long-term effects found in several studies (Abrahamse, et al., 2005).

- **Home audits**

  Tailored information is highly personalized and often very specific information. An advantage of this approach is that participants receive relevant information only instead of getting an overload of general information that may not always apply to their household situation. Examples of tailoring in the realm of energy conservation include energy audits: i.e., home visits by an auditor who gives households a range of energy-saving options (efficiency and curtailment behaviours) based on their current situation. For instance, they may advise a household to apply insulation and lower thermostat settings.

- **Feedback**

  An effective way to achieve energy savings is by providing consumers with information and feedback (Lavrijssen, 2012). *Feedback* consists of giving households information about their energy consumption, or energy savings. It can influence behaviour, because households can associate certain outcomes (e.g. energy savings) with their behaviour (Abrahamse, et al., 2005). This approach increases consumers' awareness and thereby leads to behavioural changes, and it can help to reduce energy consumption between 15% and 25% in some cases (Vassileva & Campillo, 2014).There are several forms of feedback.

Continuous feedback, daily feedback (energy saving between 7% and 13%), weekly and monthly feedback (4, 7%), comparative feedback (unknown). The different percentage are derived from a review (Abrahamse, et al., 2005)

- **Rewards**

  Monetary rewards may serve as an extrinsic motivator to conserve energy. Rewards can either be fixed or contingent on the amount of energy saved (e.g., when a certain percentage is attained). Rewards seem to have a positive effect on energy savings; all studies reviewed in the report of Abrahamse showed significant differences between households who had received a reward and those who had not.

- **Demand response, off-peak periods**

  The growing interest in energy demand has been accompanied by a distinct shift in focus away from the attitudes, behaviours and choices of individuals, towards an engagement with how energy use is constituted socially and materially. Vassileva mentioned that the energy-use awareness of occupants is crucial for the success of demand-response programs: one of the most important features of smart-grid adoption for the current and upcoming smart cities (Vassileva & Campillo, 2014). Studies that examined the effect of giving feedback about the price difference between on- and off-peak hours found this to result in shifts in consumption to off-peak hours, but no difference in overall consumption was found or reported (e.g., Herberlein & Warriner, 1983; Sexton at. Al., 1987 cited by (Abrahamse, et al., 2005)).

To develop a bundle for consumers, it is important to understand how consumers behave and what strategies have an effect on their behaviour. This paragraph provides an overview of the strategies that have had a positive effect on the behaviour of consumers and may therefore be important in developing the energy bundle.

2.4. The consumer and the energy transition

The energy supply is in transition. We are slowly working towards electricity without $C0_2$ emission in 2050. Sustainability is the norm; fossil sources are slowly disappearing. It is expected that by 2020 there will be more wind onshore, offshore wind, co-firing biomass and solar energy, and less production of electricity with gas and coal. Consumers and businesses are increasingly producers of energy. Supply appears more and more on the demand side with changing demand patterns as a result. In upcoming years, the energy sector will state for the challenge to keep the balance between the supply and the demand 24 hours per day. Not only is the consumption of electricity uncertain; the presence of wind and clouds determines how much sun and wind power is available from moment to moment. Possibilities exist for storage and to influence energy demand through financial incentives and compensation systems to ensure that there is sufficient capacity. Converting to a solid system—in which energy remains affordable and the principles of the free market remain intact—seems a difficult puzzle at this moment.

The introduction to this thesis mentioned possible changes in energy systems and behaviours of consumers. But what do those changes mean for the consumer? In the future, energy systems will expect more from the consumer. In addition, the consumer also expects more from the "new" energy grid. A smart electricity network is required by new developments.

A good example of new developments in the markets is the decentralization of energy. The network should have the ability to generate decentralized energy, and it must therefore be resistant to the two-way traffic of the energy system. At this moment, two-way traffic is already possible, as seen in the resupply of self-produced energy from solar panels. However, the advent of citizens' initiatives is expected to have a lot of impact on the energy grid.

Another development concerns the increase of fluctuating power generated by wind turbines and solar panels. It is expected that the demand for electricity by heating pumps and electric cars will increase. To make this possible, it is necessary that energy systems change to meet these new developments. But the question is, what does the consumer want and how will he/she react to these changes? To identify these reactions, several pilot projects have been set up. These projects investigate how new technologies influence the energy behaviour of consumers. One project is Smart Grid: Rendement voor iedereen. The project 'Smart Grid: Efficiency for all', will develop and test a range of new and user-supported services around electricity networks of the future. The test will take place in two medium-sized smart grids every hundred households in Amersfoort and Utrecht.

An example of the news presented to the residents:
"*Profit4All has already been going on for two weeks. By using the appliances that use a lot of energy not in the evening but instead during the sun peak, you can save 20 cents. That is similar to what you normally pay. Between 11.00 and 13.00 you get a 15 cent discount off your electricity tariff. For example, your dishwasher is running now after eating. This is the peak, and you get a 5 cent reduction on your tarriff. Thus, shifting the use of the dishwasher from the peak moment to the sun peak can ensure a 20 cent discount. And so the dishwasher can be used for free* (Jansen, 2014)*."*

The news message indicates that the project, Rendement Smart Grid voor iedereen, investigates whether people are shifting their activities to moments when the energy is cheaper.

The ability to shift demand moments to a lower electricity price or to a greater supply of renewable electricity will be very important in the future. In addition, flexible consumer behaviour and future potential of electricity storage are essential. To establish flexible behaviour among consumers, different motivations should be taken into account. Some consumers want to contribute to a more sustainable energy system, while others prefer to get a discount on their utility bill or will be happy to be self-sufficient. At the moment, there is no possibility for the consumer to use new developments as they want. The good news is that the government encourages the arrival of the new technologies such as subsidies for pilot projects and the rural import of the smart meter.

Through the smart meter, the consumer has more control over their energy consumption. It is possible to connect the smart meter with new smart technologies such as TOON[1] through apps on your cell phone (Stedin, sd) (ECN, Energie-Nederland, Netbeheer Nederland, 2013).

2.5. Energy Bundle

The behaviours of consumers and changes of the energy sources constitute a problem at this moment and will in the future. The problems that occur were described in earlier paragraphs. This section describes a possible solution to the energy transition: namely, the energy bundle. An *energy bundle* consists of several characteristics that can ensure the energy-behaviour change of consumers. Later in this section, the characteristics of the energy bundle and the impact of these characteristics on consumers will be described. How can consumers be affected and how can an energy bundle use the characteristics of the consumers to change their behaviour?

A good example of behaviour change is the waste-separation system of Avri. Avri is a waste-disposal company in a region in Gelderland. Avri is committed to optimal separation of waste. Consumers in the region pay a fixed amount each year and each time that Avri picks up their waste (garbage). Plastic and organic waste will be picked up for free. For consumers, this is an easy way to save costs and to contribute to a sustainable environment. Within two months the waste system caused 37% less garbage and 60% more collected plastic and a doubling of the amount of organic waste. This system provides consumers with an easy way to save money and with the ability to contribute to environmental sustainability. This is an effective way to influence the behaviour of the consumers. Before this system was introduced, it did not matter what the consumers did with their waste, because the consumers had to pay a fixed amount per year. Now people can consciously deal with their savings. The Avri system is an example of the energy bundle. With the energy bundle, the consumers will be affected in an easy way, like the Avri system, so that they can easily save energy and money and can contribute to a more sustainable environment.

Energy savings is of course not the only way to solve the problem. An important way to ensure a payable energy network in the future is demand response. It is important to investigate when consumers perform different activities and if they are flexible and how can this flexibility can be used. By finding out whether consumers are flexible can be clearly whether it is possible to introduce demand response or peak-off moments. To ensure that the energy bundle does not have a positive impact on the network only. The energy bundle is construct with different attributes. Whereby it also has positive influence on the energy consumer. Figure 9 the characteristics of the energy bundle, shows what the energy bundle consists of. The attributes are carefully chosen so that the characteristics can provide something for consumers and network operators.

[1] TOON is the smart thermostat of Eneco. More information about TOON on the website of www.eneco.nl/toon

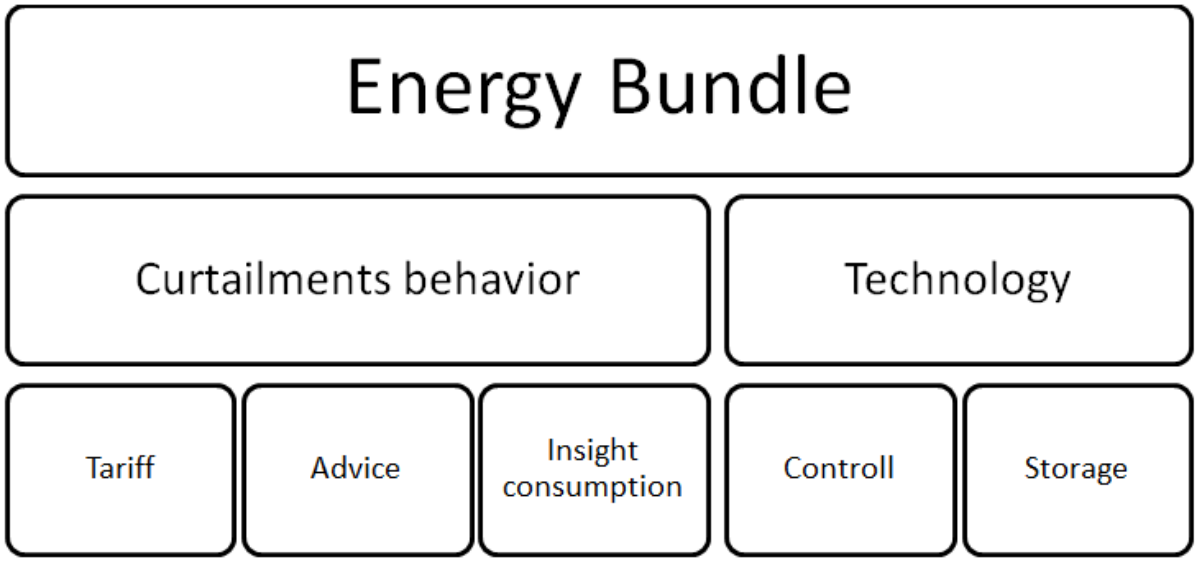


Figure 9 the characteristics of the energy bundle

Characteristics	Explanation
Variety of tariff	The variation of tariff shows what kind of flexible tariff the consumers have and whether or not they have moments where the energy tariff is lower than at other times. Because of this attribute, it is checked whether people change their activities on the basis of the variation of tariff.
Control	Control is an important attribute for the network operator. But Control can make life easier for consumers. Devices can search automatically for the best moment go on or out, based on the energy price. Network operators can thus control the devices or influence the devices on the basis of the amount of energy that is available. For example, the car can be recharged at times when there is a surplus of energy and not be recharged when there is a shortage. It is important to mention that consumers here obviously do not have any adverse effects.
Advice	As mentioned before, consumers are influenced on the basis of certain behaviour strategies. The curtailment strategies are described in paragraph 2.3. The conclusion of this paragraph, specific information about energy savings can ensure that a household can save energy depending on the level of advice. (Abrahamse, et al., 2005)

Insight energy consumption	Research shows that when consumers receive information about their energy costs or their consume energy that energy will be saved. Conscious as well as unconscious. (Abrahamse, et al., 2005). If consumers have a clear picture of when energy is cheaper or more expensive, they might adjust their activities. This is of course possible in combination with tariff.
Storage	Energy can be stored both for the benefit of network operators and for consumers. If consumers store energy when there is a surplus to use if there is shortage, then consumers save money. At this time a pilot is being carried out called Project Storage Of Energy. There is development going on. At this time, it is still not usable, but it will probably be useful for anyone in the future.

CHAPTER 3. RESEARCH DESIGN

This chapter explains the process of this research. It starts with a research model in paragraph 3.1. Paragraph 3.2 describes the choice for and set-up of the stated-preferences experiment. Paragraph 3.3 discusses how the analysis was conducted and why it was chosen for ordinal regression analysis. Paragraph 3.4 explains the theory of a business canvas.

3.1. Research model

To achieve the objectives of this research and to answer the questions listed in section 1.3, the research is subdivided into 3 main parts (see Figure 10 Research Model). The research process is divided into 3 parts. First, insight into the consumption and behaviour of the consumer was gained. Second, the preferences of individuals regarding the most important factors were analysed. Lastly, the results, ideas and opportunities of the energy bundle are collected in from of the business canvas.

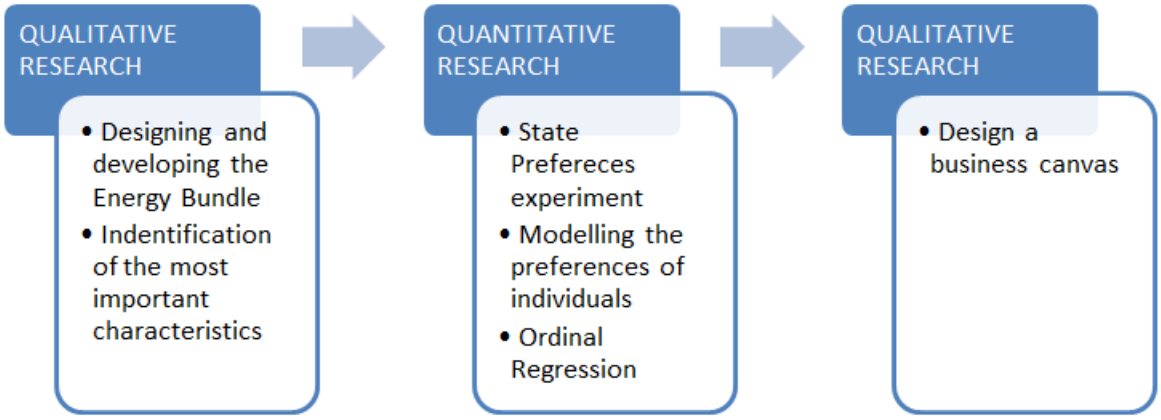


Figure 10 Research Model

3.2. Stated-preference experiment

Stated-preference modelling, which was introduced by Louviere and Hensher in 1982 and by Louviere and Woodworth in 1983, is a method applied to investigate consumers' preferences and market shares regarding hypothetical alternatives by presenting different, mutually exclusive, future alternatives or scenarios (composed by means of experimental designs). Respondents are asked to choose the scenario they consider best: a first-preference choice task (E.g. Hensher, 1994 cited in (Heuvel van den, 2014)).

Stated preference (SP) was chosen for this study over revealed preference. In the SP survey, the respondent is asked what he or she would do in a specific situation that the researcher designed.

The main advantages and disadvantages of stated preferences compared to revealed preferences are the following:

Advantages of Stated Preference (SP):

- SP can obtain ranking, rating and choice information, whereas revealed preferences (RP) can obtain only choice results;
- SP can capture hypothetical behaviour and non-existing alternatives, whereas RP can only capture existing alternatives and observable behaviour;
- No measurement errors exists in SP data;
- The range of attribute levels can easily be extended; the range of attributes in RP situation is limited;
- The ability to control multi-colinearity among attributes exists in SP;
- The choice set can be defined in a brief and clear way, and more responses can be gathered per respondent.

Disadvantages of Stated Preferences:

- Behaviour in reality can be inconsistent with SP choices; no real correlation with answers exists. In contrast, RP is derived from observed behaviour, so this is always consistent;
- Biases can occur respondents try to justify their actual behaviour of try to control policies;
- SP data must be collected in a highly specific fashion in order to avoid temporal, learning and segment biases. (Adapted from Sanko, 2001 in (Lem, 2014)

This study uses stated preferences instead of revealed preferences, both because of the need to investigate preferences of consumers regarding non-existing energy bundles, and because it examines the impact of energy bundles on certain activities.

3.3. Analyses model: Ordinal Regression

This section discusses the theory of the Ordinal Regression model. The data analysis is based on the Ordinal Regression model. This model was chosen because the respondents will rate the different energy bundles on an ordinal scale instead of choosing. The *ordinal regression model* is a model used for analysing preferences gathered on an ordinal measurement level. Application of standard logistic regression provides good insight into the cause of the occurrence of mutual cooperation. However, this analysis can be refined because the dependent variable is the level of preferences or willingness. By using an ordinal regression model that is specifically developed for ordinal data in which the distances between categories are unknown, the ordinal categories can be used as directly dependent variables. In ordinal regression, an underlying score is estimated as a linear function of the independent variables and a set of cut-off points. The probability of observing outcome *i* corresponds to the probability that the estimated linear function, plus rand error term *ε*, lies within the range of the cut-off points estimated for the outcome (e.g. StataCorp, 1999 cited in (Blokhuis, 2010).

$$\Pr(outcome_j = i) = \Pr(k_{i-1} < \sum_{i=1}^{k} \beta_i x_{ij} + \varepsilon \leq k_i$$

The regression coefficients, β_1, $\beta_{2, ..}$ β_k, which are related to the physical characteristics (x_{ij}), together with the cut-off points, k_1, k_2, …. k_{i-1}, where *i* is the number of possible outcomes, are estimated (Train, 2003 cited by (Blokhuis, 2010): k_0 is taken as - ∞ and k_i is taken as + ∞.

In this research, five levels of preference are distinguished. Respondents are assigned a level of preference on the basis of the level of the linear function plus random error term. The probabilities enter the log-likelihood function as usual, and maximization of the likelihood function provides estimates of the parameters (Blokhuis, 2010) (see section 5.4).

3.4. Business canvas

Chapters 2 through 5 will investigate the energy consumption of the households. The questionnaire if focused on the individuals, the respondents. This leads us to the last sub-question of this research: How can the conditions of different consumers be merged into one business canvas for a particular group of consumers? Chapter 6 will look for the opportunities and threats of merging different types of consumers into one canvas and the opportunities of the energy bundle: the business canvas. This section of the research design explains the theory behind the business model.

Research has shown that business models are the key to the success of a business. These business model concepts typically capture the sources of costs and revenues together with descriptions of the products, services, market participants and the value-chain position with the customers' and suppliers' benefits. However, the theoretical foundations of the business model concept display some inconsistencies in underlying assumptions, and the term 'business model' has been used in many different ways in management literature. To illustrate this, some examples of business models are given below. Amit & Zott (2001), Osterwalder & Peigner (2010), Blank & Dorf (2012), Chesbrough (2010) and Teece (2013) follow the same line in describing a business model. Amit & Zott (2001) define the business model as, depicting 'the content, structure, and governance of transactions designed so as to create value through the exploitation of business opportunities'. According to Osterwalder & Peigner (2010), 'a business model describes the rationale of how an organization creates, delivers and captures value' (Kerstens, 2014). Because of time pressure and scope, this research does not investigate which business model fits best for this study. The model is chosen for the business canvas from Osterwalder.

The Osterwalder business-model canvas is visualized in Figure 11 Business Canvas. It consists of nine different building blocks: the value proposition, customer segments, channels, customer relationships, revenue streams, key resources, key partners, key activities and cost structure. These different building blocks are explained in Table 3 Building blocks of the Osterwalder Business model (Kerstens, 2014).

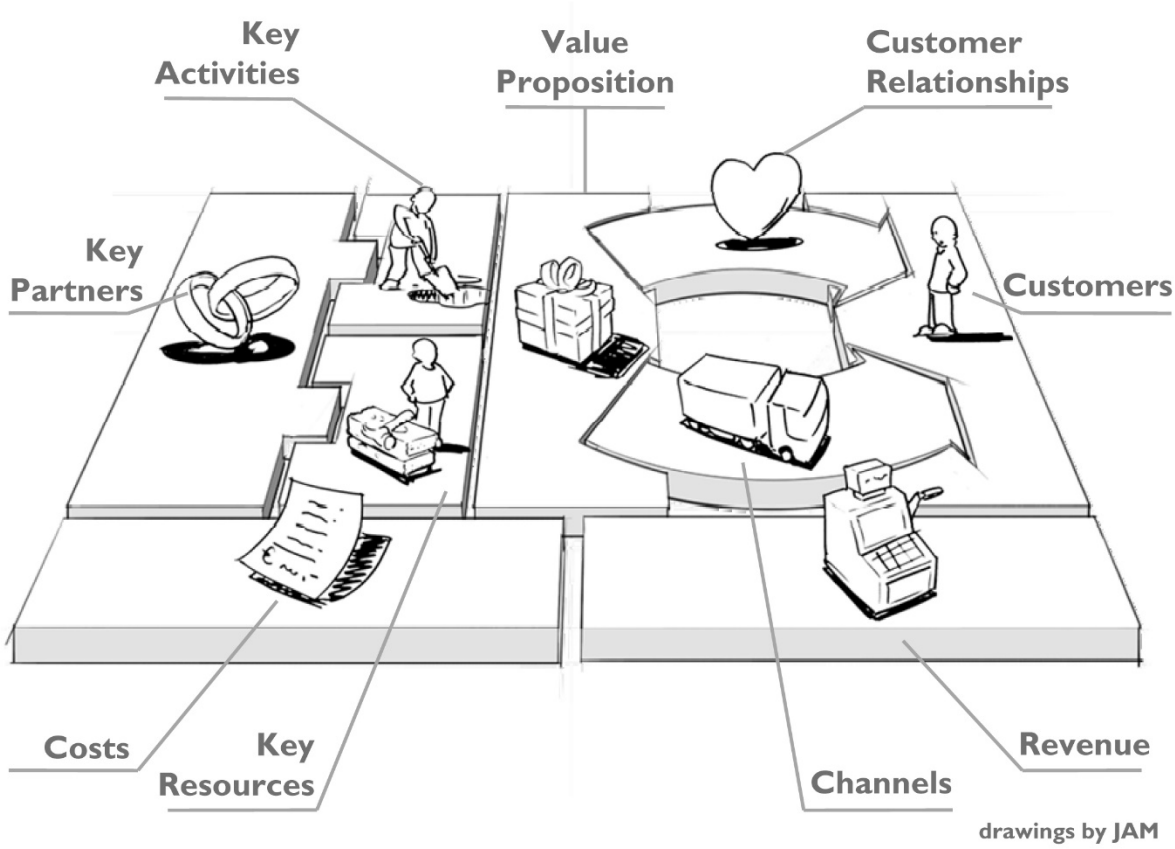


Figure 11 Business Canvas

Building Blocks	Explanation
Value proposition	The value proposition identifies the design, price, cost reduction, risk reduction, accessibility and convenience involved in using or buying a product or service. It describes the product so that customers are satisfied with the product and so that it creates value for them. The creation of a value proposition is challenging when the business model addresses a new market. It is not known whether there are really customers for the developed products and services. When thinking in terms of solving the customers' problems, it is interesting to know why competitors did not already address it and why the problem is so hard to solve.
Customer Segment	The centre of all business models is the customer. To satisfy their needs, a business first needs to know its potential customers and have a grip on their social, financial and geographical situations. It is important to discover who they are and what their daily routine is, where the business' product fits in and what would really make the customers' lives easier. With all this information, customer archetypes can be created that are grouped according to common behaviour, wishes, type of relationship, channels, profitability and other attributes.
Channels	Channels have the purpose of creating awareness of a product or service among customers. They can handle evaluation of the delivered value, are a means for purchasing and delivering products or services, and handle after-sales services.

Customer relationships	Customer relationships can be identified in different ways for specific customer segments. The first step is getting customers through the different channels described above. The next step is to keep and grow customers, as this is cheaper than attracting new customers. Creating customer relationships is the result of complex interactions between customers, channels, value proposition and marketing budget, and can lead to a repeatable, scalable and profitable business model.
Revenue streams	Revenue streams determine the strategy a business uses to generate cash from each customer segment.
Key partners	For determining key partners, it is necessary to know what the partners deliver and what the business has to do in return. The advantages of partnerships include performing activities on a higher economic scale to reduce costs, risk reduction in a competitive environment or acquisition of certain resources and activities. Partnerships can consist of strategic alliances, competition (strategic partnerships between competitors), joint ventures or buyer-supplier relationships to assure reliable supplies.
Key resources	Key resources are meant to create value for the customer. They are key assets for business operation and can be physical, intellectual, human or financial resources.
Key activities	Key activities consist of the actions needed to keep the business model running and to execute the value proposition. Examples include production, problem solving, consultancy or networking.
Cost structure	This building block represents the costs for running the business. There are two broad categories of cost structures of business models: cost-driven business models and value-driven business models. Cost-driven business models focus on minimizing costs wherever possible. Value driven models focus on value creation.

Table 3 Building blocks of the Osterwalder Business model (Kerstens, 2014)

CHAPTER 4. EXPERIMENTAL DESIGN

This chapter will provide insight into the method that was applied in this research to gain insight in the consumers' preferences concerning energy bundles. As indicated above, a stated-preference experiment was set up to measure the preferences of consumers. This chapter will explain how this experiment was constructed. For an appropriate and structured design, the guidelines provided by Hensher, et al. (2005) were applied. The problem statement of the research is refined in paragraph 4.1. Attributes and attribute-levels are identified and refined in paragraph 4.2 with insights from literature. In paragraph 4.3, the experimental design is introduced. Next, in section 4.4, the experimental design is generated and attributes are allocated. Paragraph 4.5 describes the composition of choice sets. The design of the experiment is explained in paragraph 4.6.

The primary source of preference response used in this research is stated-preference data. Stated-preference method identifies behavioural responses to choice situations that are not available in the market and in which the attribute levels offered by existing choices are modified to such an extent that the reliability of revealed preference models as predictors of response is brought into question (Hensher, 1994). With the stated-preference approach, reliable estimates of the relative importance of each attribute is provided. It allows robust understanding of how individuals make choices by observing multiple instances of choice from one individual. Individuals can be assigned to corresponding user groups (Dumont & Falzarano, 2012).

4.1. Research questions refinement

As explained in the previous chapters, demand response is a solution for the energy transition and growth of fluctuating energy sources like wind and sun. Demand response includes all the changes in electric usage by end-use consumers from their normal consumptions patterns in response to changes in the price of electricity over time. Achieving such demand-side management is called *flexibility*: the ability of users of energy to change how, when (and where) they demand power (Powells, et al., 2014). Paragraph 2.5 discussed the possibilities of this idea in the form of an energy bundle. The more consumers are willing to change their activities based on the demand of energy, the better it is for the environment and for the price of energy. We must ask, however, when consumers want to change, and for what reason they will change, and what they want to get in return. To answer these questions, the main research question for this study is the following:
Under what conditions are consumers willing to give up their flexibility in energy consumption, in the concept of the energy bundle?

How can we ensure that people become aware of their energy consumption and don't use random energy as is now the case? They need to be challenged or stimulated to use energy according to a certain manner or pattern or just by technology, so that each household has its own daily or weekly patterns that are arranged so that a balance arises between the supply and the demand of energy. This is to be done through technology that now exists and that will still be developed.
A good example of one of the technologies involves the storage of energy. At this moment, energy storage is still in a testing phase; but storage is expected to be available to consumers in the future. This allows them to save energy when there is an oversupply of energy--from wind or sun, for example—and to use this stored energy when energy is more expensive. All of the forms of changes of consumers are called demand response. This is explained in the literature study, chapter 2.

4.2. Identification and refinement of attributes and attribute-levels

The attributes that influence the preference or the decision-making of the consumer form an alternative: an energy bundle. An energy bundle has a fixed number of attributes. The assignment of the respondents is to indicate what preference he/she has for an energy bundle (Hensher, et al., 2005).
This step consists of alternative identification, attribute identification and the attribute-level identification. The first step at this stage concerns the selection of relevant attributes. Next, attribute levels have to be defined. The selection of attributes is based on the literature study and on the survey among experts by Stedin, and it forms the input of this experiment. In order to shorten the questionnaire, only attributes and attributes levels that are relevant for the potential target group will be considered in the questionnaire. The second step involves the determination of attribute levels. The remaining 5 attributes, including the associated levels used in the experiment, are presented in Table 4 Selected attributes and corresponding levels.

Attribute	Level	Labels
1. Tariff type	0	Fixed
	1	4 day parts
	2	Flexible
2. Control	0	No
	1	Self-Control
	2	Automatic
3. Insight energy consumption	0	Yearly
	1	Monthly
	2	All time
4. Advice	0	No Advice
	1	General
	2	Personal
5. Storage	0	No
	1	Yes

Table 4 Selected attributes and corresponding levels

- **Tariff**

This attribute indicates the type of energy tariff: flexible or fixed. From the literature study, it is clear that consumers can be influenced through price. In previous studies, different ways of investing were investigated. Consumers can invest their money to save energy (investment behaviour), or can be influenced by price curtailment. To investigate whether consumers are influenced by price, tariff type has been added to the energy bundle with the following levels.

- Fixed price: Always a fixed price. This is the current situation in the Netherlands.
- 4 day parts: The tariff is predetermined per day-part. Per day part, a certain price will be established. Four day parts have been chosen so that the moments when the sun is shining and when few people use power will be cheaper than the other two parts.
- Flexible: The day before, the tariff is determined for the next day.

- **Control**

Control specifies whether a consumer has the possibility to monitor his/her energy consumption by using a smart thermostat, smartphone, and other devices that can communicate with each other. The following levels are defined.

- No control: The consumer has all the control, but this means that the consumer cannot use devices that communicate with each other or with thermostats. This is a typical situation in the Netherlands.
- Self-Control: Using tools can exercise control on the consumers' devices and appliances, allowing them to communicate with each other to ensure that the consumer can make optimal use of energy. The consumer always has the control.
- Automatic: Smart devices are set to take advantage of the most favourable times without their users doing something. This method of energy consumption is the most optimal, because the devices ensure that energy is used at the lowest tariff.

- **Insight-energy consumption**

Specifies how often a consumer can view his/her energy consumption. The following levels are defined.

- Yearly: the consumer gets the final payment every year. This is the current situation in the Netherlands.
- Monthly: the consumer can check energy consumption every month.
- All time: the consumer can check energy consumption whenever he/she wants.

- **Advice**

Advice indicates at which level you can get advice to ensure that you know how to save energy and which possible beneficial investments you can make at your home or environment.

- No advice at all: the consumer gets no advice.
- General advice: the consumer gets general advice.
- Personal advice: the consumer gets personal advice concerning the most profitable way to save energy given their current situation.

- **Storage**

Storage specifies whether the consumer can use energy storage, whether the consumer can save energy when the energy price is low or when the consumer generated his/her own energy and used the stored energy at different times.

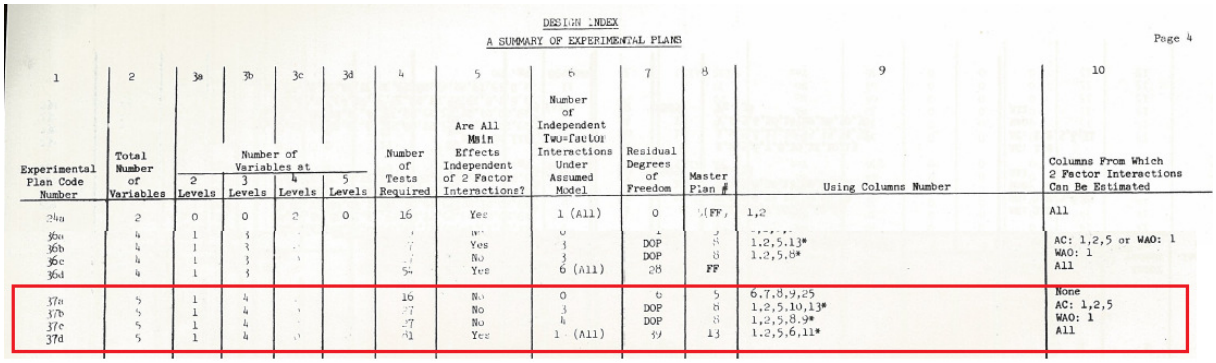
- Yes
- No

Attributes 2, 3, and 4 are based on the curtailment behaviour of the energy consumer. As discussed in chapter 2, Identifying The Energy Consumer, these intervention strategies can influence the energy consumption of the consumer. They can also ensure that the consumer saves energy. Attribute 1 is chosen to stimulate the behaviour the consumer based on the variety of tariff. And attribute 5 is a possible solution for the future. Further explanation about the composition of the energy bundle can be found in chapter 2.5: Energy Bundle.

4.3. Generation of experimental design and allocation of attributes

The next step is to combine attribute levels into alternatives which can be evaluated by respondents. The characteristics are established and the experiment can be generated. This means that the combination between the attribute levels has to be made. A full-factorial design would result in 162 alternatives ($3^4 * 2^1$). This is based on an unlabelled experiment in which the number of alternatives is calculated by L^A. *L* represents the number of levels and *A* the number of alternatives. With this type of design, it is possible to estimate all main effects and all interaction effects independent of one another. But from a practical perspective this ensures that the questionnaire is too long to handle by the respondents, so the experiment will be based on a fractional factorial design (Hensher, et al., 2005).

The number (minimum number) of treatment combinations necessary for a fractional factorial design is based on Figure 12 Design index: a summary of experimental plans .



DESIGN INDEX
A SUMMARY OF EXPERIMENTAL PLANS

Page 4

1	2	3a	3b	3c	3d	4	5	6	7	8	9	10
Experimental Plan Code Number	Total Number of Variables	Number of Variables at 2 Levels	3 Levels	4 Levels	5 Levels	Number of Tests Required	Are All Main Effects Independent of 2 Factor Interactions?	Number of Independent Two-Factor Interactions Under Assumed Model	Residual Degrees of Freedom	Master Plan #	Using Columns Number	Columns From Which 2 Factor Interactions Can Be Estimated
24a	2	0	0	2	0	16	Yes	1 (All)	0	1 (FF)	1,2	All
36a	4	1	3									
36b	4	1	3				Yes	3	DOP	8	1,2,5,13*	AC: 1,2,5 or WAO: 1
36c	4	1	3				No	3	DOP	8	1,2,5,8*	WAO: 1
36d	4	1	3			54	Yes	6 (All)	28	FF		All
37a	5	1	4			16	No	0	6	5	6,7,8,9,25	None
37b	5	1	4			27	No	3	DOP	8	1,2,5,10,13*	AC: 1,2,5
37c	5	1	4			27	No	4	DOP	8	1,2,5,8,9*	WAO: 1
37d	5	1	4			81	Yes	1 (All)	59	13	1,2,5,6,11*	All

Figure 12 Design index: a summary of experimental plans (Hahn & Saprio, 1966)

The number of treatment combinations depends on the number of attributes that need to be estimated. In this case, there is a total of 5 different attributes: 4 attributes consist of 3 levels, and 1 consists of 2 levels. A combination of the levels results in 16, 27 or 81 treatment combinations.

This is significantly smaller than the 162 treatment combinations within a full factorial design. The more attributes that need to be estimated for the experiment, the more treatment combinations are required for the experiment. To come to a decision, the choice is based on column 4, Number of Tests Required, and 6, Number of Independent two-Factor interactions Under Assumed Model. To have a small number of alternatives experimental plan code number 37d (81 alternatives) drops out. To get more information about the preferences of the consumer, the interaction between attributes can be investigated. Column 6 shows if it is possible to examine the interactions between attributes. This means that only the numbers 37b and 37c remain. Now it is the choice between attributes that can have interactions with all the others or with three self-selected interactions. The preference for this research is the self-selected interactions, and thus number 37b.

In total, 27 treatment combinations are sufficient to create an orthogonal uncorrelated design. See Figure 12 Design index: a summary of experimental plans . Hahn & Shapiro (1966) have provided a design matrix, Master Plan 8, that belongs to Experimental Plan Code 37b which resulted from the design consideration. This plan, based on number of attributes and their levels, is translated into a workable and clear design matrix, and the explanation of the symbols can be found on the next page in Table 6 Design matrix and explanation of the symbols.

The correlation test shows that all attributes are statistically independent (uncorrelated). See Table 5 Correlation matrix. Orthogonality between the design attributes represents the basic criterion in the generation process. Optimal designs optimize the amount of information obtained from a design and are considered statistically efficient. By using the predefined orthogonal fractional factorial design, the amount of information obtained from a design is optimized and correlations within the design are minimized to zero (Hensher, et al., 2005)

	TT	CO	IE	AD	OP
TT					
CO	0,00				
IE	0,00	0,00			
AD	0,00	0,00	0,00		
OP	0,00	0,00	0,00	0,00	

Table 5 Correlation matrix

Treatment combinations	Design Matrix					Symbol	Explanation
	TT	CO	IE	AD	OP	TT	Tariff type
1	*0*	*0*	*0*	*0*	*0*	CO	Control
2	*0*	*0*	*1*	*1*	*0*	IE	Insight Energy cost
3	*0*	*0*	*2*	*2*	*1*	AD	Advice
4	*0*	*1*	*0*	*1*	*1*	OP*	Storage
5	*0*	*1*	*1*	*2*	*0*		
6	*0*	*1*	*2*	*0*	*0*		
7	*0*	*2*	*0*	*2*	*0*		
8	*0*	*2*	*1*	*0*	*1*		
9	*0*	*2*	*2*	*1*	*0*		
10	*1*	*0*	*0*	*0*	*0*		
11	*1*	*0*	*1*	*1*	*0*		
12	*1*	*0*	*2*	*2*	*1*		
13	*1*	*1*	*0*	*1*	*1*		
14	*1*	*1*	*1*	*2*	*0*		
15	*1*	*1*	*2*	*0*	*0*		
16	*1*	*2*	*0*	*2*	*0*		
17	*1*	*2*	*1*	*0*	*1*		
18	*1*	*2*	*2*	*1*	*0*		
19	*2*	*0*	*0*	*0*	*0*		
20	*2*	*0*	*1*	*1*	*0*		
21	*2*	*0*	*2*	*2*	*1*		
22	*2*	*1*	*0*	*1*	*1*		
23	*2*	*1*	*1*	*2*	*0*		
24	*2*	*1*	*2*	*0*	*0*		
25	*2*	*2*	*0*	*2*	*0*		
26	*2*	*2*	*1*	*0*	*1*		
27	*2*	*2*	*2*	*1*	*0*		

Table 6 Design matrix and explanation of the symbols

* *If a two-level attribute is assigned to a three-level column then all number 2's are changed to 0's (see section 3C for further discussion); referred to as "Collapsing the attribute".*

4.4. Generation of the evaluation task

An evaluation set consists of one or more different treatment combinations. Alternatives consist of a set of attribute levels, of which the respondent has to rate the alternative that he/she prefers. The respondent has to evaluate 3 different energy bundles, which will be offered in random order.

Figure 13 an example of an evaluation task illustrates an example of an evaluation task. As can be seen, in each case one energy bundle will be present. Every evaluation set is named Energie bundel (energy bundle). As this is a stated-preference experiment, the decision maker should rate every energy bundle. To find out whether consumers will be willing to adjust their activities to the energy bundle, the consumer is asked to evaluate two other sets about their activities. (See Figure 14 Evaluation set about the activities on the next pages.) In this way, it is possible to examine what attributes are important for the consumer in relation to the activities.

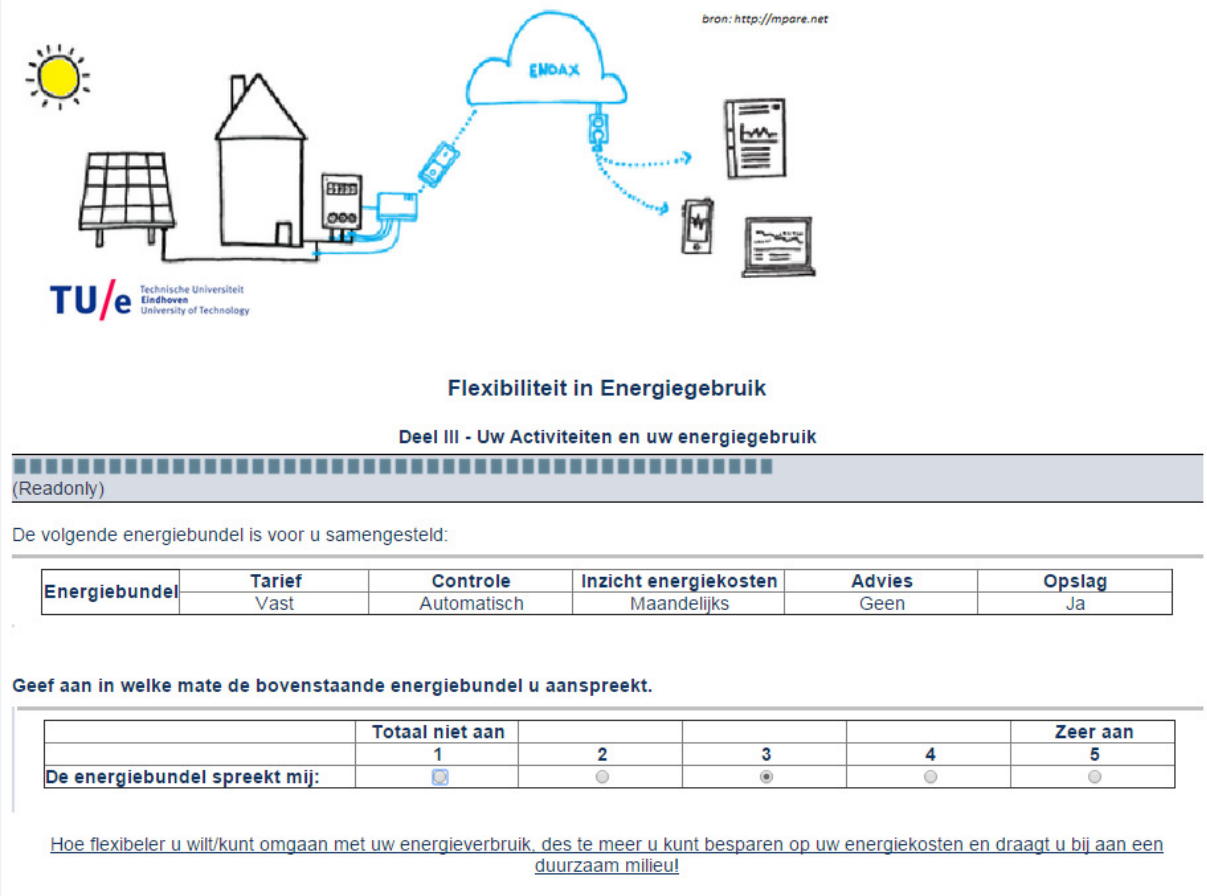
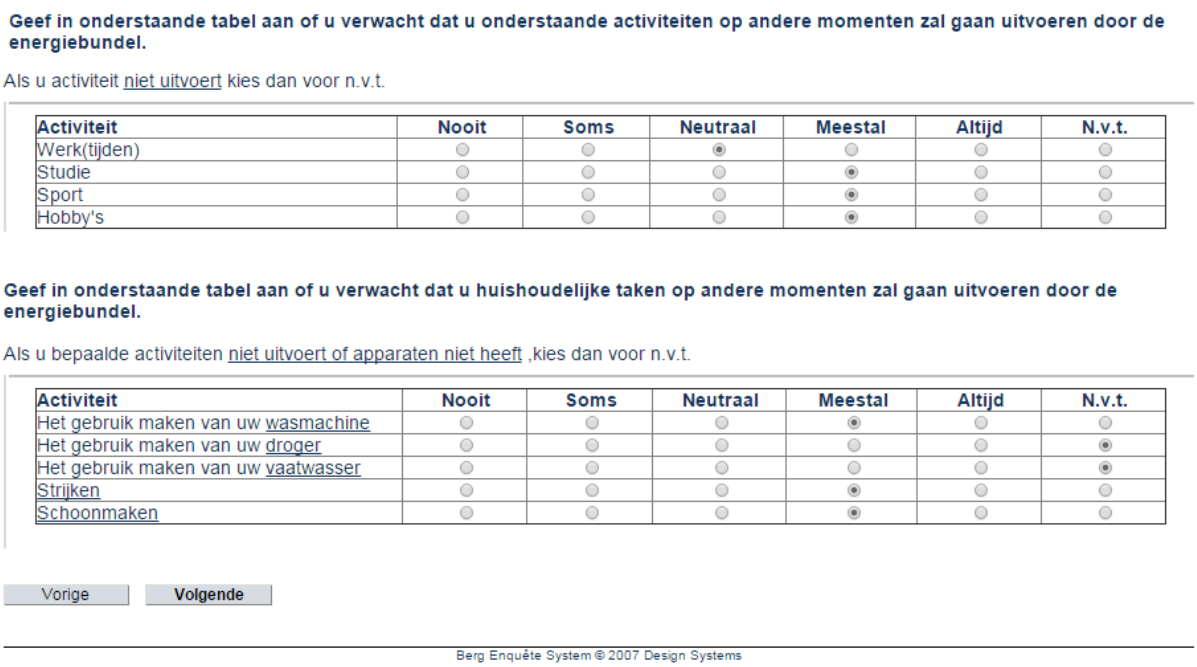


Figure 13 an example of an evaluation task from the questionnaire



Geef in onderstaande tabel aan of u verwacht dat u onderstaande activiteiten op andere momenten zal gaan uitvoeren door de energiebundel.

Als u activiteit niet uitvoert kies dan voor n.v.t.

Activiteit	Nooit	Soms	Neutraal	Meestal	Altijd	N.v.t.
Werk(tijden)	○	○	◉	○	○	○
Studie	○	○	○	◉	○	○
Sport	○	○	○	◉	○	○
Hobby's	○	○	○	◉	○	○

Geef in onderstaande tabel aan of u verwacht dat u huishoudelijke taken op andere momenten zal gaan uitvoeren door de energiebundel.

Als u bepaalde activiteiten niet uitvoert of apparaten niet heeft ,kies dan voor n.v.t.

Activiteit	Nooit	Soms	Neutraal	Meestal	Altijd	N.v.t.
Het gebruik maken van uw wasmachine	○	○	○	◉	○	○
Het gebruik maken van uw droger	○	○	○	○	○	◉
Het gebruik maken van uw vaatwasser	○	○	○	○	○	◉
Strijken	○	○	○	◉	○	○
Schoonmaken	○	○	○	◉	○	○

Vorige Volgende

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Figure 14 Evaluation set about the activities

4.5. Survey instrument

A Dutch internet-based questionnaire was distributed to a random sample of respondents in the Netherlands. The questionnaire is presented in Appendix. This questionnaire was set up in the Berg Enquête System, an online survey tool.

Questions and information relate to the respondent's current level of experience and appear realistic. There should not be sentences with multiple interpretations. The questionnaire was tested for these sorts of flaws by around 10 test respondents. The test respondents consisted of experts form Stedin and people without knowledge about the subject. Totta Research and TNS Nipo also checked the interpretation of the questions. A second bigger test-questionnaire involves 50 respondents.

There are two sources of influence on preference behaviour: first, characteristics that relate to the individuals' preconceptions that are represented by socio-economic and socio-demographic variables and context influence; second, attributes that relate to the description of the alternatives. To gain insight into both sources of influence, the questionnaire consists of a stated-preference part and of background questions about individual. The aim is to find homogeneity within groups and heterogeneity between groups. With this information, different groups can be addressed in the right way. Consumer characterization can be done by socio-demographic factors, attitudes and habitats.

The awareness of energy and the activities from the respondents is questioned. Therefore insight is provided by questioning the participants about their housing situation and their energy-saving devices and questioning about their daily activities. In the following four sections, these 4 parts, including the stated-preference part, are explained.

However, before respondents are questioned about personal factors, they must agree to two requirements: the respondent needs to be older than 20 and living in the postcode area 2000-4000. This decision was made because the subjects need to be full-grown adults and because the postcode area is the work area of Stedin.

4.5.1. Part 1: Housing situation and energy–saving devices

First, Table 7 Part 1 of the questionnaire, a set characterizations is presented. The respondent will be questioned about those characteristics. The questions are about their home owner and year of construction and applying energy-saving devices; applications that have relation with the awareness and the use of energy.

Home owner	Year of construction	Applications
Owner-occupied (Co)-owners	Before 1945	Solar panels
Rented house (private landlord)	1945 - 1964	Solar water heater
Rented house (Housing association)	1965 – 1984	Heat pump
Others	1985 – 2005	HR Boiler
Tools	I do not know	Roof isolation
Smart Thermostat		Facade isolation
Clock Thermostat		Floor isolation
Online Energy Monitoring		Double glazing
Energy monitoring in Excel or Paper		LED lighting
None of the above tools		Home appliances with A+,A++, A+++ label
		None of the above applications

Table 7 Part 1 of the questionnaire

The link between the characterizations and the energy bundle is that respondents can be grouped on the basis of the characterizations of Table 7.

Commissioned by Stedin has the company Motivaction research, research been done to segmentation of the energy consumer. The consumers can be divided into 4 groups: unconscious energy users (32%), pragmatic comfort seekers (23%), environmentally conscious improvers (32%) and the dutiful environmentally conscious (13%) (Randsdorp & Schoemaker, 2014). This study clearly shows that energy consciousness determines how consumers will react to their energy use. The data of the questionnaire can be investigated to determine whether it is true that respondents with energy-savings devices react differently than respondents without energy-savings devices or with the use of tools. The link between homeowners and energy-savings has not yet been made in the literature. However, these points all link to energy behaviour of the respondents, and questioning this can yield insight into whether there is a link.

4.5.2. Part 2: Activity schedule

To gain insight into the flexibility of the respondents, the respondents were questioned about their work, study, sport, leisure and households activities. Those activities are the most common activities and usually exclude household activities.

In order to examine whether respondents have the ability to be flexible in their own time, the questionnaire asked the respondent by activity if they have fixed moments, flexible time, or if do not perform this activity. Part 2 provides insight into what kind of activities the respondent performs and when, whether he/she has fixed time to start and end, and whether their start and end times are flexible. Figure 15 Questionnaire Part II Activities, shows how this was evaluated. Here it is important that the respondents indicate when they perform activities outdoors, because it cannot be analysed when they are not at home.

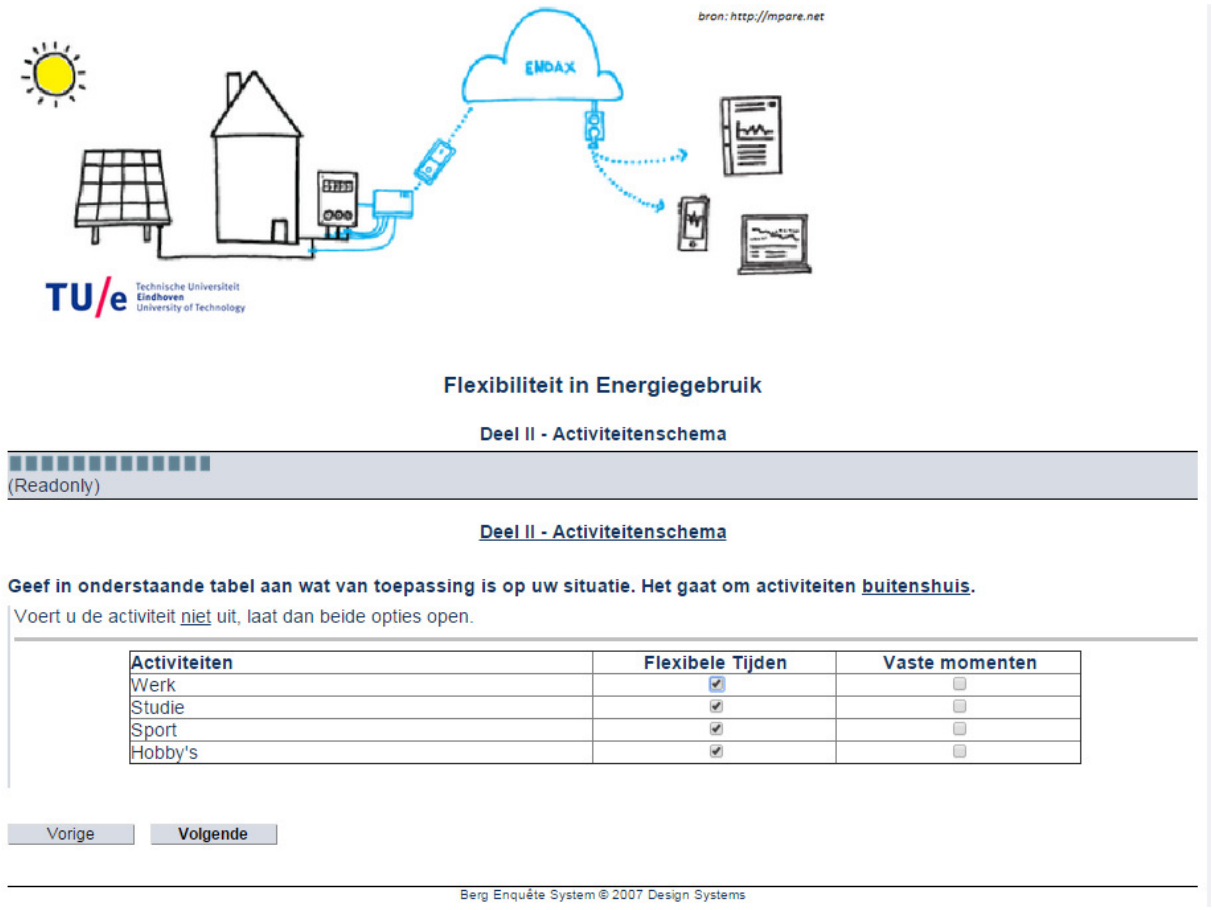
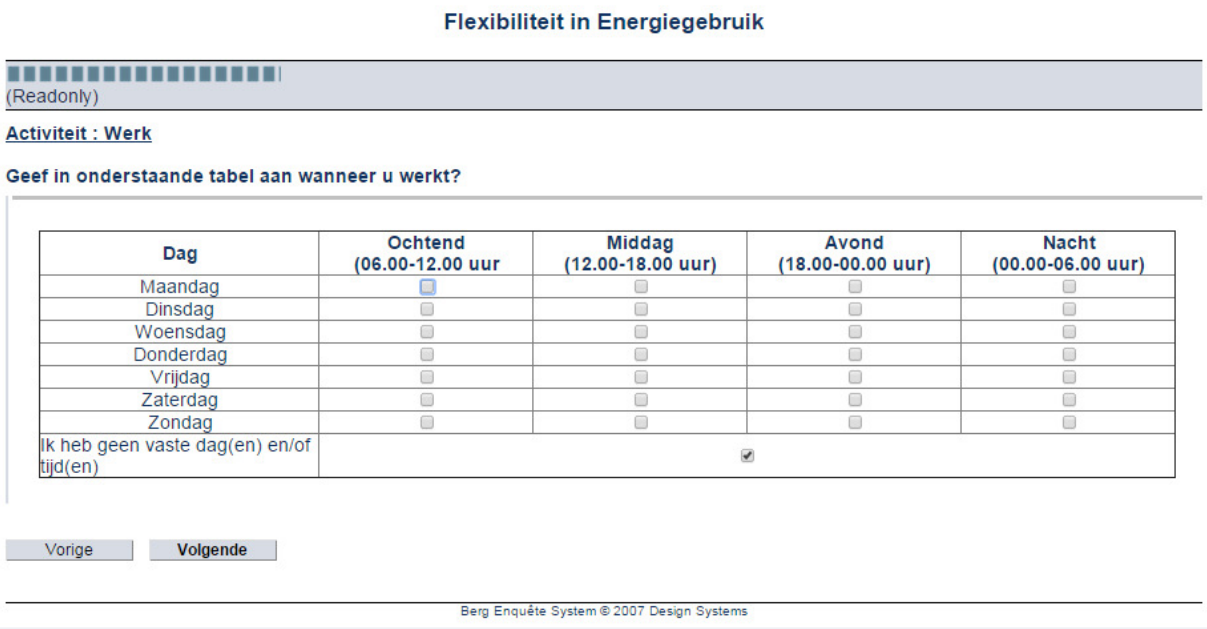


Figure 15 Questionnaire Part II Activities

Respondents were asked at what times they performed particular activities. The next step is to determine when the respondents generally performed their activities and whether they were flexible. Figure 16 Questionnaire Part II Activity pattern, shows how respondents were asked about their activity schemes. This is one of the 4 activities.



Flexibiliteit in Energiegebruik

(Readonly)

Activiteit : Werk

Geef in onderstaande tabel aan wanneer u werkt?

Dag	Ochtend (06.00-12.00 uur	Middag (12.00-18.00 uur)	Avond (18.00-00.00 uur)	Nacht (00.00-06.00 uur)
Maandag	☐	☐	☐	☐
Dinsdag	☐	☐	☐	☐
Woensdag	☐	☐	☐	☐
Donderdag	☐	☐	☐	☐
Vrijdag	☐	☐	☐	☐
Zaterdag	☐	☐	☐	☐
Zondag	☐	☐	☐	☐
Ik heb geen vaste dag(en) en/of tijd(en)	☑			

Vorige Volgende

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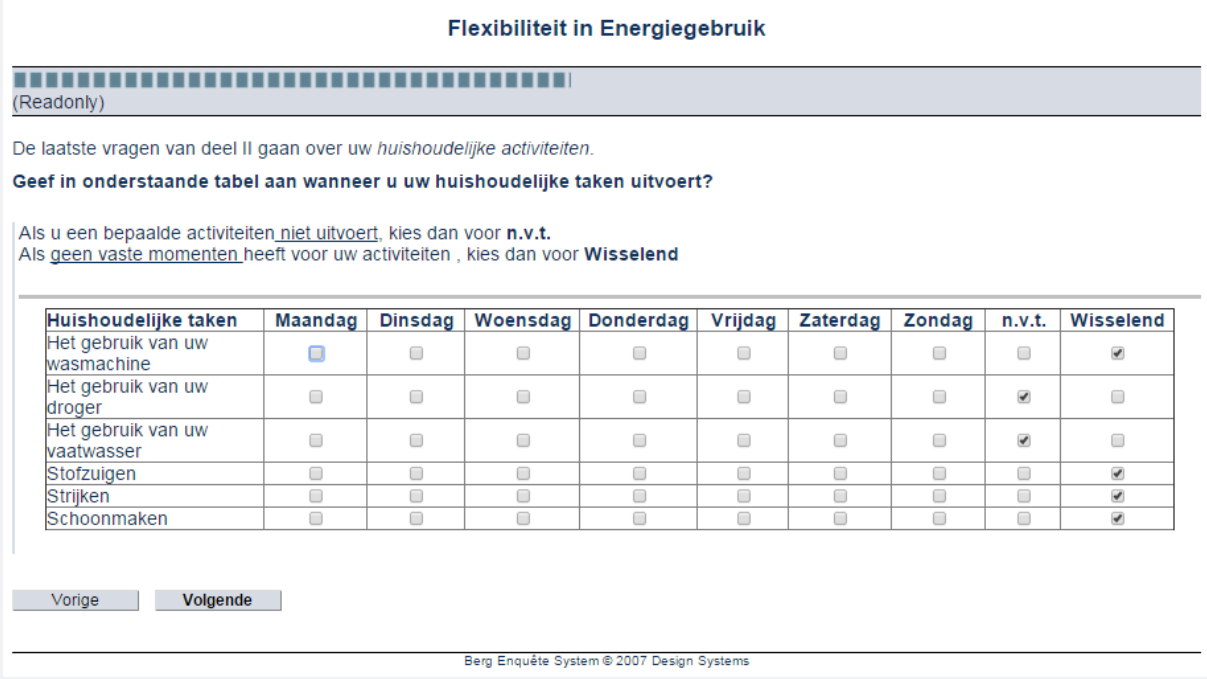
Figure 16 Questionnaire Part II Activity pattern

To further investigate if the respondents have certain fixed housework patterns, the household activities are questioned about household activity. The household activities are related to literature study and consist of the use of your washing machine, the use of your dryer, the use of your dishwasher, vacuuming, ironing and cleaning. These devices / activities amount to 20% of total energy use. In addition, these activities are flexible. The use of the refrigerator or the use of light is less flexible or not at all flexible. The refrigerator is always on, and without light in the evening the consumers cannot do anything. Therefore these final six activities are chosen. Figure 17 Questionnaire Part II Household activities, shows how this is asked in the questionnaire.



Flexibiliteit in Energiegebruik

(Readonly)

De laatste vragen van deel II gaan over uw *huishoudelijke activiteiten*.

Geef in onderstaande tabel aan wanneer u uw huishoudelijke taken uitvoert?

Als u een bepaalde activiteiten niet uitvoert, kies dan voor **n.v.t.**
Als geen vaste momenten heeft voor uw activiteiten , kies dan voor **Wisselend**

Huishoudelijke taken	Maandag	Dinsdag	Woensdag	Donderdag	Vrijdag	Zaterdag	Zondag	n.v.t.	Wisselend
Het gebruik van uw wasmachine	☐	☐	☐	☐	☐	☐	☐	☐	☑
Het gebruik van uw droger	☐	☐	☐	☐	☐	☐	☐	☑	☐
Het gebruik van uw vaatwasser	☐	☐	☐	☐	☐	☐	☐	☑	☐
Stofzuigen	☐	☐	☐	☐	☐	☐	☐	☐	☑
Strijken	☐	☐	☐	☐	☐	☐	☐	☐	☑
Schoonmaken	☐	☐	☐	☐	☐	☐	☐	☐	☑

Vorige Volgende

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Figure 17 Questionnaire Part II Household activities

4.5.3. Part 3 Evaluation sets

The third part consists of the stated-evaluation part, which is based on 27 evaluation sets. However, as 27 sets are too many to handle for a respondent, every respondent had to rate three different energy bundles. Attributes that will be researched are given in section 4.2. How this information is collected is presented in section 4.4

4.5.4. Part 4 Personal characteristics

The socio-demographic factors that are considered include gender, education, family composition, family numbers and the career. See Table 8 Personal .

Gender	Family Composition	Career
Male	Single	Fulltime
Female	Living with parents	Part-time
	Single with children	Volunteer work
Education	With partner without children	Jobseekers
Primary Education	With partner with children	Pensioner
Secondary Education	Living with roommates	Disabled
Lower Education (MBO)		Student
Higher Education (HBO)		Part-time / Bijbaan
Science Education (WO)		
Science Promotion (PhD)		

Table 8 Personal characteristics

CHAPTER 5. IDENTIFYING CONSUMERS' PREFERENCES

The set-up questionnaire provides data that facilitates the modelling of preferred behaviour of respondents. This chapter describes the data collection approach in section 5.1. Paragraph 5.2 continues by describing the analysis of the obtained data. In this paragraph, insight is provided into the background of the respondents. With this knowledge, interesting user groups for further research are determined and described in 5.3, the model analysis. After that paragraph, the different ordinal regression models will be presented.

5.1. Data Collection

One approach is applied to invite respondents to fill in this questionnaire. This approach was to address an internet panel of the market agency, PanelClix[2]. This resulted in 526 completed questionnaires. A rule of thumb is used by Orme to calculate the desired number of respondents. According to Rose & Bliemer (2013), this is the most commonly cited rule of thumb used to calculate preference-study sample-size requirements (Rose & Bliemer cited in (Megens, 2014):

$$N \geq \frac{500\ L^{max}}{J * S}$$

Where
L^{max} is the largest number of levels of any of the attributes;
J is the number of alternatives per choice set;
S is the number of choice sets.

Within this experiment, L^{max} is 3; J is 5; and S is 1. Therefore, the desired minimal number of respondents is 300. Based on the experiments, the minimum of respondents is 500. In the present study, 526 complete responses were obtained, which is sufficient given the rule of thumb. It is assumed that this number is also sufficient to analyse the differences between distinguished target groups.

5.2. Descriptive analysis

This section describes information drawn from the data of the experiment. Information is presented about how user characteristics are divided over the sample, about the differences in energy-saving devices, and about activities both economic and demographic.

5.2.1. Description of the research sample

The results of this experiment are based on answers from 526 respondents. The personal characteristics of the respondents were collected in the fourth part of the questionnaire. Table 9 Characteristics of the respondents, illustrates characteristics of the respondents, on the next page an overview of the characteristics.

[2] http://panelclix.com

User group	Research Sample[3]		Research Sample
Gender		**Age**	
Male	41%	21 - 30	3%
Female	59%	31 - 40	26%
		41 - 50	21%
Education		51 - 60	23%
Primary Education	4%	61 - 70	22%
Secondary Education	14%	71 and older	4%
Lower Education (MBO)	38%		
Higher Education (HBO)	27%	**Family Composition**	
Science Education (WO)	16%	Single	33%
Science Promotion (PhD)	2%	Living with parents	4%
		Single with children	6%
Career		With partner without children	34%
Fulltime	38%	With partner with children	18%
Part-time	18%	Living with roommates	6%
Volunteer work	7%		
Jobseekers	7%	**Family numbers**	
Pensioner	13%	1	33%
Disabled	8%	2	40%
Student	6%	3	13%
Part-time / Bijbaan	3%	4	9%
		5	3%
		6	1%
		8 - 16	2%

Table 9 Characteristics of the respondents

As can be concluded from Table 9 Characteristics of the respondents, females are highly represented. They are over-represented given the population in the Netherlands. It should be noted that the respondents only come from the province of Utrecht and Zuid-Holland, so it is possible that the ratios in those regions are different. Furthermore, the division between low- and high-educated people is almost equal. The percent of low-educated people is 56%, and for high-educated people is 44%.

About career; 50% of respondents have a job. The remaining 50% of the respondents is looking for work (7%), are retired (13%), are disabled (8%), are students (7%) are volunteering and have part-time jobs (3%) (bijbaan).

[3] The total percentage for the different characteristics is not always 100%. This is caused by rounding off, or because respondents indicated that they did not know the answer to a question, or because they indicated that their suiting option was not in the list.

The property-family-composition ratio is equal for 2, 3, and 4-person households in the Netherlands. For this research, two-person households are highly represented. This can also be explained by the target group: the defined area of Utrecht and Zuid-Holland.

5.2.2. Part 1: The consumer's house situation and energy-savings devices

Part 1 of the questionnaire included questions used to investigate respondents' awareness of energy and the house situation of the respondents. Table 10 House situation and energy applications, shows enough variation between the different possibilities of home owners. This also applies for the year of construction. As can be concluded from the applications, most people utilize the standard energy-saving options, such as the boiler and double glazing. A large proportion of respondents also use LED lighting and appliances with renewable energy labels. On the other hand, few people use solar panels, solar water heaters or heat pumps. This also applies to the relatively new techniques, the smart thermostat and online energy monitoring. Thereby it is clearly that the respondents group has little or no experience in the field of energy tools. This can be explain because a lot of those tools are recently introduced, including the smart thermostat. In addition, a large part of the Netherlands did not have smart meter. Whereby, trough using applications on your PC or smart phone. In the coming year Stedin and the other network operators are working for a large input of smart meters. Thus, there is a high probability that people in the next few years will be using these energy tools more.

Characteristics	Sample	Characteristics	Sample
Home Owners		**Applications**	
Owner-occupied (Co)-owners	40%	Solar panels	3%
Rented house (private landlord)	14%	Solar water heater	2%
Rented house (Housing association)	44%	Heat pump	5%
Others	2%	HR Boiler	47%
		Roof isolation	24%
Year of Construction		Facade isolation	21%
Before 1945	20%	Floor isolation	15%
1945 – 1964	15%	Double glazing	83%
1965 – 1984	23%	LED lighting	46%
1985 – 2005	20%	Home appliances with A^{+},A^{++}, A^{+++} label	44%
I do not know	9%	None of the above applications	5%
		Tools	
		Smart Thermostat	9%
		Clock Thermostat	25%
		Online Energy Monitoring	9%
		Energy monitoring in Excel or	17%

	Paper	
	None of the above tools	49%

Table 10 House situation and energy applications

5.2.3. Part 2: The flexibility of the consumer

The next section is about flexibility and aims to understand the activity patterns of the respondents. Important for this research, the respondents were asked if they do various activities outdoors. This applies for all the 4 activities: work, study, sport and hobby. This section shows the different activities of the respondents. This will be displayed through graphs, to form an image of when the activities are performed.

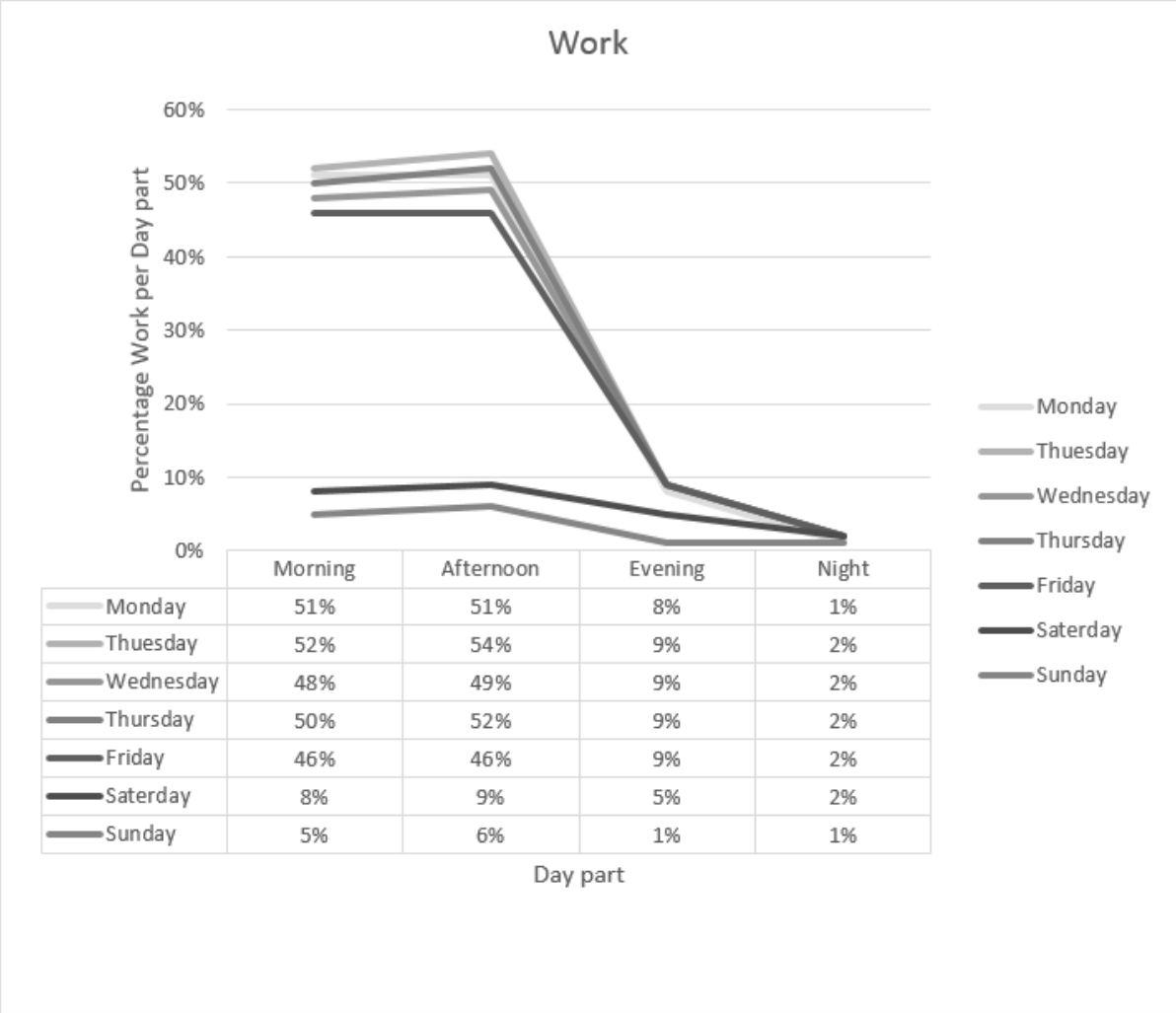
As can be concluded from Table 11 the activities of the respondents, in total 78% of the total respondents identified work as an activity. From this working group, 48% have flexible working times and 52% have a fixed working time. 89% of the respondents have a hobby. In addition, it can be concluded that this activity is exactly the most flexible activity. 88% of respondents indicate that they have no fixed times for their hobbies. This is followed by sport (73%) and study (71%). It can be concluded that the activity, work, is the least flexible.

	Yes		**No**	
Activities	Number of respondents	Percentage	Number of respondents	Percentage
Work	412	78%	114	22%
Study	221	42%	305	58%
Sport	391	74%	135	26%
Hobby	466	89%	60	11%
Flexible			**Fixed**	
Work	199	48%	213	52%
Study	158	71%	63	29%
Sport	287	73%	104	27%
Hobby	410	88%	56	12%

Table 11 the activities of the respondents

To clearly and concisely present data about when respondents are doing their activities, it is converted into graphs. See the following figures. From these figures it can be clearly seen when the majority of the respondents perform their activities.

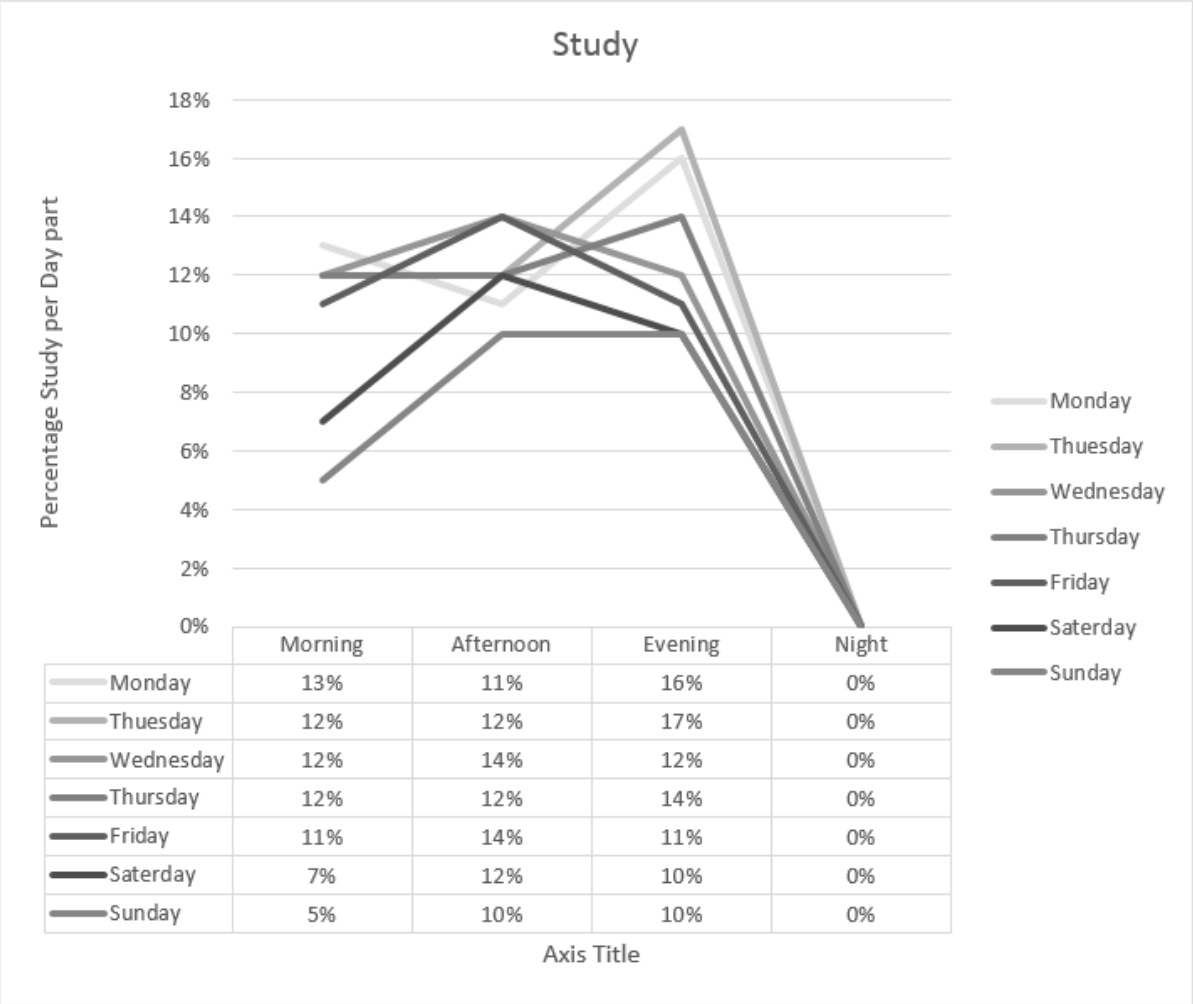
As can be concluded from Figure 18 Percentage Activity Work Per Day Part, on the next page the most people work on Monday till Friday and in the morning and in the afternoon. It should be noted that 31% of respondents have no fixed working days and thus a variable pattern. APPENDIX 4 – TABLE ACTIVITY contains a table with all the details of the activities.



	Morning	Afternoon	Evening	Night
Monday	51%	51%	8%	1%
Thuesday	52%	54%	9%	2%
Wednesday	48%	49%	9%	2%
Thursday	50%	52%	9%	2%
Friday	46%	46%	9%	2%
Saterday	8%	9%	5%	2%
Sunday	5%	6%	1%	1%

Figure 18 Percentage Activity Work Per Day Part

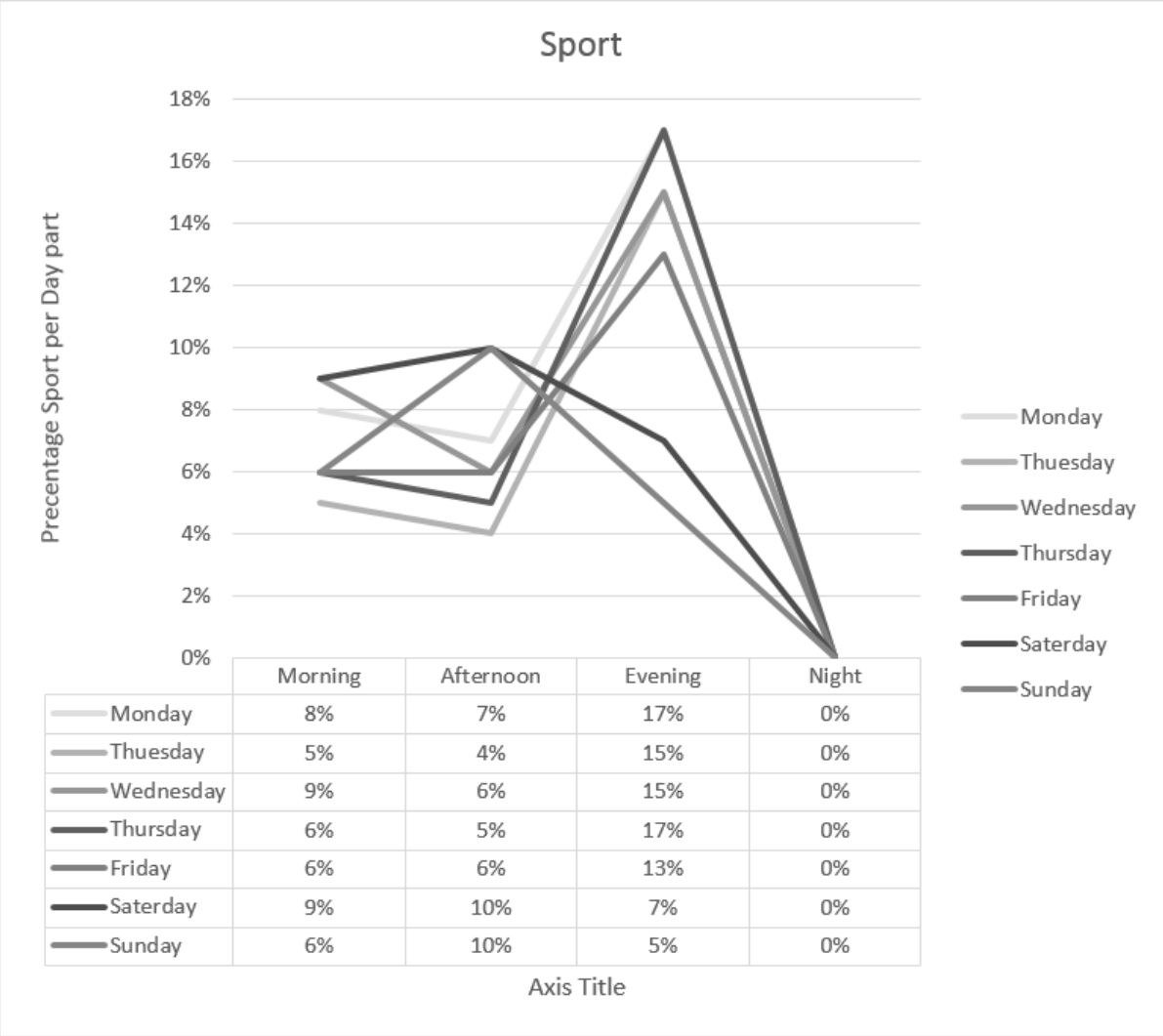
As can be concluded from Figure 19 Percentage Activity Study Per Day Part, most of the respondents go to school in the evening. This can be explained by the determination of the target group: the respondents needed to be 21 or older. It can therefore be assumed that this group of respondents also include part-time study or study alongside their jobs. This is also deducible from Table 9 Characteristics of the respondents: only 6% are students. From Figure 19 Percentage Activity Study Per Day Part, it can also be concluded that respondents did not always understand that it concerned the activities that are performed outside and not the moments that the respondents study at home. As can be concluded from Table 11 the activities of the respondents, 51% of the respondents indicated that they do not have fixed moments for their study.



	Morning	Afternoon	Evening	Night
Monday	13%	11%	16%	0%
Thuesday	12%	12%	17%	0%
Wednesday	12%	14%	12%	0%
Thursday	12%	12%	14%	0%
Friday	11%	14%	11%	0%
Saterday	7%	12%	10%	0%
Sunday	5%	10%	10%	0%

Figure 19 Percentage Activity Study Per Day Part

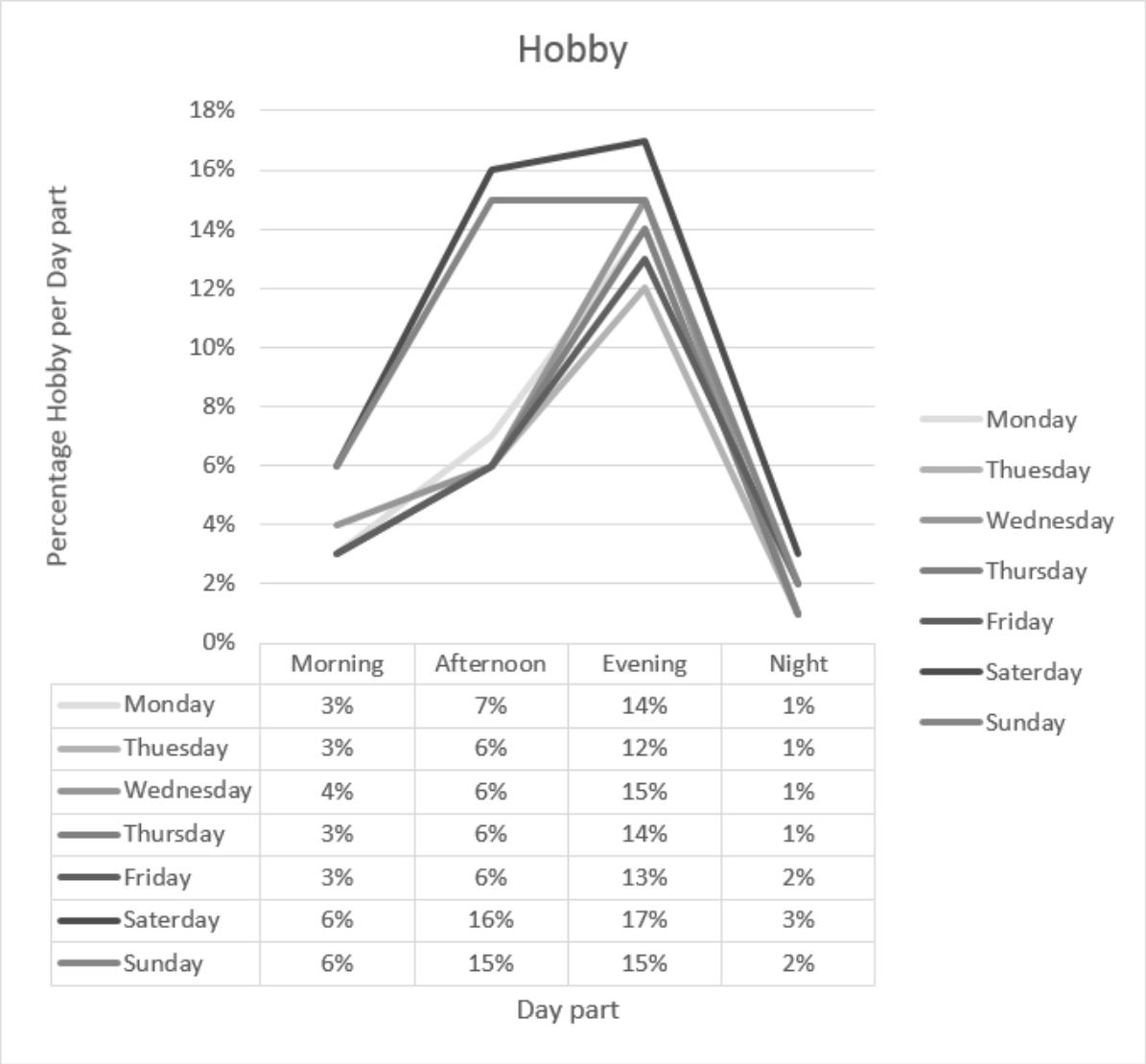
As can be concluded from Figure 20 Percentage Activity Sport Per Day Part, the respondents exercise in the evening during weekdays. A large part of the respondents exercise on Monday and Thursday evenings. During weekends, many play sports in the afternoon.
As can be concluded from Table 9 Characteristics of the respondents, 40% of the respondents that are exercising do so at varying times. It is clear that the respondents generally exercise in the evening.



	Morning	Afternoon	Evening	Night
Monday	8%	7%	17%	0%
Thuesday	5%	4%	15%	0%
Wednesday	9%	6%	15%	0%
Thursday	6%	5%	17%	0%
Friday	6%	6%	13%	0%
Saterday	9%	10%	7%	0%
Sunday	6%	10%	5%	0%

Figure 20 Percentage Activity Sport Per Day Part

As can be concluded from Figure 21 Percentage Activity Hobby Per Day Part, hobby is part of leisure and will be done when all the mandatory activities are finished. It is therefore logical to state that hobbies tend to be done during evenings and weekends. Basically the same holds as with sports, only the weekend is different. Respondents do their hobbies for the most part during weekends.



	Morning	Afternoon	Evening	Night
Monday	3%	7%	14%	1%
Thuesday	3%	6%	12%	1%
Wednesday	4%	6%	15%	1%
Thursday	3%	6%	14%	1%
Friday	3%	6%	13%	2%
Saterday	6%	16%	17%	3%
Sunday	6%	15%	15%	2%

Figure 21 Percentage Activity Hobby Per Day Part

In the last part of the questions about activities, respondents were asked when they perform their household activities. As can be concluded from Table 12: Household Activities, 47% from the respondent do not have a wash dryer and 48% do not have a dishwasher. The washing machine, dryer and dishwasher is used on fixed times. But an equally large proportion of respondents use the devices at variables times. The other activities—vacuuming, ironing and cleaning up—are performed at variable times. It can be concluded that those activities are more flexible. It is important to mention that the activities vacuuming, ironing and cleaning up should be done by themselves, and the other activities are by done by devices.

Household activities			
	Inapplicable	Variable use	Fixed
Washing machine	2%	52%	46%
Dryer	47%	26%	27%
Dishwasher	48%	29%	23%
Vacuuming	2%	60%	38%
Ironing	23%	53%	24%
Cleaning up	2%	65%	37%

Table 12: Household Activities

As can be concluded from Figure 22: Household Activities during the Week, household activities other than dishwasher are often performed during weekends. The dishwasher is used the same amount every day.

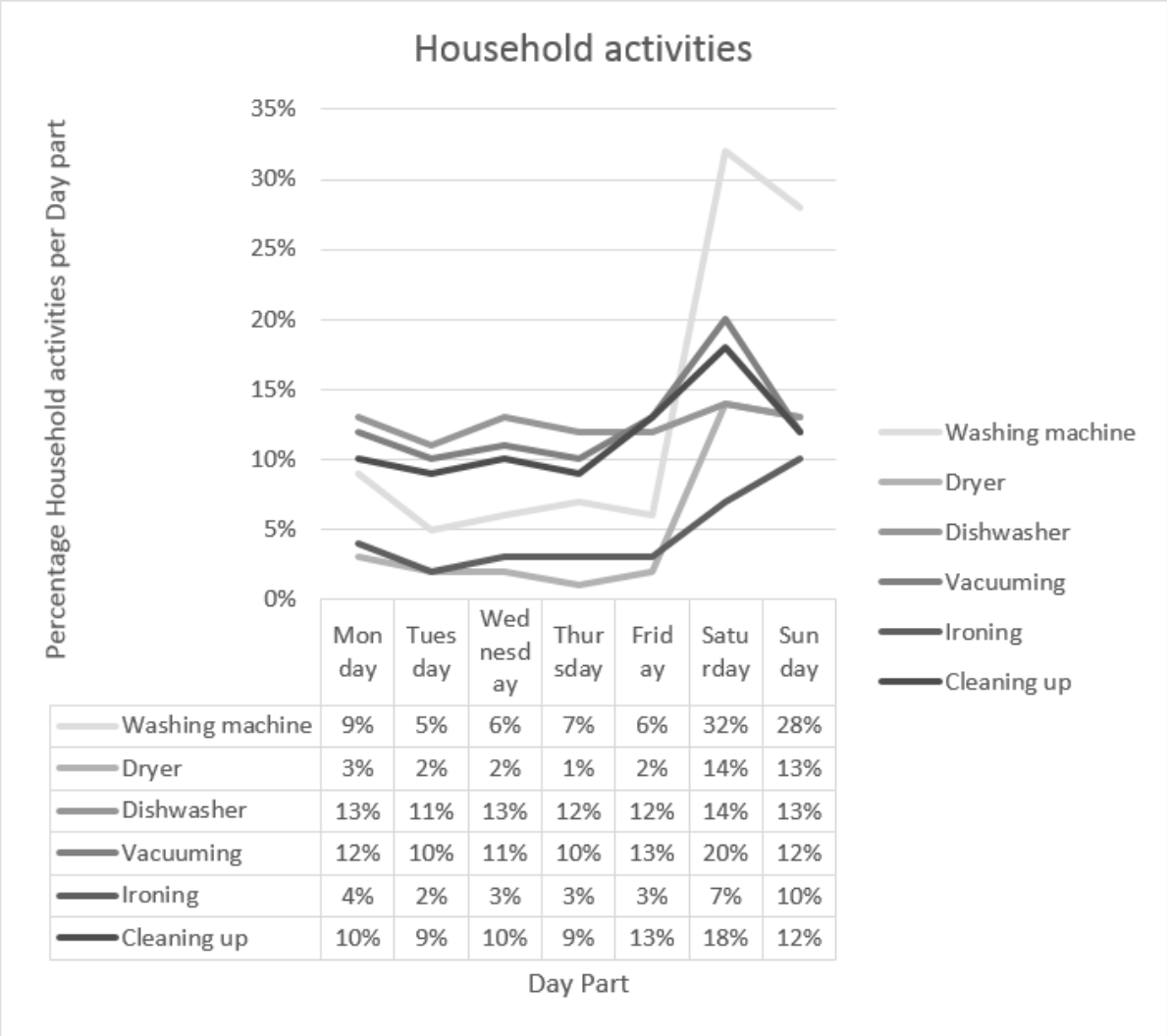


Figure 22: Household Activities during the Week

5.3. Model analysis

Several user characteristics are found to explain possible differences in the preferences of the energy bundles. Because of time constraints, not every characteristic can be researched in depth. Expected outcomes from the analysis are that will women will respond differently than men, because some activities are more frequently performed by women than by men. Gender is included to explain differences in preferences. Taking into account that these are the most easily addressable and identifiable user characteristics, gender will be further researched.

The present research is about rating data. This means that an alternative that is not chosen but is rated results in ordinal data (i.e., 1, 2, 3, 4 or 5). There is direct information about the order of preferences. To be able to estimate the preferred levels of attributes in the models, the attribute-levels were coded.

Effect coding means that n levels of the attributes are coded by n-1 indicator variables. The n-1 levels are coded 1 on the corresponding indicators and coded 0 on all other indicator variables. The last n level is coded -1 for all indicator variables. Table 13: Attributes With Effect Coding, shows the effect coding from the applied attributes that is used in SPSS to analyse the data.

Attributes	Levels	Indicator variables		Labels
Tariff Type	0	1	0	Fixed
	1	0	1	4 Day parts
	2	-1	-1	Flexible
Control	0	1	0	No control
	1	0	1	Self-control
	2	-1	-1	Automatic
Insight Energy cost	0	1	0	Yearly
	1	0	1	Monthly
	2	-1	-1	Always
Advice	0	1	0	No advice
	1	0	1	General
	2	-1	-1	Personal
Energy storage	0	1	-1	No
	2	-1	1	Yes

Table 13: Attributes With Effect Coding

In this research, SPSS 22 was used to estimate the parameters of the preference models. From the results of the evaluation sets, the utility of each alternative can be estimated. For every attribute-level, parameter β can be estimated. To derive the part-worth utilities of the attribute-levels, the parameters are multiplied with the coded values as can be seen in Table 14 part-worth utilities

Attribute level	First indicator	Second	Derived part-worth utility
Level 1	1	0	$\beta_1 * 1 + \beta_2 * 0$
Level 2	0	1	$\beta_1 * 0 + \beta_2 * 1$
Level 3	-1	-1	$\beta_1 * -1 + \beta_2 * -1$

Table 14 part-worth utilities

Models Goodness of fit

To get insight in whether the models predict the observed data well, the model's fit will be calculated. It can be tested if the estimated parameters of the model provide an improvement of the model without estimations. Also, different models with both estimated parameters can be compared to know which one has the best predictive power. In this research, maximum Pseudo R^2 and likelihood ratio are applied

Likelihood ratio

The likelihood ratio test is a popular form of testing the model fit. It is based on the likelihood function, and therefore has the same foundation as the pseudo R^2. The *likelihood ratio* is the likelihood of the estimated model divided by the likelihood of the base model with zero parameters. The likelihood ratio-test expresses how much more likely the data is under one model than under another. This ratio is between 0 and 1. The more likely the assumption is, the smaller the ratio will be. The likelihood ratio can be compared to a critical value to decide if the estimated model outperforms the base comparison model. The formula for the likelihood ratio is described like this:

D= -2 (((LL0 - LLM)

LL_0 = is the log likelihood function for the estimated model no parameters
(Model intercept only)
LL_m is the log likelihood function for the estimated model

It should be compared to a chi-square statistic with degrees of freedom equal to the difference in number of parameters between the compared models. If D is larger than the chi-square the ratio assumption is rejected, and the estimated model is preferred over the model restriction. If D is less than the chi-square, it cannot be concluded that the estimated model is better than the base model.

Pseudo R^2

The pseudo R^2 shows how the estimated model performs against a model in which all parameters are set to zero. Louviere et al. (2000) indicate that a model Pseudo R^2 should be between 0.2 and 0.4. Models with R^2 below 0.1 are considered weak. According to Hensher, et al. (2005), 0.3 represents a decent model fit.
represents a decent model fit.

$$R^2 = 1 - \frac{LL_m}{LL_o}$$

LL_m = Likelihood estimated model
LL_o= Likelihood estimated with no parameters (model intercept only)

5.4. Ordinal regression analysis

This section shows the ordinal-regressions analysis of the data that consists of four different models: one general model, one model for the activity work, one model for the activity washing with washing machine. The final model will give insights into the differences between the preferences of men and women, as mentioned in the previous section. For the models of this paragraph, a 90% confidence interval was used to identify significant parameters.

5.4.1. General model energy bundles

The model's goodness-of-fit

The Pseudo R^2 for the current model is 0.10. Given the previous comment in 5.3. This model could be considered weak. Table 15 Model fitting information shows the information about the general model. For this research we accept this value for Pseudo R^2, because this model provides meaningful information about the general preferences of energy consumers.

The Likelihood ratio of the model Male ($LL_{m)}$ is -230.237 and for the model with no parameters is -258.12. The likelihood ratio for this model (D) 55.766. It should be compared to a chi-square statistic with degrees of freedom (0.90) equal to the difference in number of parameters between the compared models this is approximated 14.7. If D is larger than the chi-square the ratio assumption is rejected, and the estimated model is preferred over the model restriction. If D is less than the chi-square, it cannot be concluded that the estimated model is better than the base model. The model is better than the model with a few constants. However, the model is limited in a position back to predict the observed behavior and thus acceptable in this case.

Model		Likelihood	Chi-Square	Df	Sig.
Intercept Only	LL_0	-258.12			
Final	LL_m	-230.237	55.766	9	0.00
Pseudo R^2	0.010				

Table 15 Model fitting information

To investigate the preferences of the respondents, the following tables show the results of the analysis of the general model. As can be concluded from Table 16 Parameters Estimates- on the next page. Control, the variables insight energy cost and yearly and storage are not significant. And that means they are not important for the consumer. The respondents will not base their rating on these attributes.

		Estimate	*p< 0,1*
Threshold	Preference a=1	-1.935	**.000**
	Preference a=2	-0.825	**.000**
	Preference a=3	1.177	**.000**
	Preference a=4	3.293	**.000**
Tariff	Fixed	0.023	0.730
	4 day parts	-0.106	0.110
Control	**No control**	**-0.325**	**.000**
	Self-control	**0.275**	**.000**
Insight energy consumption	**Yearly**	**-0.258**	**.000**
	Monthly	0.098	0.158
Advice	No advice	-0.106	0.123
	General Advice	-0.027	0.683
Storage	**No**	**0.092**	**0.079**

Table 16 Parameters Estimates

As can be concluded from Table 17 Path-Worth Utility of the General Model, the different attributes influence the preferences of the respondents. Respondents liked to have smart tools to control their energy consumption. In addition, respondents prefer to keep the control itself instead of using the automatic. The respondents prefer the attribute insight energy consumption when they get insight always instead of yearly. It can also be concluded from Table 17 that respondents did not see the positive effects of storage. The respondents would rather have no storage.

Attributes	Attribute levels	Indicator variables		Path-Worth Utility
Control	No control	1	0	-0.325
	Self-control	0	1	0.275
	Automatic	-1	-1	0.050
Insight energy consumption	Yearly	1	0	-0.258
	Monthly	0	1	0.000
	Always	-1	-1	0.258
Storage	No	1	-1	0.092
	Yes	-1	1	-0.092

Table 17 Path-Worth Utility of the General Model

It is now known that the preferences and attributes are important for the respondents. The following model is to examine whether there are difference between male and female.

5.4.2. Preferences in terms of gender

To find out whether men have reasons that differ from those of women for the preferences of the energy bundle, we examined differences between the genders.

Model's goodness-of-fit

The Pseudo R^2 for the current model is 0.088 and 0.083. Given the previous comment this model could be considered weak. Table 18 Model fitting information difference of Gender shows the information about the general model. For this research we accept this value for Pseudo R^2, because this model provides meaningful information about the general preferences of energy consumers.

The Likelihood ratio of the model Male ($LL_{m)}$ is -167.098 and for the model with no parameters is -183.277. The likelihood ratio for this model (D) 32.358. It should be compared to a chi-square statistic with degrees of freedom (0.90) equal to the difference in number of parameters between the compared models this is approximated 14.7. If D is larger than the chi-square the ratio assumption is rejected, and the estimated model is preferred over the model restriction. If D is less than the chi-square, it cannot be concluded that the estimated model is better than the base model. The model is better than the model with a few constants. However, the model is limited in a position back to predict the observed behavior and thus acceptable in this case.

The Likelihood ratio of the model Female ($LL_{m)}$ is -219.264 and for the model with no parameters is -200.978. The likelihood ratio for this model (D) 36.572. It should be compared to a chi-square statistic with degrees of freedom (0.90) equal to the difference in number of parameters between the compared models this is approximated 14.7. If D is larger than the chi-square the ratio assumption is rejected, and the estimated model is preferred over the model restriction. If D is less than the chi-square, it cannot be concluded that the estimated model is better than the base model. The model is better than the model with a few constants. However, the model is limited in a position back to predict the observed behavior and thus acceptable in this case.

Model		Likelihood	Chi-Square	Df	Sig.
Male					
Intercept Only	LL_0	-183.277			
Final	LL_m	-167.098	32.358	9	0.00
Pseudo R^2	0.088				
Female					
Intercept Only	LL_0	-219.264			
Final	LL_m	-200.978	36.572	9	0.00
Pseudo R^2	0.083				

Table 18 Model fitting information difference of Gender

To find out whether men have reasons that differ from those of women for the preferences of the energy bundle, we examined differences between the genders. Table 19: Parameter Estimates Male and Female, are parameter estimates of both genders, on the next page.

		Male		Female	
		Estimate	*p< 0,1*	Estimate	P<0,1
Threshold	Preference a=1	-1.963	**.000**	-1.935	**.000**
	Preference a=2	-.787	**.000**	-.867	**.000**
	Preference a=3	1.230	**.000**	1.147	**.000**
	Preference a=4	3.550	**.000**	3.157	**.000**
Tariff	Fixed	.173	.101	-.084	.333
	4 day parts	**-.219**	**.035**	-0.20	.818
Control	**No control**	**-.342**	**.001**	**-.315**	**.000**
	Self-control	**.378**	**.000**	**.192**	**.028**
Insight energy consumption	**Yearly**	**-.209**	**.051**	**-.296**	**.001**
	Monthly	.084	.430	.109	.242
Advice	**No advice**	-.002	.988	**-.185**	**.037**
	General Advice	-.153	.140	.082	.334
Storage	No	.088	.287	.086	.205

Table 19: Parameter Estimates Male and Female

The data from Table 19: Parameter Estimates Male and Female, is translated to Table 20: Path-Worth Utility Male and Female – on the next page. This table distinguishes between preferences of women and men. One large difference between male and female is that men find tariffs more important than women. Women do not find the tariff important; they instead find advice particularly important. Both find control and insight into the costs important in the energy bundle. Therefore the men find self-control more important than the women. Both prefer the energy bundle when it contains insight in the costs. Women find this more important than men do.

				Male	Female
Attributes	Attribute levels	Indicator variables		Path-Worth Utility	
Tariff	Fixed	1	0	.000	
	4 day parts	0	1	-.219	
	Flexible	-1	-1	.219	
Control	No control	1	0	-.342	-.315
	Self-Control	0	1	.378	.192
	Automatic	-1	-1	-.036	.123
Insight energy consumption	Yearly	1	0	-.209	-.296
	Monthly	0	1	.000	.000
	Always	-1	-1	.209	.296
Advice	No advice	1	0		-.185
	General advice	0	1		.000
	Personal advice	-1	-1		.185

Table 20: Path-Worth Utility Male and Female

5.4.3. Energy bundle and the activity

To provide insight into how respondents react regarding their activities, all of the activities are investigated and calculated. However, it appears from the analysis that all the activities not be significant, see Table 21 Model fitting information activities. This means that the offered composition of the energy bundle does not affect changes in the activities. The respondents will not adapt their activities to the provided energy bundle, and the proposed attributes. It is possible that other attributes that other attributes can ensure that respondents change their activities.

Model		Log Likelihood	Chi-Square	Df	Sig.
Work					
Intercept Only	LL_0	-202.860			
Final	LL_m	-201.981	1.758	9	0.995
Study					
Intercept Only	LL_0	-186.395			
Final	LL_m	-183.317	6.156	9	0.724
Sport					
Intercept Only	LL_0	-212.551			
Final	LL_m	-208.754	7.593	9	0.576
Hobby					
Intercept Only	LL_0	-228.195			
Final	LL_m	-225.090	6.209	9	0.719

Table 21 Model fitting information activities

5.4.4. Energy bundle and the household activity

The model's goodness-of-fit

The Pseudo R^2 for the current model is -0.050. Given the previous comment this model could be considered weak. Table 22 Model fitting information Household activity shows the information about the general model. For this research we accept this value for Pseudo R^2, because this model provides meaningful information about the general preferences of energy consumers.

The Likelihood ratio of the model ($LL_{m)}$ is -242.311 and for the model with no parameters is –254.399. The likelihood ratio for this model (D) 24.174. It should be compared to a chi-square statistic with degrees of freedom (0.90) equal to the difference in number of parameters between the compared models this is approximated 14.7. If D is larger than the chi-square the ratio assumption is rejected, and the estimated model is preferred over the model restriction. If D is less than the chi-square, it cannot be concluded that the estimated model is better than the base model. The model is better than the model with a few constants. However, the model is limited in a position back to predict the observed behavior and thus acceptable in this case.

Model		Likelihood	Chi-Square	Df	Sig.
Intercept Only	LL_0	-254.399			
Final	LL_m	-242.311	24.174	9	0.004
Pseudo R^2	-0.050				

Table 22 Model fitting information Household activity

To provide insight into how respondents react regarding their households activities, one of the activities was investigated in more detail: washing with the washing machine. This activity is widely used. Only 2% do not use the washing machine. See Table 12: Household Activities, paragraph 5.2.3. Respondents were asked if they could identify, on the basis of the energy bundle, if they want to change their activity. The Respondents had several options: never (1), sometimes (2), regularly (3), usually (4), and always (5).

This section examined which attributes of the energy bundle affect the flexibility of the consumer regarding the activity, washing. Table 23: Parameters Estimates of the Activity Washing shows the parameter estimates of this model.

		Estimate	*p< 0,1*
Threshold	Wash. - 1	-1.506	**.000**
	Wash. - 2	-.564	**.000**
	Wash. - 3	.733	**.000**
	Wash. - 4	2.274	**.000**
Tariff	**Fixed**	**-.211**	**.002**
	4 day parts	**.153**	**.023**
Control	No control	.072	.280
	Self-control	-.085	.204
Insight energy consumption	**Yearly**	**.123**	**.067**
	Monthly	**-.187**	**.008**
Advice	No advice	-.048	.492
	General Advice	-.030	.646
Storage	No	.003	.949

Table 23: Parameters Estimates of the Activity Washing

As can be concluded from Table 23: Parameters Estimates of the Activity Washing, the attributes tariff and insight are significant and thus important to the respondents. As can be concluded from Table 24 Path-Worth Utility activity Washing on the next page, the respondents make their choices in order to be flexible on the basis of the attributes tariff and insight of energy costs.

The respondents are prepared to adjust their activity washing to the energy bundle. Which is depend on the attributes tariff and insight energy consumption. If the energy bundle contains with tariff 4 day parts and insight yearly then the consumers will often adjust their washing machine on the energy bundle. Always insight and flexible tariff provide this also just less often.

Attributes	Attribute levels	Indicator variables		Path-Worth Utility
Tariff	Fixed	1	0	-.211
	4 day parts	0	1	.153
	Flexible	-1	-1	.058
Insight energy consumption	Yearly	1	0	.123
	Monthly	0	1	-.187
	Always	-1	-1	.064

Table 24 Path-Worth Utility activity Washing

CHAPTER 6. BUSINESS MODEL

The previous chapters examined how consumers behave, how they respond to the energy bundle, and what their preferences are. In this way, the activities pattern was made visible. In this chapter, the results and conclusions from all the previous chapters are merged in a conceptual plan: a business canvas. This conceptual plan will examine the opportunities and threats of the energy bundle for the consumers and the network operator, Stedin. It will also consider how the ideas for the energy bundle, the demand response, and the activities can be explored and developed to make it real. The business canvas provides a structural design and can be developed into a business plan.

6.1. Business canvas regarding Energy Bundle

The theory of the business canvas was explained in Chapter 3. This section will briefly discuss the opportunities of the energy beam.

Value proposition
The main value of the energy bundle is that it can be introduced now and can be expanded in the future. What is not feasible or not yet possible short-term in the area of new technology is the storage of energy. It may be possible on the longer term, and can add value to the energy bundle. At this moment, it is not profitable; but there is hope for the future. Further, reflection on the energy bundle opportunities for the network operator as for the consumer. The consumers can compose their energy bundle according to their own wishes, and the network operator can make better forecasts based on the behaviour of the consumers.

Customer Segment (Target group)
Because the ideas were conceived in association with Stedin, the work area of Stedin was used when it comes to the determination of the target group. The target group is the energy consumers in the homes, so it goes about the households in the area of Utrecht and Zuid-Holland that are connect to the grid of Stedin. The possibility exists to develop the target group in other provinces.

Channels
An important part of the approach to consumers is the government. The government has benefited from the introduction of the energy bundle or similar services. The Netherlandish government has the target to reduce 16% CO_2 emissions and to generate 14% of the total energy needs in the form of sustainable (renewable) energy. An example of the same action is the introduction of health insurance in 2006. The government can be one of the opportunities to introduce the energy bundle to consumers and thus makes the contact with the consumer. And otherwise the contact with suppliers of Eneco Group. The suppliers can take care of contact with consumers. This will be explained in the Key partners. Except for the fact that nationally can be offered, it is important that a marketing plan is drawn up in order to sell the energy bundle to the general public.

The risk with a new product is that it is not immediately accepted. This is because of the theory of *Diffusion of Innovations* by Rogers. For consumers, it is hard to switch between energy suppliers, unknown parties, or new products. This is explained in more detail in the discussion.

Customer relationship

It important to organize an organization in which different companies or parts of companies come together. For the consumer, this organization should not be confusing or complicated. Consumers should have contact with suppliers as they do now, except the suppliers can now offer other services through the collaboration with Stedin.

Key partners

At this moment Stedin works together with a lot of different companies in pilot projects to find out what the consumers want. The results and developments of those pilots can be used in the form of the energy bundle in conjunction with a supplier to be put on the market. In this way, not only the supplier and the consumer can benefit from the energy bundle, but also the network operator, Stedin. In this way, Stedin has a better grip on the situation of the consumers.

To make a success of the energy bundle or a similar service, it is important for Stedin to work together with different companies. An important advantage of Stedin is that Stedin is part of the Eneco group. See Figure 23: The Company Eneco Groep with the Different Departments Including Stedin. If Stedin and parts of the Eneco group work together to set up the energy bundle and elaboration these ideas. Than can Stedin use the knowledge and experience of the suppliers' side. Eventually, the suppliers have the contracts with the consumers and thus the direct contacts with them. Stedin cannot contact the consumers by themselves. Stedin is not allowed to create or develop services or products because Stedin is a semi-government agency.

Figure 23: The Company Eneco Groep with the Different Departments Including Stedin

By entering into an agreement with the suppliers of the Eneco Group, Stedin can control the introduction of the energy bundle. Stedin can contribute to a sustainable future and the energy network can be organized to meet the needs of the consumers.

Key resources
It was mentioned previously that it is important to set up a new organization with part of Eneco and eventually with people of the government. What exactly is needed is not in the scope of this business canvas.

Key activities
The first activities of Stedin include working out the energy bundle or similar services. What are the wishes of the consumers? The consumers have a central role in the activities of Stedin. In addition, it is important to develop new technologies around the smart meter. The smart meter is a digital meter, and can be read remotely.

The smart meter makes it easier to control energy consumption. Applications for the smart phone or PC can be developed to control energy consumption. It is scientifically proven that consumers save energy when there is insight into their energy consumption. Stedin can direct those developments. Further research can be conducted into how consumers perform their activities in certain areas and what kind of energy saving devices consumers use in these areas. It can also be investigated whether the consumer would like to use energy-saving devices.

Revenue streams
If there is a global view about the revenue model of the situation of the energy bundle, it is important to note that Stedin cannot make any profit because Stedin is semi-government. Consumers can, of course, save money with the energy bundle, as consumers use their flexibility in their energy consumption. The content of the energy bundle can provide energy savings as described in the literature, such as the personal advice, always insight in the energy consumption. Further insight into a revenue model cannot be given here, because it is a legally complicated matter how Stedin can be a part of a new organization and can help with the introduction of the energy bundle.

In this brief explanation about the possibilities of the energy bundle and the chance for Stedin to introduce this energy bundle. The energy bundle can be a success if Stedin has partner who have the contacts with the consumer and the opportunities to the introduce the energy bundle. However, the energy bundle needs to be further developed in order to be better attuned to the requirements and the wished of the different companies and the consumers. A number of still to examine options are described in the discussion.

6.2. The start for the merging of groups in the energy beam

It is now known what the opportunities of the energy bundle are and how people can respond to the energy bundle. It is also important to examine how groups can be merged. Because of the limited timespan of this research, it is not possible to group respondents out of the data. However, the possible options can be given concerning what will be possible combinations. So these options can investigated in further research. An important category is research into smaller regions. We can investigate what kind of people live in those regions, what their activities are, and what their preferences are regarding the energy bundle. In addition, groups can be formed on the basis of the composition of the energy bundle. Furthermore, we can look into groups according to degree of energy awareness. Further research is needed to make a success of the energy bundle.

CHAPTER 7. CONCLUSIONS

This chapter presents the results of this research and thereby answers the research questions. The conclusions are drawn by first answering the sub-questions and thereafter the main question.

The energy bundle will not ensure that the energy transition is solved, but it can provide new opportunities. In this study, consumers are investigated on the basis of their current activity patterns to determine whether they are flexible. It can be concluded that in the future more flexibility will emerge. From 2010, new work is introduced to allow employees to have more flexible start and end times and more opportunity to work at home. This study aims to determine how consumers organize their activity patterns and how flexibility can be used in the field of energy consumption. In order to gain these insights, the research sub-questions will be answered first.

What will be the desire of consumers regarding to their energy use in the future based on energy consumption, future home technology and innovations?

It is difficult to predict what consumers actually want. By answering this sub-question we identify effective strategies for consumers to save energy and therefore to save money. In the literature (Abrahamse, et al., 2005), several types of interventions for stimulating energy-savings are introduced. It showed that the following strategies have a positive influence on the behaviour of consumers. Information is a commonly used strategy to promote energy-conservation behaviour. Providing information aims to increase people's awareness about energy problems and their knowledge about how to reduce these problems. A commitment is an oral or written pledge or promise to change behaviour. Commitment may be a successful strategy for reducing household energy use, especially in view of the long-term effects found in several studies (Abrahamse, et al., 2005). Tailored information is highly personalized and often very specific information. An advantage of this approach is that participants receive relevant information only rather than getting an overload of general information that may not always apply to their household situations. An effective way to achieve energy savings is to provide consumers with information and feedback (Lavrijssen, 2012). Feedback consists of giving households information about their energy consumption, or energy savings. It can influence behaviour, because households can associate certain outcomes (e.g., energy savings) with their behaviours (Abrahamse, et al., 2005). Monetary rewards may serve as an extrinsic motivator to conserve energy. Rewards can either be fixed or contingent on the amount of energy saved (e.g., when a certain percentage is attained). Rewards seem to have a positive effect on energy savings. All studies reviewed in the report of Abrahamse show significant differences between households that received a reward and those that did not. The growing interest in energy demand has been accompanied by a distinct shift in focus away from the attitudes, behaviours and choices of individuals, towards an engagement with how energy use is constituted socially and materially.

Vassileva mentioned that occupants' energy-use awareness is crucial for the success of demand-response programs—one of the most important features of smart-grid adoption for the current and upcoming smart cities (Vassileva & Campillo, 2014).

Which energy bundles can be developed to meet the requirements of the consumer, the requirements of the network operators and the expected innovations in the future?

During this study, the energy bundle is developed. The first sub-questions provided background information so that the energy bundle could be developed, whereupon it could be tested in the form of the questionnaire. The energy bundle consists of 5 different attributes, as shown in Table 25: The Energy Bundle with the Attributes and the Levels. Each attribute has its own value and contribution. Together with Stedin, it is searched for characteristics which are important for the consumer, so that the energy bundle can be acceptable for the consumer. The importance of Stedin has to do with the total impact of the energy bundle on the consumer and the impact that it may bring.

	Attributes	Levels
Energy Bundle	**Tariff**	Fixed
		4 day parts
		Flexible
	Control	No Control
		Self-control
		Automatic
	Advice	No advice
		General advice
		Personal advice
	Insight energy consumption	Yearly
		Monthly
		Every time
	Storage	No
		Yes

Table 25: The Energy Bundle with the Attributes and the Levels

The expected impact of tariff is that it will incline consumers to choose for the cheapest. This fact is taken into account in composing the energy bundle. Therefore, there are no actual prices listed in the energy bundle; only descriptions are given. The consequence of this may be that is not clear to the consumer whether it brings profit. Control is the attribute that can be valued for Stedin. Control specifies whether a consumer has the possibility to monitor his/her energy consumption using a smart thermostat, smartphone, and other devices that can communicate with each other. Advice and insight into energy costs will be described in the literature to help the consumer use less energy (Abrahamse, et al., 2005) (Han, et al., 2013) (Nieuwenhuisen, 2010). Finally, we consider storage. Consumers can store energy when they are less flexible to ensure that they use energy when it is cheapest. It can also contribute at the time that consumers generate their own power. They can store self-produced energy and use it at a later point in time.

For Stedin, storage is also important because it could lead to fewer high-peak moments as consumers make use of stored energy. Chapter 4, EXPERIMENTAL DESIGN, describes the various energy bundles that are presented to the consumer.

Which energy bundles and attributes does the energy consumer prefer?

It was concluded that respondents are flexible in their activities. 4 models were then estimated: the general model, differences between male and female, the activities in relation to the energy beam, and a household's activity in relation to the energy bundle. The general model shows that self-control and insight into energy consumption are the most positive attributes of the energy bundle. However, automatic control and no storage also ensure a positive approach. However, this value is very small and thus less important. See Table 17 Path-Worth Utility of the General Model. When the energy bundle includes self-control and no storage, respondents thus tend to approach the bundle positively. When the energy bundle consists of control, yearly insight into energy consumption, and storage of energy then they will value the energy bundle negatively. When examining whether respondents will adjust their activities to the energy bundle, it was revealed that not all of the activities are significant. This means that the respondents are not prepared to adapt all of their activities to the energy bundle. Upon examining whether consumers like to adjust their household activities, it appeared that the activity washing machine is significant. The characteristics tariff and insight into energy consumption are important for determining whether respondents like to change the activity washing machine.

How can the conditions of different consumer be merged into one business plan for a particular group of consumer and what are opportunities for Stedin regadering the energy bundle.

Due to the limited timespan of this research, research was done into the possibility of merging certain group of individuals. It is investigated what the opportunities of the energy bundle can be for Stedin. Table 26 Summary Business Canvas, shows the summary of the business canvas, on the next pages.

<table>
<tr><th>Key partners</th><th>Key Activities</th><th>Value propositions</th><th>Customer Relations</th><th>Customer Segments</th></tr>
<tr><td rowspan="3">Connection with the suppliers of the Eneco Group

National introduction of the Energy bundle by the government</td><td>Further development of the energy bundle</td><td rowspan="3">The energy bundle;

A combination of energy saving developments;

The combination with the activities of consumers;

On short term to introduce</td><td>x</td><td rowspan="3">Energy consumers;

Connected to the electricity and gas network;

Households in the area Utrecht and Zuid-Holland.</td></tr>
<tr><td>Key Resources</td><td>Channels</td></tr>
<tr><td>x</td><td>See Key partners</td></tr>
<tr><td colspan="5">Revenue Streams
▪ Consumers can decide in what sizes the consumers save money, because it depends how they assembling the energy bundle
▪ Complicated revenue model because Stedin is semi-government</td></tr>
</table>

Table 26 Summary Business Canvas

Under what conditions are consumers willing to give up their flexibility in energy consumption, in the concept of the energy bundle?

This study shows that consumers approach the developed energy bundle positively when the consumer has insight into energy consumption and self-control. However, consumer are not always want to change their activities. This means that the offered composition of the energy bundle does not affect changes in the activities. The respondents will not adapt their activities to the provided energy bundle, and the proposed attributes. It is possible that other attributes that other attributes can ensure that respondents change their activities. Further research is needed to investigate the other options.
However, consumers are willing to adapt their household activities to the energy bundle. In addition, the tariff 4 day parts and insight energy consumption yearly are important for those changes.
In general, the energy bundle can be a success for Stedin as well for the consumer. From the data it can be concluded that the energy bundle does not yet contain the desired attributes to allow consumers to change their activities. But the data indicate that consumers are willing to give the energy bundle a chance.

CHAPTER 8. DISCUSSION

In this chapter, the research findings are discussed. The results of previous research are explained. Additionally, this chapter identifies limitations of the research and opportunities for further research.

This study provides new insight into the preferences of energy consumers regarding their activities and the development of the energy bundle. It is not realistic to expect that the energy transition will be completely solved by the introduction of the energy bundle.

The first limitation of this research concerns the questionnaire. The survey provided some form of disability. New products or unfamiliar topics can often not part of a survey, because a survey should be clear and easy to understand for every respondent. So the survey cannot contain too much explanation, which often is needed when introducing new or unfamiliar topics. See APPENDIX 5 - COMMENTS ON QUESTIONNAIRE, for comments on the survey that some of the respondents considered difficult. You can also see from these comments that many different types of respondents took part in the questionnaire. It is also important to note that the energy bundle is a new product. And thus it can be hard to understand for respondents without knowledge and experience. So it is with the new products or innovations. See Figure 24: The Theory of Diffusion of Innovations Rogers.

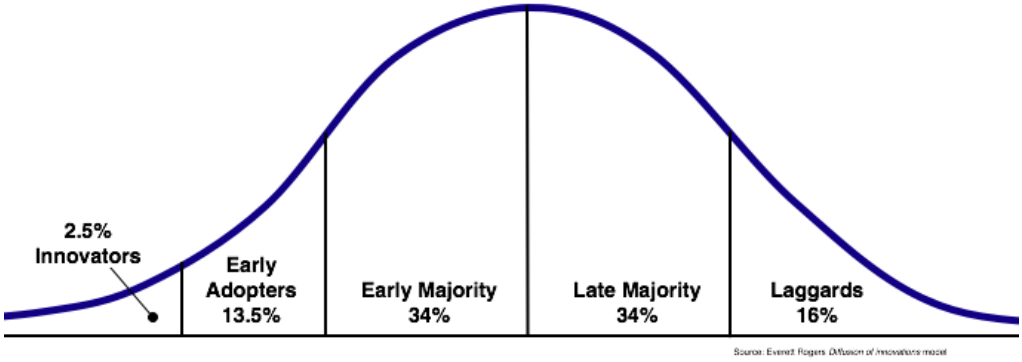


Figure 24: The Theory of Diffusion of Innovations Rogers

This theory explains the introduction of new products. It explains that time is needed to get new products to the general public. And it is important to introduce a new product key and to make a marketing plan on the basis of the theory of Rogers

An important limitation of the study is that it made clear how one person behaves in the household. Therefore, preferences in relation to the behaviour of one person were investigated. But 67% of the households of the research sample consist of two or more people. This study does not show how other people in households react. For example, a man fills in the questionnaire. He proves to be very flexible and is also willing to use his flexibility in relation to the energy bundle. However, he also has a wife and a child. The woman works part-time and takes care of the child.

The woman is not at all flexible. But this is not known, because this research only questioned one person about his activities and did not consider the activities of his entire household. Further research is needed to see how total households will respond to the energy bundle and their flexibility.

Further research is needed to clarify how the energy bundle can be introduced in certain areas. Therefore, it is necessary to examine what kind of people live in the areas. This is possible with the data from the questionnaire. The data showed the postcode area of the different people. It therefore needs to be determined whether there are differences between certain areas and whether there are enough different activity patterns and flexible people in certain areas. One possibility for the energy bundle is that the nationally will be introduced by the government. For this, of course, much research is needed to see what the possibilities are.

It is possible to investigate the energy bundle further. It possible to add the attributes price as one the attributes of the composite energy bundle. And also it is important that consumers are able to calculate what their rewards are if they can be flexible. It can also be determined under which conditions consumers are prepared to change their activities.

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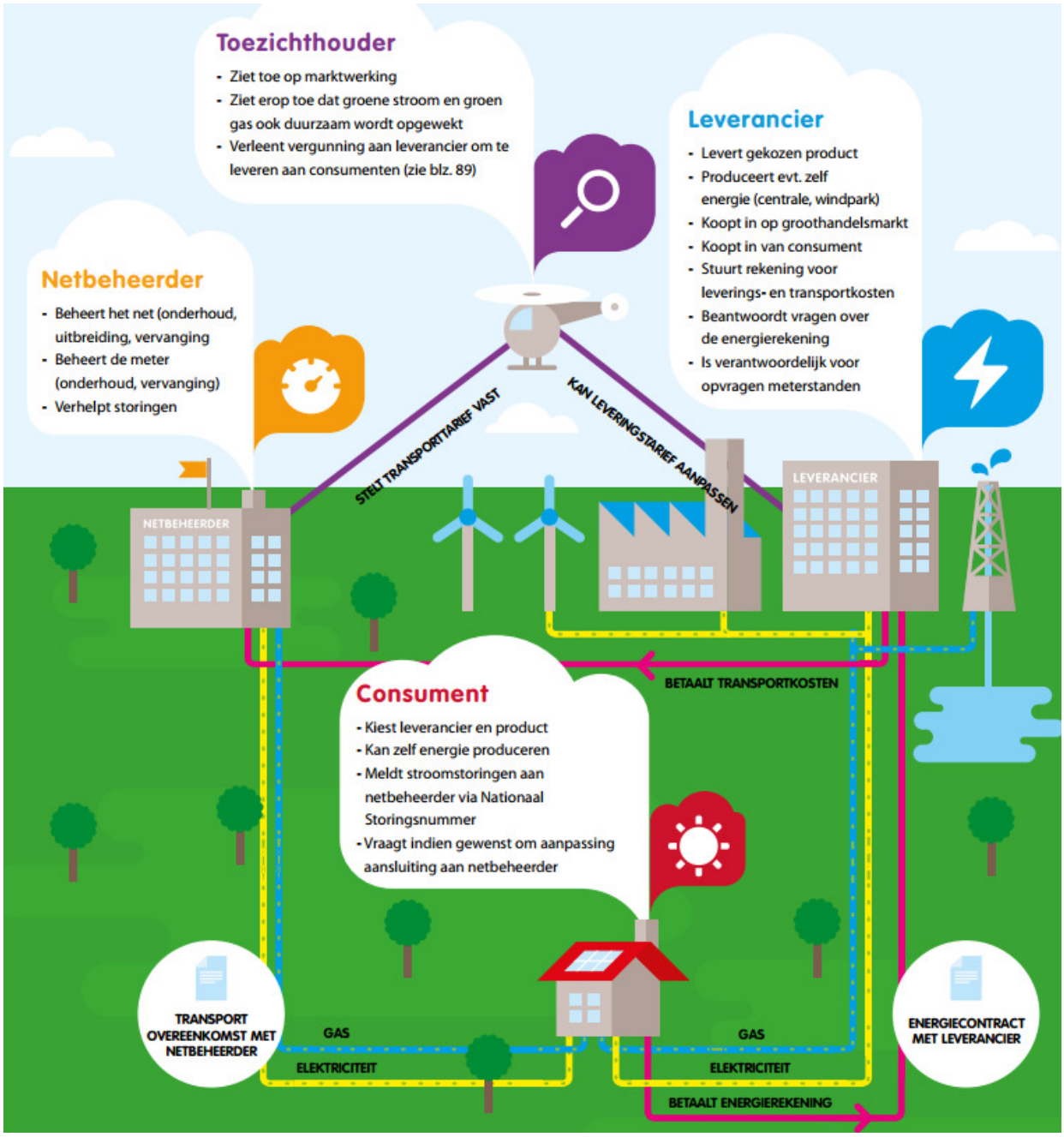
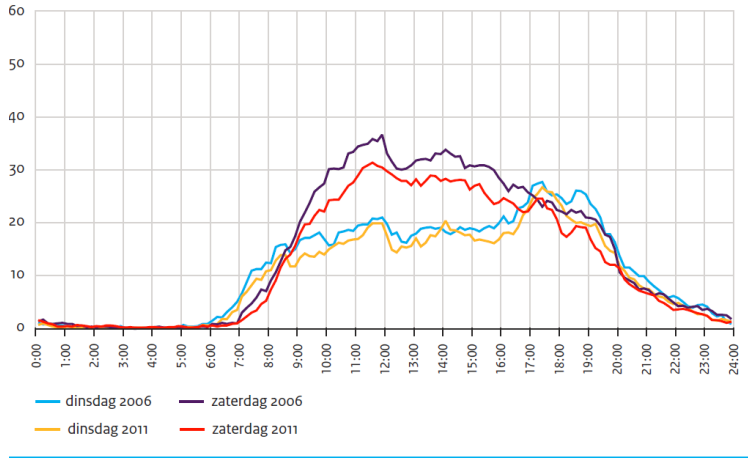
APPENDIX 1 – THE PRESENT ENERGY SYSTEM



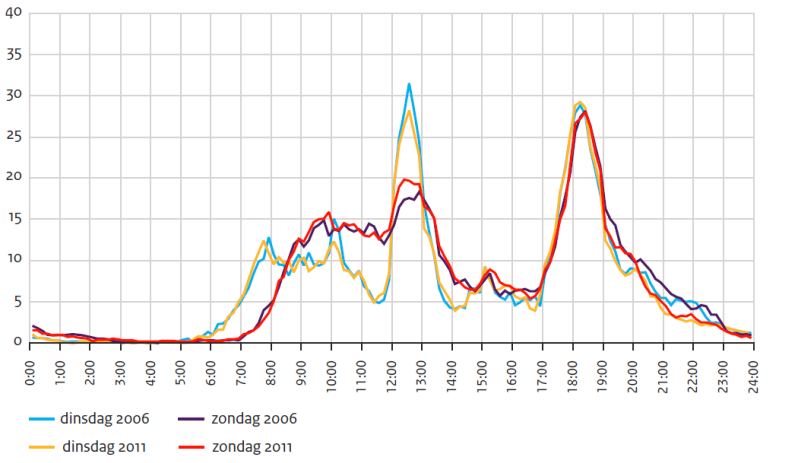
APPENDIX 2 – ACTIVITY PATTERNS FOR CERTAIN ACTIVITIES



Bron: SCP (TBO'06); SCP en CBS (TBO'11)

Household activities and take care for the children, population older than 12 years old (in percentage) (Sociaal en Cultureel Planbureau , 2013)

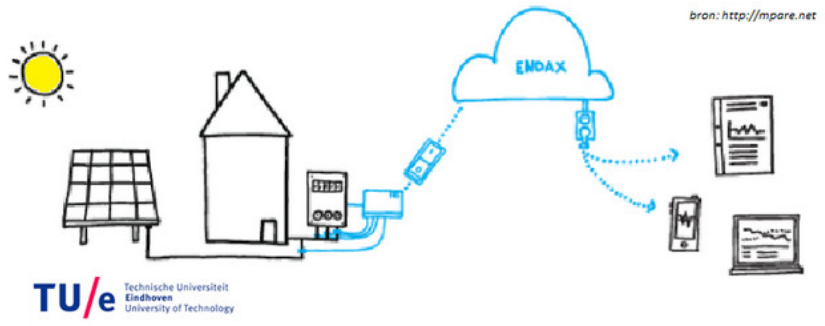
From the second figure Household activities and take care for the children, population older than 12 years old (in percentage) (Sociaal en Cultureel Planbureau , 2013) can be concluded that people do their household activities in most cases on Saturday, the percentage is higher here than on the week day, Tuesday. And the last picture shows the pattern of eating. Here you can see that in many cases diner is eaten around 6pm.



Bron: SCP (TBO'06); SCP en CBS (TBO'11)

Pattern of eating, population older than 12 years old (in percentage) (Sociaal en Cultureel Planbureau , 2013)

APPENDIX 3 – QUESTIONNAIRE



Flexibiliteit in Energiegebruik

(Readonly)

Welkom,

Om te kijken of u tot de doelgroep van deze enquête behoort, worden er eerst twee selectievragen gesteld. Indien u niet behoort tot de doelgroep wordt u doorgeleid naar een pagina van PanelClix.

Wat is uw leeftijd (in jaren)?

30

Wat zijn de vier cijfers van uw postcode (woonadres)?

3086

Volgende

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Next page

Flexibiliteit in Energiegebruik

(Readonly)

Welkom!

Geachte heer/mevrouw,

Deze enquête is onderdeel van een afstudeerproject over **flexibiliteit in energiegebruik.** Het onderzoek gaat over activiteiten en de voorkeuren op het gebied van energie.
De enquête bestaat uit 4 onderdelen en zal ongeveer 10 minuten duren.

Alvast hartelijk dank voor uw deelname!

Wanneer u vragen en/of opmerkingen heeft kunt contact met mij opnemen via m.schut@student.tue.nl

Uw gegevens zullen vertrouwelijk worden gebruikt en zullen niet op persoonsniveau worden gebruikt. Ze worden vertrouwelijk en anoniem verwerkt.

Start vragenlijst

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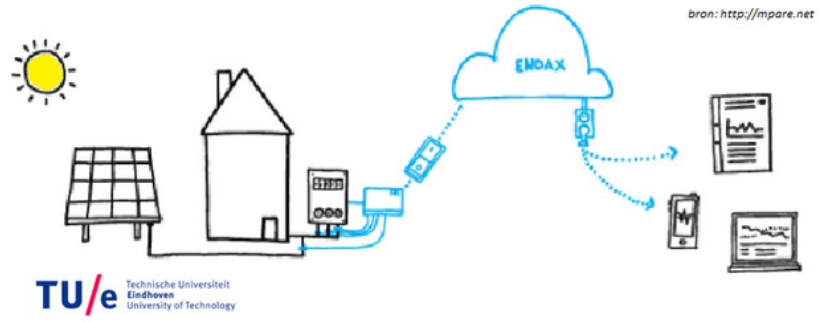

Flexibiliteit in Energiegebruik

Deel I - Woonsituatie en energie besparende middelen

(Readonly)

Welke situatie is voor u van toepassing?

- ○ Koopwoning (mede)-eigenaar
- ○ Huurwoning (van particuliere verhuurder)
- ◉ Huurwoning (van woningbouwcoperatie)
- ○ Anders

In welke periode is uw huis gebouwd?

- ○ Voor 1945
- ◉ 1945 - 1964
- ○ 1965 - 1984
- ○ 1985 - 2005
- ○ 2005 en later
- ○ Weet ik niet

Gebruikt u in uw huis gebruik van 1 of meerdere onderstaande toepassingen?
Meerdere opties zijn mogelijk

- ☐ Zonnepanelen
- ☐ Zonneboiler
- ☑ Warmtepomp
- ☑ HR Ketel
- ☑ Dakisolatie
- ☐ Gevelisolatie
- ☐ Begane grondvloer geïsoleerd
- ☑ Dubbel Glas
- ☐ Meer dan de helft van de lampen in huis zijn voorzien van LED-lampen
- ☑ Wij hebben in huis meer dan twee apparaten met energielabel A, A+, A++, A+++
- ☐ Ik heb geen van bovenstaande toepassingen in mijn woning

Van welke middelen maakt u gebruik in huis?
Meerdere opties zijn mogelijk

- ☐ Slimme thermostaat: Zoals TOON, thermostaat die van afstand bestuurd kan worden of zich aanpast aan het leefgedrag van de bewoners.
- ☑ Klokthermostaat Kunt u de temperatuur in uw woning vooraf mee instellen.
- ☐ Online energiemonitoring via software of website u energieverbruik bijhouden.
- ☐ Bijhouden van energieverbruik in Excel of op papier
- ☐ Ik of mijn huishouden maken geen gebruik van boven genoemde middelen.

Vorige Volgende

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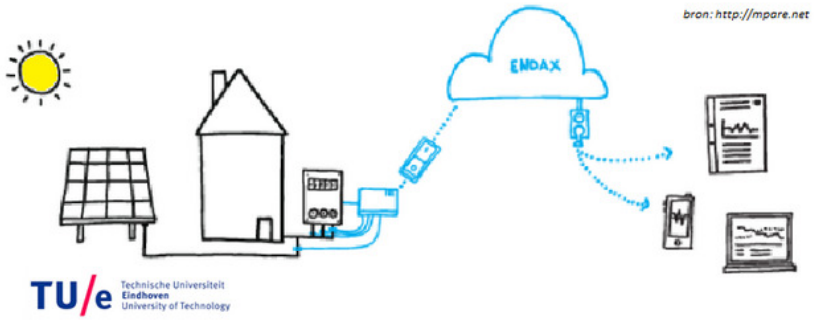

Flexibiliteit in Energiegebruik

Deel II - Activiteitenschema

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Deel II - Activiteitenschema

Geef in onderstaande tabel aan wat van toepassing is op uw situatie. Het gaat om activiteiten buitenshuis.

Voert u de activiteit niet uit, laat dan beide opties open.

Activiteiten	Flexibele Tijden	Vaste momenten
Werk	☑	☐
Studie	☑	☐
Sport	☑	☐
Hobby's	☑	☐

Vorige Volgende

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Next page

Flexibiliteit in Energiegebruik

(Readonly)

Activiteit : Werk

Geef in onderstaande tabel aan wanneer u werkt?

Dag	Ochtend (06.00-12.00 uur	Middag (12.00-18.00 uur)	Avond (18.00-00.00 uur)	Nacht (00.00-06.00 uur)
Maandag	☐	☐	☐	☐
Dinsdag	☐	☐	☐	☐
Woensdag	☐	☐	☐	☐
Donderdag	☐	☐	☐	☐
Vrijdag	☐	☐	☐	☐
Zaterdag	☐	☐	☐	☐
Zondag	☐	☐	☐	☐
Ik heb geen vaste dag(en) en/of tijd(en)	☑			

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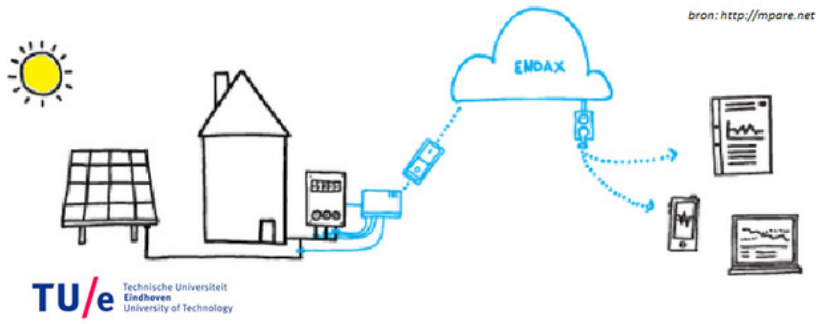

Flexibiliteit in Energiegebruik

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Activiteit: Studie

Geef in onderstaande tabel aan wanneer u zich bezig houdt met uw studie?

Dag	Ochtend (06.00-12.00 uur	Middag (12.00-18.00 uur)	Avond (18.00-00.00 uur)	Nacht (00.00-06.00 uur)
Maandag	☐	☐	☐	☐
Dinsdag	☐	☐	☐	☐
Woensdag	☐	☐	☐	☐
Donderdag	☐	☐	☐	☐
Vrijdag	☐	☐	☐	☐
Zaterdag	☐	☐	☐	☐
Zondag	☐	☐	☐	☐
Ik heb geen vaste dag(en) en/of tijd(en)	☑			

Vorige Volgende

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Flexibiliteit in Energiegebruik

(Readonly)

Activiteit: Sport

Geef in onderstaande tabel aan op welke momenten u tijd aan uw sport besteedt?

Dag	Ochtend (06.00-12.00 uur	Middag (12.00-18.00 uur)	Avond (18.00-00.00 uur)	Nacht (00.00-06.00 uur)
Maandag	☐	☐	☐	☐
Dinsdag	☐	☐	☐	☐
Woensdag	☐	☐	☐	☐
Donderdag	☐	☐	☐	☐
Vrijdag	☐	☐	☐	☐
Zaterdag	☐	☐	☐	☐
Zondag	☐	☐	☐	☐
Ik heb geen vaste dag(en) en/of tijd(en)	☑			

Vorige Volgende

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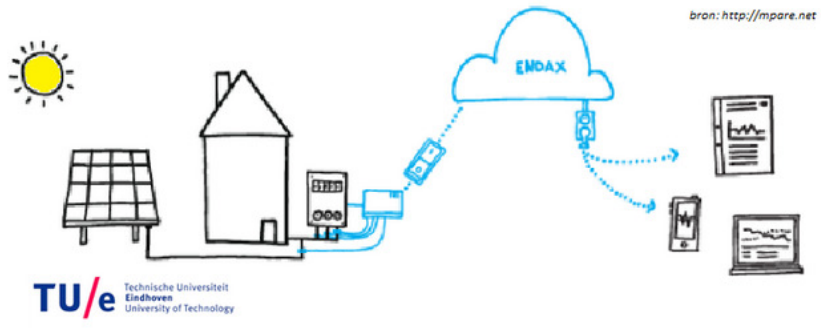

Flexibiliteit in Energiegebruik

(Readonly)

Activiteit: Hobby's

Geef in onderstaande tabel aan op welke momenten u tijd aan hobby's besteedt?

Dag	Ochtend (06.00-12.00 uur	Middag (12.00-18.00 uur)	Avond (18.00-00.00 uur)	Nacht (00.00-06.00 uur)
Maandag	☐	☐	☐	☐
Dinsdag	☐	☐	☐	☐
Woensdag	☐	☐	☐	☐
Donderdag	☐	☐	☐	☐
Vrijdag	☐	☐	☐	☐
Zaterdag	☐	☐	☐	☐
Zondag	☐	☐	☐	☐
Ik heb geen vaste dag(en) en/of tijd(en)	☑			

Vorige Volgende

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Next page

Flexibiliteit in Energiegebruik

(Readonly)

De laatste vragen van deel II gaan over uw *huishoudelijke activiteiten*.

Geef in onderstaande tabel aan wanneer u uw huishoudelijke taken uitvoert?

Als u een bepaalde activiteiten niet uitvoert, kies dan voor **n.v.t.**
Als geen vaste momenten heeft voor uw activiteiten , kies dan voor **Wisselend**

Huishoudelijke taken	Maandag	Dinsdag	Woensdag	Donderdag	Vrijdag	Zaterdag	Zondag	n.v.t.	Wisselend
Het gebruik van uw wasmachine	☐	☐	☐	☐	☐	☐	☐	☐	☑
Het gebruik van uw droger	☐	☐	☐	☐	☐	☐	☐	☑	☐
Het gebruik van uw vaatwasser	☐	☐	☐	☐	☐	☐	☐	☑	☐
Stofzuigen	☐	☐	☐	☐	☐	☐	☐	☐	☑
Strijken	☐	☐	☐	☐	☐	☐	☐	☐	☑
Schoonmaken	☐	☐	☐	☐	☐	☐	☐	☐	☑

Vorige Volgende

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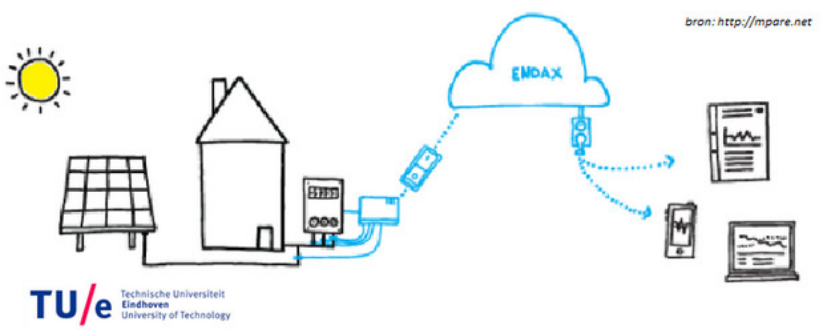


Flexibiliteit in Energiegebruik

Deel III – Energiebundels

(Readonly)

Dit deel van de enquête gaat over energiebundels. Op deze pagina wordt de energiebundel besproken en de eigenschappen van een energiebundel. Daarna krijgt U een aantal vragen die betrekking hebben op 3 verschillende energiebundels.

Energiebundels:
Het duurzaam en bewust omgaan met onze energie wordt steeds belangrijker. Dat resulteert in een groter aandeel groene energie en dus een lagere uitstoot van CO2, maar kan anderzijds ook leiden tot energiebesparingen en dus lagere energiekosten.

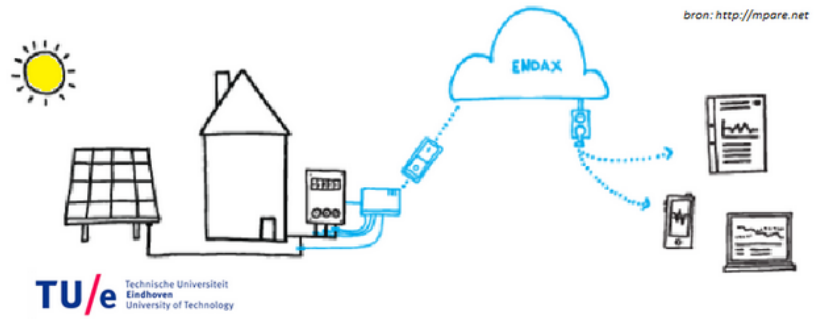
Er zijn een aantal hulpmiddelen die u kunnen helpen om duurzamer en bewuster met energie om te gaan. Deze hulpmiddelen combineren we in dit onderzoek in energiebundels. Wij zijn geïnteresseerd in uw voorkeuren voor bepaalde energiebundels.

De energiebundel bestaat uit een aantal hulpmiddelen.

Hulpmiddelen	Omschrijving	Opties	Omschrijving
Tarief	Geeft aan in welke mate uw energie tarief flexibel is of juist vast.	• A) Vast • B) 4 dagdelen • C) Flexibel	• A) Altijd één vastgesteld tarief • B) Tarief vast gesteld per dagdeel • C) Flexibel Tarief, voorafgaande aan de dag worden de tarieven over de dag vast gesteld.
Controle	Geeft aan of u mogelijkheid heeft om controle uit te oefenen op uw energiegebruik met behulp van een slimme thermostaat, smartphone en apparaten die onderling met elkaar kunnen communiceren. C	• A) Geen • B) Zelf Controle • C) Automatisch	• A)U heeft zelf alle controle • B) Met behulp van hulpmiddelen kunt U controle uitoefenen op de uw apparaten • C) Slimme apparaten zorgen automatische dat ze aan/uit gaan bij het meest gunstige situatie.
Inzicht energieverbruik	Laat zien hoe vaak u uw energieverbruik kan inzien	• A) Jaarlijks • B) Maandelijks • C) Altijd	• A) Jaarlijks inzicht Energieverbruik • B) Maandelijks inzicht in uw energieverbruik • C) Altijd inzicht in uw energieverbruik
Advies	Zorgt ervoor dat u weet hoe u energie kan besparen en welke mogelijke investeringen in uw huis of omgeving voor u voordelig kunnen zijn.	• A) Geen • B) Algemeen • C) Persoonlijk	• A) U ontvangt geen advies • B) U ontvangt een algemeen advies • C) U ontvangt een advies gericht op persoonlijke situatie
Opslag	Geeft aan of u uw energie kan opslaan wanneer het goedkoper is of wanneer u de energie zelf heeft opwekt, en de opgeslagen energie op een ander tijdstip wilt gebruiken.	• A) Ja • B) Nee	• A) U kunt uw energie opslaan en later gebruiken • B) U kunt geen gebruiken maken van het opslaan

Op de volgende pagina zullen we u een voorbeeldvraag uitleggen.

Vorige Volgende



Flexibiliteit in Energiegebruik

Deel III - Voorbeeld Vraag

(Readonly)

De volgende energiebundel is voor u samengesteld:

Energiebundel	Tarief	Controle	Inzicht energiekosten	Advies	Opslag
	Flexibel	Automatisch	Altijd	Algemeen	Nee

Toelichting bij de energiebundel:

Eigenschappen	Toelichting
Flexibel	U heeft een flexibel energie tarief, en dus kunt u energie besparen door u apparaten aan te zetten wanneer de energie het goedkoopste is.
Automatisch	Uw controle is vastgesteld op automatisch, dat betekent dat uw apparaten automatisch aan/uit gaan op het moment dat het voor u het voordeligste is.
Altijd	U heeft de mogelijkheid om uw actuele energiekosten in te zien.
Algemeen	U ontvangt een algemeen advies over hoe u energie kan besparen en welke mogelijke investeringen in uw huis of omgeving voor u voordelig kunnen zijn.
Nee	U heeft niet de mogelijkheid om uw energie op te slaan.

U krijgt bij de energiebundel de vraag of de voorgestelde energiebundel u aanspreekt. Vervolgens wordt er vragen gesteld of u bepaalde activiteiten zou gaan aanpassen aan de eigenschappen van de energiebundel, waardoor u wellicht geld kan besparen op uw energieverbruik door de inzet van uw flexibiliteit en mogelijk bijdraagt aan een duurzamer milieu. U krijgt in totaal 3 verschillende energiebundels voorgesteld.

Vorige Volgende

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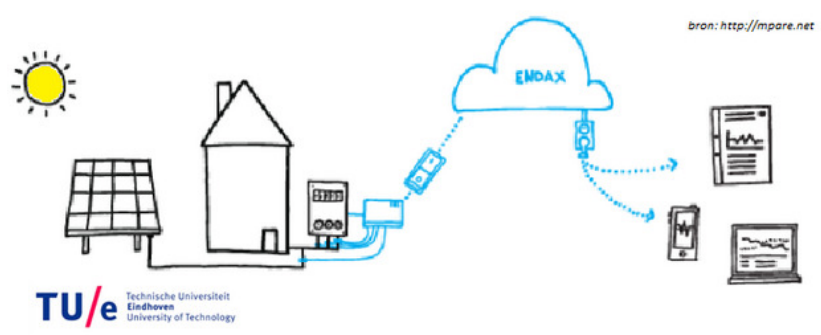

Flexibiliteit in Energiegebruik

Deel III - Uw Activiteiten en uw energiegebruik

(Readonly)

De volgende energiebundel is voor u samengesteld:

Energiebundel	Tarief	Controle	Inzicht energiekosten	Advies	Opslag
	Vast	Automatisch	Maandelijks	Geen	Ja

Geef aan in welke mate de bovenstaande energiebundel u aanspreekt.

	Totaal niet aan				Zeer aan
	1	2	3	4	5
De energiebundel spreekt mij:	○	○	◉	○	○

Hoe flexibeler u wilt/kunt omgaan met uw energieverbruik, des te meer u kunt besparen op uw energiekosten en draagt u bij aan een duurzaam milieu!

Geef in onderstaande tabel aan of u verwacht dat u onderstaande activiteiten op andere momenten zal gaan uitvoeren door de energiebundel.

Als u activiteit niet uitvoert kies dan voor n.v.t.

Activiteit	Nooit	Soms	Neutraal	Meestal	Altijd	N.v.t.
Werk(tijden)	○	○	◉	○	○	○
Studie	○	○	○	◉	○	○
Sport	○	○	○	◉	○	○
Hobby's	○	○	○	◉	○	○

Geef in onderstaande tabel aan of u verwacht dat u huishoudelijke taken op andere momenten zal gaan uitvoeren door de energiebundel.

Als u bepaalde activiteiten niet uitvoert of apparaten niet heeft ,kies dan voor n.v.t.

Activiteit	Nooit	Soms	Neutraal	Meestal	Altijd	N.v.t.
Het gebruik maken van uw wasmachine	○	○	○	◉	○	○
Het gebruik maken van uw droger	○	○	○	○	○	◉
Het gebruik maken van uw vaatwasser	○	○	○	○	○	◉
Strijken	○	○	○	◉	○	○
Schoonmaken	○	○	○	◉	○	○

Vorige Volgende

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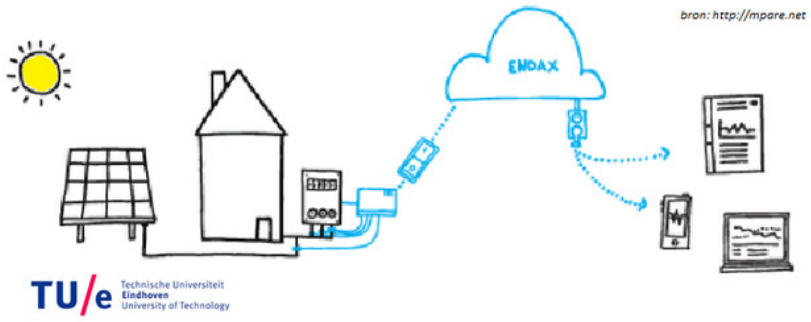

Flexibiliteit in Energiegebruik

Deel III - Uw Activiteiten en uw energiegebruik

(Readonly)

De volgende energiebundel is voor u samengesteld:

Energiebundel	Tarief	Controle	Inzicht energiekosten	Advies	Opslag
	Flexibel	Geen	Altijd	Persoonlijk	Ja

Geef aan in welke mate de bovenstaande energiebundel u aanspreekt.

	Totaal niet aan				Zeer aan
	1	2	3	4	5
De energiebundel spreekt mij:	○	○	◉	○	○

Hoe flexibeler u wilt/kunt omgaan met uw energieverbruik, des te meer u kunt besparen op uw energiekosten en draagt u bij aan een duurzaam milieu!

Geef in onderstaande tabel aan of u verwacht dat u onderstaande activiteiten op andere momenten zal gaan uitvoeren door de energiebundel.

Als u activiteit niet uitvoert kies dan voor n.v.t.

Activiteit	Nooit	Soms	Neutraal	Meestal	Altijd	N.v.t.
Werk(tijden)	○	○	◉	○	○	○
Studie	○	○	○	◉	○	○
Sport	○	○	○	◉	○	○
Hobby's	○	○	○	◉	○	○

Geef in onderstaande tabel aan of u verwacht dat u huishoudelijke taken op andere momenten zal gaan uitvoeren door de energiebundel.

Als u bepaalde activiteiten niet uitvoert of apparaten niet heeft ,kies dan voor n.v.t.

Activiteit	Nooit	Soms	Neutraal	Meestal	Altijd	N.v.t.
Het gebruik maken van uw wasmachine	○	○	○	◉	○	○
Het gebruik maken van uw droger	○	○	○	○	○	◉
Het gebruik maken van uw vaatwasser	○	○	○	○	○	◉
Strijken	○	○	○	◉	○	○
Schoonmaken	○	○	○	◉	○	○

Vorige Volgende

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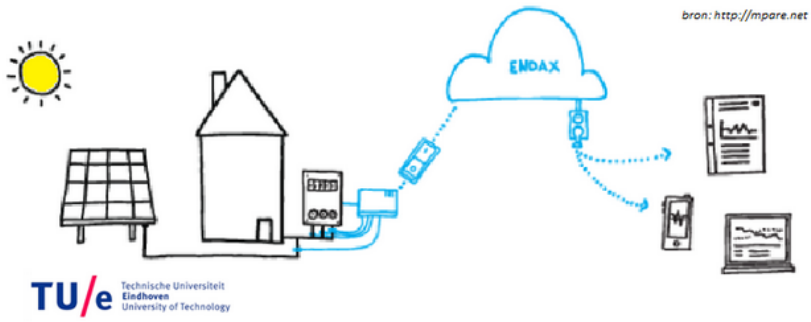

Flexibiliteit in Energiegebruik

Deel III - Uw Activiteiten en uw energiegebruik

(Readonly)

De volgende energiebundel is voor u samengesteld:

Energiebundel	Tarief	Controle	Inzicht energiekosten	Advies	Opslag
	Vast	Automatisch	Altijd	Algemeen	Nee

Geef aan in welke mate de bovenstaande energiebundel u aanspreekt.

	Totaal niet aan				Zeer aan
	1	2	3	4	5
De energiebundel spreekt mij:	○	○	◉	○	○

Hoe flexibeler u wilt/kunt omgaan met uw energieverbruik, des te meer u kunt besparen op uw energiekosten en draagt u bij aan een duurzaam milieu!

Geef in onderstaande tabel aan of u verwacht dat u onderstaande activiteiten op andere momenten zal gaan uitvoeren door de energiebundel.

Als u activiteit niet uitvoert kies dan voor n.v.t.

Activiteit	Nooit	Soms	Neutraal	Meestal	Altijd	N.v.t.
Werk(tijden)	○	○	◉	○	○	○
Studie	○	○	○	◉	○	○
Sport	○	○	○	◉	○	○
Hobby's	○	○	○	◉	○	○

Geef in onderstaande tabel aan of u verwacht dat u huishoudelijke taken op andere momenten zal gaan uitvoeren door de energiebundel.

Als u bepaalde activiteiten niet uitvoert of apparaten niet heeft ,kies dan voor n.v.t.

Activiteit	Nooit	Soms	Neutraal	Meestal	Altijd	N.v.t.
Het gebruik maken van uw wasmachine	○	○	○	◉	○	○
Het gebruik maken van uw droger	○	○	○	○	○	◉
Het gebruik maken van uw vaatwasser	○	○	○	○	○	◉
Strijken	○	○	○	◉	○	○
Schoonmaken	○	○	○	◉	○	○

Vorige Volgende

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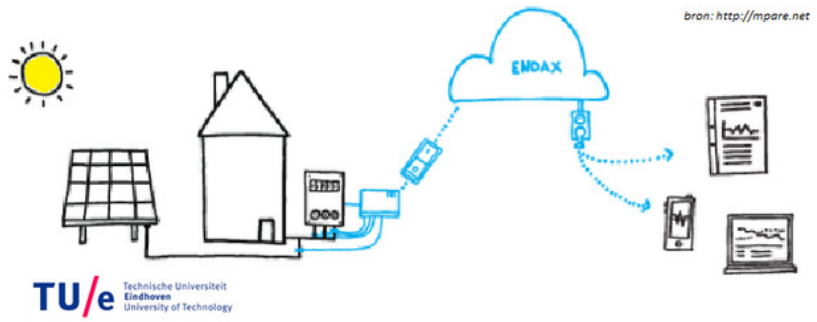

Flexibiliteit in Energiegebruik

Deel IV: Persoonlijke kenmerken

(Readonly)

U bent aangekomen bij het laatste gedeelte van de enquête. Tot slot nog enkele vragen over uw persoonlijke situatie.

Deze gegevens worden uiteraard volledig anoniem verwerkt en zullen niet worden herleid naar een persoon of adres.

Wat is uw geslacht?

- ☐ Man
- ◉ Vrouw

Wat is uw hoogst afgeronde opleiding?

- ○ Basisschool / Lagere School
- ○ Voortgezet Onderwijs
- ○ Middelbaar beroepsonderwijs - MBO
- ○ Hoger Beroepsonderwijs - HBO
- ◉ Wetenschappelijk onderwijs - WO
- ○ Wetenschappelijk promotie - PhD

Wat is uw gezinssamenstelling?

- ○ Alleenstaand
- ○ Thuiswonend bij ouders
- ○ Alleenstaand met thuiswonend(e) kind(eren)
- ○ Met partner zonder thuiswonend(e) kind(eren)
- ◉ Met partner met thuiswonend(e) kind(eren)
- ○ Samenwonend met huisgenoten

Uit hoeveel personen bestaat uw huishouden?*Inclusief uzelf*

4

Welk(e) situatie(s) zijn van toepassing?

- ☐ *Fulltime werkend*
- ☑ *Parttime werkend*
- ☐ *Vrijwilligerswerk*
- ☐ *Werkzoekend*
- ☐ *Met pensioen of VUT*
- ☐ *Arbeidsongeschikt*
- ☐ *Student*
- ☐ *Bijbaan*

Vorige Volgende

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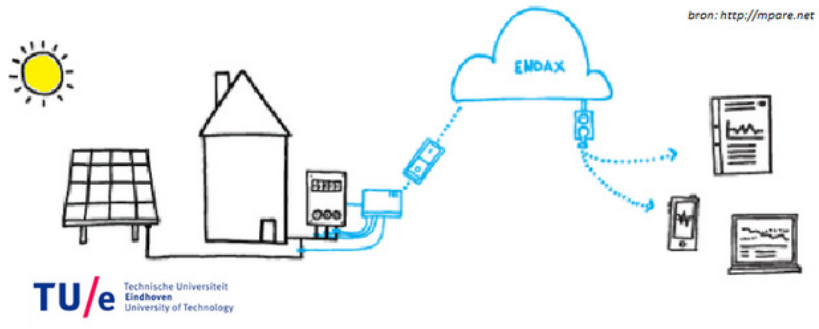

Flexibiliteit in Energiegebruik

(Readonly)

Heeft u nog vragen of opmerkingen over de enquête?

Geen.

Vorige Volgende

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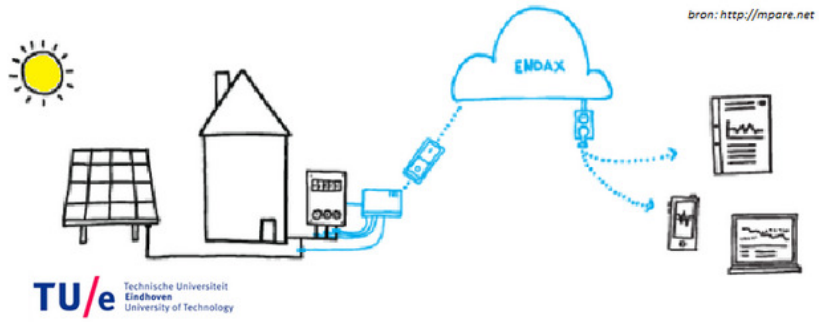

Flexibiliteit in Energiegebruik

(Readonly)

Dit is het einde van de enquête.

Hartelijk dank voor uw medewerking!

Vorige Einde vragenlijst

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APPENDIX 4 – TABLE ACTIVITY

Activities[4]	Day- Part			
	Monday M.	Monday M.	Monday E.	Monday N.
Work	51%	51%	8%	1%
Study	13%	11%	16%	0%
Sport	8%	7%	17%	0%
Hobby	3%	7%	14%	1%
	Tuesday M.	Tuesday M.	Tuesday E.	Tuesday N.
Work	52%	54%	9%	2%
Study	12%	12%	17%	0%
Sport	5%	4%	15%	0%
Hobby	3%	6%	12%	1%
	Wednesday M.	Wednesday M.	Wednesday E.	Wednesday N.
Work	48%	49%	9%	2%
Study	12%	14%	12%	0%
Sport	9%	6%	15%	0%
Hobby	4%	6%	15%	1%
	Thursday M.	Thursday M.	Thursday E.	Thursday N.
Work	50%	52%	9%	2%
Study	12%	12%	14%	0%
Sport	6%	5%	17%	0%
Hobby	3%	6%	14%	1%
	Friday M.	Friday M.	Friday E.	Friday N.
Work	46%	46%	9%	2%
Study	11%	14%	11%	0%
Sport	6%	6%	13%	0%
Hobby	3%	6%	13%	2%
	Saturday M.	Saturday M.	Saturday E.	Saturday N.
Work	8%	9%	5%	2%
Study	7%	12%	10%	0%
Sport	9%	10%	7%	0%
Hobby	6%	16%	17%	3%
	Sunday M.	Sunday M.	Sunday E.	Sunday N.
Work	5%	6%	1%	1%
Study	5%	10%	10%	0%
Sport	6%	10%	5%	0%
Hobby	6%	15%	15%	2%
	Variable			
Work	31%			
Study	51%			
Sport	40%			
Hobby	60%			

[6] The total sample of the different characteristics is not always 100%. This is caused by rounding off, or because respondents indicated that they did not know the answer to the question, or because they indicated that their suiting option was not in the list.

APPENDIX 5 – COMMENTS ON QUESTIONNAIRE

De Enquette heeft zoals vele niet de mogelijkheid dat je invult aan boord van een varend schip te wonen. Dan namelijk heb je niets met die energie voorzieningen te maken, immers ze hebben GEEN super lang verlengsnoer!!! Misschien leuk als er eens een enquette komt gericht op ons varensgezellen
Ik heb helemaal geen zin om over energie na te denken. Ik heb een contract en dat bevalt prima
Veel te lastig onderzoek om in te vullen. Heb deel 3 moeten uitprinten, daardoor niet meer representatief
de veranderingen die je doorvoert op basis van het energieverbruik qua bundels zijn wat onduidelijk te duiden. Ik denk dat het betere resultaten geeft wanneer u de vraag stelt of er veranderingen optreden in het energieverbruik, of je je energieverbruik aanpast op basis van de bundels, want dat is wat je wilt weten.
Nee, alleen dat ik op zich tevreden ben over m'n huidige energieleveranciers en -gebruik. En dat ik door m'n handicap niet de tijd / energie heb om naast m'n werk en m'n leukere vrijetijdsbestedingen hier heel erg mee bezig te zijn.
Soms incorrect taalgebruik staat slordig. Voor de rest een goed opgezette enquête.
ik heb mij nog nooit verdiept in energie kosten, leveranciers en hoor nu zelfs voor het eerst over een bundel. ik als een alleenstaande met mijn geringe energie kosten altijd bij een zelfde leverancier gebleven. enige wat ik weleens heb gedaan is bij wie ik goedkoopst uitkom en dat is diegene waar ik nog altijd tevreden klant van ben. daarom wist ik niet veel over uw vragen te beantwoorden sorry. de hele schema leek mij een beetje een raadsel.
Ik betaal een vast bedrag voor energie
De hele energiemeter spreekt me niet aan. Ik houd al jaren mijn energieverbruik per week bij. Als dat afwijkend is, bedenk ik wat de reden is en als dat mogelijk is houd er de komende week rekening mee.
ik zit vastgeroest in mijn energieverbruik. Hoog- en dalurentarief, gaskachel, geen isolatie. En ik wil niet veranderen van leverancier, omdat dat bij mij altijd nadelig uitpakt.
Bijzondere manier van vragen. Wel erg goed gedaan!! ï¿½
Onduidelijke vragen op zijn tijd
repetitief, wel handig dat ik niet hoefde te kiezen tussen studeren en baan, leuke tekening bovenaan
Energiegebruik en beperking ervan zijn vaak zeer sterk afhankelijk van de geboden mogelijkheden door b.v. verhuurder (denk aan energiebesparende isolatie of HR ketel, danwel energie- leverancier). De speelruimte als eindgebruiker is eigenlijk maar beperkt. Bovendien: bij minder verbruik wordt de prijs van energie per eenheid verhoogd, per saldo is er dus niet veel te verdienen is toch veelal de gedachte.
bundels niet duidelijk. 'ballonetje' met uitleg vast, controle, etc bij het aangeven van voorkeur bundel, zou verduidelijken
Waarom geen categorie freelancer en categorie huisman/huisvrouw aan het einde?
Succes met je studie!
Goeie enquete

2 pagina's info teveel om te onthouden voor vragen die daarop volgen
Vond de vraagstelling vooral onduidelijk bij het enalaatste deel. Vooral de eerste vraag, omdat daar ineens bij Tarief "vier dagdelen" stond. Wellicht had ik het voorgaande niet goed gelezen, waardoor ik dat niet begreep, het kwam echter onduidelijk op mij over. Ik wil vast tarief en ga mijn levenswijze niet aanpassen aan eventueel goedkoper energieverbruik. Dat is volgens mij wat jullie wilden weten. Succes !
de toelichting over de verschillende energiepakketten en wat de termen precies inhouden zou bij de vragen erbij moeten staan, na dit eenmaal doorgelezen te hebben zit het niet goed genoeg in je hoofd om de energiepakketten goed in te kunnen schatten.
Ik vond het jammer dat er geen uitleg was zoals bij de voorbeeldvraag bij de vervolgvragen (over de termen flexibel, 4 dagdelen e.d.)
succes met je studie
Leuk en afwisselend
Er wordt nergens rekening gehouden met het feit dat wij allerlei mogelijke besparingen en milieuvriendelijke zaken allang bedacht hebben en voor zover mogelijk in onze huursituatie ook uitgevoerd of uit laten voeren.
Ja,enqueye gaat volkomen voorbij aan de mogelijkheid dat iemand in huidige bundel (weekend stroom goedkoop) perfect bezuinigend en tevreden kan zijn.
het was even niet echt duidelijk over de veranderingen in je activiteiten wat komt door een andere sammenstelling van je bundel.
Interessant onderzoek. Diep verder uit en kijk naar het effect. Wil wel proefhuishouden zijn bij experiment. Kom met mooie product/marktcombinaties!
Soepeltjes
Onoverzichtelijk
Goeie enquête
vrij ingewikkeld Ik heb dubbel tarief elektra geen gasaansluiting en gebruik daarom de meeste van mijn apparaten in de voordeeluren
het was een interesante enqute
ja de vraag bent u alleenstaand ja volgende wat is de gezinsamenstelling ALLEENSTAAND waarom deze vraag ????
vragen waren zeer onduidelijk
Leuk onderzoek
Op dit moment maakt mijn huishouden gebruik van stadsverwarming. Hierdoor betalen we relatief veel vastrecht en huur voor de warmtewisselaar en relatief weinig per kWh. Hierdoor krijgen we weinig financieel voordeel wanneer we minder warmte gebruiken. Daarom letten we meer op het besparen van elektriciteit.

THE FLEXIBILITY OF THE CONSUMERS AND THEIR PREFERENCES OF THE ENERGY BUNDLES

Author: Maaike Schut

Graduation program:
Construction Management and Urban Development 2013-2014

Graduation committee:
Prof. dr. ir. W. F. Scheafer (Chairman TU/e)
Dr. Ing. P.J.H.J. van der Waerden (Graduation Supervisor TU/e)
Dr. ir. E.G.J. Blokhuis (Graduation Supervisor Stedin)
Ir. A. Rijneveld (Graduation Supervisor Stedin)

Date of graduation:
25-02-2015

ABSTRACT
In the future, energy supply and demand will grow and be in greater flux than today. To prevent the network operators from reinforcing their energy grid, it is necessary to find new solutions; otherwise the energy systems will be unaffordable. One of the possible solutions is the energy bundle. This study developed an energy bundle based on the energy behaviour and the activity patterns of the energy consumer in the Netherlands. Through a survey, respondents were questioned about the preferences regarding the energy bundle and their activities. Ordinal regression analyse is used to analyse the preferences of the consumer and the willingness to change their activities by the energy bundle. As the last part this research explains the possibilities to introduce this energy bundle for Stedin, one of 8 the network operators in the Netherlands.

Keywords: Energy, Flexibility, Consumer behaviour, Network operators, Energy transition,

INTRODUCTION

The current energy systems in the Netherlands are demand-driven. Consumers can use energy every moment of the day for a fixed price. The current system consists of the network operator, the energy supplier, the energy consumer and the supervisor. Network operator is responsible for the pipes and the connections with the households, one of 8 network operators is Stedin. The suppliers take care of the consumer through the contract and the supply of energy. The consumer has contract with a suppliers. (ECN, Energie-Nederland en Netbeheer Nederland, 2014). Stedin ensures that consumers of Stedin are always provided with energy. The network operator is responsible for the transportation of electricity and gas. Stedin is the owner of all the stations, cables and pipes required for energy distribution in its region. It is the owner and responsible party for the meters at the consumers' houses. They are responsible only up to the point of transportation in industrial connections.

Traditional energy usage behaviour is changing, and new energy systems have been and will be developed. The use of renewable energy will increase. Consumers, private initiatives, and other collective projects will produce their own energy and will have an impact on the energy grid. The increasing use of solar panels, heating pumps, and electric transport has major consequences for our current energy system. Generating energy from renewable sources means that the energy network has to deal with large variability in supply of energy through solar and wind energy. The current energy systems are not designed for large-scale variable supplies of electrical energy and variable increases in demand. Technological innovations in combination with new services should make energy affordable and reliable in the future. And the energy systems need to be resistant to transition of fluctuation of the sustainable produced energy.

PROBLEM DEFINITION AND RESEARCH QUESTION

In the future, energy supply and demand will grow and be in greater flux than today. To prevent the network operators from reinforcing the energy grid, it is necessary to find new solutions; otherwise the energy systems will be unaffordable. One of the possible solutions is demand response. *Demand response* is defined as a customer's ability to alter electricity demand by reducing or shifting consumption in response to market prices or other market conditions (Chao, 2010).

An energy bundle is developed to determine whether it could provide a solution to the energy transition. At this moment is not known under what kind of conditions consumers change their behaviour. This research will investigate the flexibility of the energy consumer by identifying activity patterns and willingness to change their activities. And there will be investigated what kind of recommendations in the concept of the energy bundle preference the energy consumer. The following research question will investigate if the energy bundle can be a solution for the energy transition.

Under what conditions are consumers willing to give up their flexibility in energy consumption in the concept of the energy bundle?

Sub-questions:

To provide an answer to the main question, the following sub-questions will be investigated:

1. What will be the desire of consumers regarding energy use in the future based on energy consumption, future home technology and innovations?
2. Which energy bundles and attributes can be developed to meet the requirements of the consumer, the requirements of the network operators and the expected innovations in the future?
3. Which energy bundles and attributes do the energy consumers prefer?
4. How can the conditions of different consumers be merged into one business plan for a particular group of consumers. And what are opportunities for Stedin regadering the energy bundle.

ENERGY CONSUMPTIOM – ENERGY TRANISATION – ENERGY BUNDLE

Activiteiten, energie verbruik

Several studies have investigated behavioural changes and attitudes and have included experiments by energy consumers with new technologies. It appears that attitudes and behaviour do change—and change quite radically—over time. Understand this process will be important in the area of energy consumption (Owens & Driffill, 2008). Research suggests that consumers often are not informed or are not sufficiently informed about their energy consumption and about energy saving possibilities in their houses.

Energy-saving behaviour is related to household energy conservation and can be divided into two categories: efficiency behaviour or investment behaviour and curtailment behaviour. *Investment behaviour* is about spending money on improving energy efficiency, such as on insulation. *Curtailment behaviour* involves repetitive efforts to reduce energy use, such as lowering thermostat settings. Contextual factors, knowledge, motivations, abilities and socio-demographic variables may influence energy-saving behaviour (Han, et al., 2013) (Abrahamse, et al., 2005). To develop a bundle for consumers, it is important to understand how consumers behave and what strategies have an effect on their behaviour.

The energy supply is in transition. We are slowly working towards electricity without $C0_2$ emission in 2050. Sustainability is the norm; fossil sources are slowly disappearing. It is expected that by 2020 there will be more wind onshore, offshore wind, co-firing biomass and solar energy, and less production of electricity with gas and coal. Consumers and businesses are increasingly producers of energy. Supply appears more and more on the demand side with changing demand patterns as a result. In upcoming years, the energy sector will state for the challenge to keep the balance between the supply and the demand 24 hours per day. Not only is the consumption of electricity uncertain; the presence of wind and clouds determines how much sun and wind power is available from moment to moment. Possibilities exist for storage and to influence energy demand through financial incentives and compensation systems to ensure that there is sufficient capacity. Converting to a solid system—in which energy remains affordable and the principles of the free market remain intact—seems a difficult puzzle at this moment.

The ability to shift demand moments to a lower electricity price or to a greater supply of renewable electricity will be very important in the future can be possible solution for the energy transition. In addition, flexible consumer behaviour and future potential of electricity storage are essential. To establish flexible behaviour among consumers, different motivations should be taken into account. Some consumers want to contribute to a more sustainable energy system, while others prefer to get a discount on their utility bill or will be happy to be self-sufficient. At the moment, there is no possibility for the consumer to use new developments as they want. The good news is that the government encourages the arrival of the new technologies such as subsidies for pilot projects and the rural import of the smart meter.

Through the smart meter, the consumer has more control over their energy consumption. It is possible to connect the smart meter with new smart technologies such as TOON[5] through apps on your cell phone (Stedin, sd) (ECN, Energie-Nederland, Netbeheer Nederland, 2013).

The behaviours of consumers and changes of the energy sources constitute a problem at this moment and will in the future. The problems that occur are mentioned. A possible solution to the energy transition: the energy bundle. An *energy bundle* consists of several characteristics, see figure 1. That can ensure the energy-behaviour change of consumers. In table 1, the characteristics of the energy bundle and the impact of these characteristics on consumers will be described. How can consumers be affected and how can an energy bundle use the characteristics of the consumers to change their behaviour?

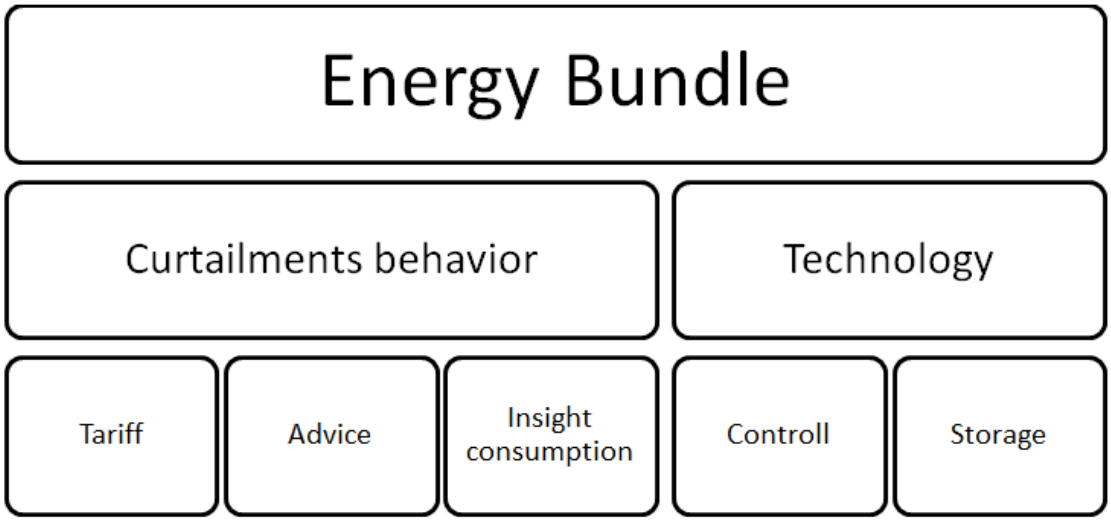

Figure 1 Energy bundle with the 5 attributes

Characteristics	Explanation
Variety of tariff	The variation of tariff shows what kind of flexible tariff the consumers have and whether or not they have moments where the energy tariff is lower than at other times. Because of this attribute, it is checked whether people change their activities on the basis of the variation of tariff.
Control	Control is an important attribute for the network operator. But Control can make life easier for consumers. Devices can search automatically for the best moment go on or out, based on the energy price. Network operators can thus control the devices or influence the devices on the basis of the amount of energy that is available. For example, the car can be recharged at times when there is a surplus of energy and not be recharged when there is a shortage. It is important to mention that consumers here obviously do not have any adverse effects.

[5] TOON is the smart thermostat of Eneco. More information about TOON on the website of www.eneco.nl/toon

Advice	As mentioned before, consumers are influenced on the basis of certain behaviour strategies. The curtailment strategies are described in paragraph 2.3. The conclusion of this paragraph, specific information about energy savings can ensure that a household can save energy depending on the level of advice. (Abrahamse, et al., 2005)
Insight energy consumption	Research shows that when consumers receive information about their energy costs or their consume energy that energy will be saved. Conscious as well as unconscious. (Abrahamse, et al., 2005). If consumers have a clear picture of when energy is cheaper or more expensive, they might adjust their activities. This is of course possible in combination with tariff.
Storage	Energy can be stored both for the benefit of network operators and for consumers. If consumers store energy when there is a surplus to use if there is shortage, then consumers save money. At this time a pilot is being carried out called Project Storage Of Energy. There is development going on. At this time, it is still not usable, but it will probably be useful for anyone in the future.

Table 1 Characteristics and the explanation of the Energy bundle

EXPERIMENTAL DESIGN

Stated-preference modelling, which was introduced by Louviere and Hensher in 1982 and by Louviere and Woodworth in 1983, is a method applied to investigate consumers' preferences and market shares regarding hypothetical alternatives by presenting different, mutually exclusive, future alternatives or scenarios (composed by means of experimental designs). Respondents are asked to choose the scenario they consider best: a first-preference choice task (E.g. Hensher, 1994 cited in (Heuvel van den, 2014)). In the Stated Preference survey, the respondent is asked what he or she would do in a specific situation that the researcher designed. This study uses stated preferences instead of revealed preferences, both because of the need to investigate preferences of consumers regarding non-existing energy bundles, and because it examines the impact of energy bundles on certain activities. The experimental design has led to further developments of the energy bundle and created the different attribute-levels and the questionnaire of this research.

The attributes of the energy bundle

- **Tariff**

This attribute indicates the type of energy tariff: flexible or fixed. From the literature study, it is clear that consumers can be influenced through price. In previous studies, different ways of investing were investigated. Consumers can invest their money to save energy (investment behaviour), or can be influenced by price curtailment. To investigate whether consumers are influenced by price, tariff type has been added to the energy bundle with the following levels.

- Fixed price: Always a fixed price. This is the current situation in the Netherlands.
- 4 day parts: The tariff is predetermined per day-part. Per day part, a certain price will be established. Four day parts have been chosen so that the moments when the sun is shining and when few people use power will be cheaper than the other two parts.

- Flexible: The day before, the tariff is determined for the next day.

- **Control**

Control specifies whether a consumer has the possibility to monitor his/her energy consumption by using a smart thermostat, smartphone, and other devices that can communicate with each other. The following levels are defined.

- No control: The consumer has all the control, but this means that the consumer cannot use devices that communicate with each other or with thermostats. This is a typical situation in the Netherlands.
- Self-Control: Using tools can exercise control on the consumers' devices and appliances, allowing them to communicate with each other to ensure that the consumer can make optimal use of energy. The consumer always has the control.
- Automatic: Smart devices are set to take advantage of the most favourable times without their users doing something. This method of energy consumption is the most optimal, because the devices ensure that energy is used at the lowest tariff.

- **Insight-energy consumption**

Specifies how often a consumer can view his/her energy consumption. The following levels are defined.

- Yearly: the consumer gets the final payment every year. This is the current situation in the Netherlands.
- Monthly: the consumer can check energy consumption every month.
- All time: the consumer can check energy consumption whenever he/she wants.

- **Advice**

Advice indicates at which level you can get advice to ensure that you know how to save energy and which possible beneficial investments you can make at your home or environment.

- No advice at all: the consumer gets no advice.
- General advice: the consumer gets general advice.
- Personal advice: the consumer gets personal advice concerning the most profitable way to save energy given their current situation.

- **Storage**

Storage specifies whether the consumer can use energy storage, whether the consumer can save energy when the energy price is low or when the consumer generated his/her own energy and used the stored energy at different times.

- Yes
- No

Attributes 2, 3, and 4 are based on the curtailment behaviour of the energy consumer. As discussed in chapter 2, Identifying The Energy Consumer, these intervention strategies can influence the energy consumption of the consumer. They can also ensure that the consumer saves energy. Attribute 1 is chosen to stimulate the behaviour the consumer based on the variety of tariff. And attribute 5 is a possible solution for the future.

Through using a questionnaire, information is collected about the respondents are collected. The respondents is questioned about their social and demographic characteristics, the performed activities and the preferences of the energy bundle. APPENDIX 3 - QUESTIONNAIRE, shows the total questionnaire of this research.

RESULTS

The data from the questionnaire is collected and described and analysis by ordinal regression analysis. For this research 4 models were estimated: the general model, differences between male and female, the activities in relation to the energy beam, and a household's activity in relation to the energy bundle. The general model shows that self-control and insight into energy consumption are the most positive attributes of the energy bundle. However, automatic control and no storage also ensure a positive approach. However, this value is very small and thus less important. See Table 17 Path-Worth Utility of the General Model. When the energy bundle includes self-control and no storage, respondents thus tend to approach the bundle positively. When the energy bundle consists of control, yearly insight into energy consumption, and storage of energy then they will value the energy bundle negatively. When examining whether respondents will adjust their activities to the energy bundle, it was revealed that none of the activities are significant. This means that the respondents are not prepared to adapt all of their activities to the energy bundle. Upon examining whether consumers like to adjust their household activities, it appeared that the activity washing machine is significant. The characteristics tariff and insight into energy consumption are important for determining whether respondents like to change the activity washing machine.

BUSINESS CANVAS

In this section of the research is investigated what the opportunities of the energy bundle can be for Stedin. Table 26 Summary Business Canvas, shows the summary of the business canvas. For Stedin can be the energy bundle a success, but they need to find a partner. For further investigation about the energy bundle. Also there is made a start with merging groups of people. It is also important to examine how groups can be merged. Because of the limited timespan of this research, it is not possible to group respondents out of the data. However, the possible options can be given concerning what will be possible combinations. So these options can investigated in further research. An important category is research into smaller regions. We can investigate what kind of people live in those regions, what their activities are, and what their preferences are regarding the energy bundle. In addition, groups can be formed on the basis of the composition of the energy bundle. Furthermore, we can look into groups according to degree of energy awareness. Further research is needed to make a success of the energy bundle.

CONCLUSION AND FINDINGS

This study shows that consumers approach the developed energy bundle positively when the consumer has insight into energy consumption and self-control. However, consumer are not always want to change their activities. This means that the offered composition of the energy bundle does not affect changes in the activities. The respondents will not adapt their

activities to the provided energy bundle, and the proposed attributes. It is possible that other attributes that other attributes can ensure that respondents change their activities. Further research is needed to investigate the other options.
However, consumers are willing to adapt their household activities to the energy bundle. In addition, the tariff 4 day parts and insight energy consumption yearly are important for those changes.
In general, the energy bundle can be a success for Stedin as well for the consumer. From the data it can be concluded that the energy bundle does not yet contain the desired attributes to allow consumers to change their activities. But the data indicate that consumers are willing to give the energy bundle a chance.

This study provides new insight into the preferences of energy consumers regarding their activities and the development of the energy bundle. It is not realistic to expect that the energy transition will be completely solved by the introduction of the energy bundle. The first limitation of this research concerns the questionnaire. The survey provided some form of disability. New products or unfamiliar topics can often not part of a survey, because a survey should be clear and easy to understand for every respondent. So the survey cannot contain too much explanation, which often is needed when introducing new or unfamiliar topics. So it is with the new products or innovations. See Figure 24: The Theory of Diffusion of Innovations Rogers.

An important limitation of the study is that it made clear how one person behaves in the household. Therefore, preferences in relation to the behaviour of one person were investigated. But 67% of the households of the research sample consist of two or more people. This study does not show how other people in households react. For example, a man fills in the questionnaire. He proves to be very flexible and is also willing to use his flexibility in relation to the energy bundle. However, he also has a wife and a child. The woman works part-time and takes care of the child. The woman is not at all flexible. But this is not known, because this research only questioned one person about his activities and did not consider the activities of his entire household. Further research is needed to see how total households will respond to the energy bundle and their flexibility.

It is possible to investigate the energy bundle further. It possible to add the attributes price as one the attributes of the composite energy bundle. And also it is important that consumers are able to calculate what their rewards are if they can be flexible. It can also be determined under which conditions consumers are prepared to change their activities.

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Ing. Maaike Schut

Born in 1990 in Heiloo. Maaike began her engineering studies in Alkmaar in 2007, graduate as Bachelor of Built Environment in 2011. Willing to study further, Maaike decided to focus on management aspect within the construction industry. Arising from this he has successfully completed the Master Construction Management and Engineering at the Eindhoven University of Technology in 2015.

2007 – 2011	Bachelor of Built Environment (minor: Project- and Process management
2009	Assistant planner at Teerenstra Bouw bv in Heiloo
2010 – 2011	Assistant Projectmanger OIII Architect and IQNN vastgoed in Amsterdam
2011 – 2015	Master Construction Management and Engineering
2015 – Now	Projectcoordinatior at Draaijer + Partners in Utrecht

DE FLEXIBILITEIT VAN DE CONSUMENT EN DE VOORKEUREN VOOR EEN ENERGIE BUNDEL

Auteur: Maaike Schut

Keywords: ENERGIE, FLEXIBILITEIT, CONSUMENTENGEDRAG, NETBEHEERDERS, ENERGIETRANSITIE, ENERGIE BUNDLE

INTRODUCTION

Het huidige energie systeem is vraag gestuurd. De consument kan energie gebruiken op elk moment van de dag voor een vaste prijs. Het huidige systeem bestaat uit de netbeheerder, de energie leveranciers, de consument en de toezichthouder. (ECN, Energie-Nederland en Netbeheer Nederland, 2014) Netbeheerder is verantwoordelijk voor het netwerk en de aansluitingen, leveranciers zorgen voor levering van energie, de consument heeft een contract met leverancier over prijs voor de levering van electriciteit en gas en toezichthouder houdt toezicht op de gang van zaken van de verschillende partijen.

Het opwekken van energie door middel van duurzame energie bronnen zorgen ervoor dat het energy systeem te maken heeft met grote aanbod verschillen, door bijvoorbeeld zonne energie en wind energie. Het huidige systeem is niet ontworpen voor de grote variatie aan aanbod van energie en het toenemende gebruik van eletriciteit door consumenten, deze veranderingen noemen we de energie tranisatie.

PROBLEEM DEFINITIE EN ONDERZOEKSVRAGEN

In de toekomst, vraag en aanbod van energie zal toenemen. Om te voorkomen dat netbeheerders het huidige energie netwerk moeten verzwaren is het van belang dat er gezocht wordt naar nieuwe oplossingen om dit verzwaren te voorkomen. Het verzwaren van het netwerk betekent voor de netbeheerders grote investeringen met als gevolg dat energie voor consumenten steeds duurder zal worden en als er geen oplossing wordt gevonden kan het netwerk ontbetaalbaar worden voor consumenten. Een mogelijk oplossing voor de energie tranisitie is demand respons. (vraag gestuurd) Demand respons wordt gedefinieerd als het vermogen van de consument om de vraag naar elektriciteit te verminderen en/of te verplaatsen naar andere momenten, door bijvoorbeeld het tarief van energie of andere marktomstandigheden. (Chao, 2010) In dit onderzoek zal een nieuwe mogelijkheid voor demand respons worden ontwikkeld, namelijk de energie bundel. Deze energie bundel is ontwikkeld om te onderzoeken of er mogelijkheden zijn om in Nederland consumenten gericht aan te sturen aan de hand van het energie aanbod. Ook zal gekeken worden of de energie bundel een oplossing kan zijn voor de energietransitie. Op dit moment is niet bekend onder welke omstandigheden consumenten bereidt is om zij/haar gedrag te veranderen.

Dit onderzoek zal de flexibiliteit van de energie gebruiker onderzoeken door het identificeren van de activiteit patronen en bereidheid om hun activiteiten te veranderen. Er zal worden onderzocht wat de voorkeuren van consumenten zijn voor het concept van de energie bundel De volgende onderzoeksvraag is opgesteld om te kunnen onderzoeken of de energie bundel een oplossingen kan zijn.

Onder welke voorwaarden zijn consumenten bereid om hun flexibiliteit in energiegebruik op te geven in het concept van de energie bundel?

Om een antwoord te kunnen geven op de hoofdvraag zullen de volgende sub-vragen worden beantwoord:

1. Wat wordt er in de toekomst verlangt van de consument met betrekking tot het energiegebruik, toekomstige technieken en innovaties?
2. Welke energie bundels kunnen worden ontwikkelend om aan de voorwaarden van de consument te voldoen, de eisen van de netbeheerder en de verwachtingen innovaties in toekomst?
3. Wat zijn de voorkeuren van de consumenten op het gebied van de energie bundels en attributen van de energie bundel?
4. Hoe kan de voorwaarden van de verschillende consumenten worden samengevoegd tot een business canvas voor een bepaalde groep consumenten. En wat zijn de mogelijkheden voor Stedin met betrekking tot de energie bundel.

ENERGY BUNDLE

Langzaam wordt er naar toegewerkd dat elektriciteit zonder C02-uitstoot wordt geproduceerd. Dit zal omstreeks 2050 zijn. Duurzaamheid is de norm; fossiele bronnen zijn langzaam aan het verdwijnen. De verwachting is dat in 2020 meer wind energie worden geproduceerd, er meegestookd wordt van biomassa en meer zonne-energie, en minder productie van elektriciteit met gas en kolen. Consumenten en bedrijven worden steeds vaker producenten van energie. De leverlingzijde lijkt meer en meer op de vraagzijde met de veranderende vraag patronen als gevolg. In de komende jaren zal de energiesector staan voor de uitdaging om de balans tussen het aanbod en de vraag 24 uur per dag te houden. Niet alleen is het verbruik van elektriciteit onzeker; de aanwezigheid van wind en wolken bepaalt hoeveel zon en windenergie is beschikbaar van moment tot moment. Mogelijkheden zijn voor opslag en om de vraag naar energie door middel van financiële prikkels en compensatie systemen beïnvloeden om ervoor te zorgen dat er voldoende capaciteit. Het omzetten van een solide systeem waarbij energie betaalbaar blijft en de principes van de vrije markt intact blijven, lijkt een moeilijke puzzel op dit moment. Het vermogen om de vraag momenten verschuiven naar een lagere elektriciteitsprijs of om een groter aanbod van duurzame elektriciteit zal zeer belangrijk zijn in de toekomst. Bovendien, flexibel gedrag van de consument en de toekomstige mogelijkheden van opslag van elektriciteit zijn essentieel. Om flexibel gedrag bij consumenten vast te stellen, moeten onderzoek gedaan worden naar de beweegreden. De mogelijke oplossing voor de energie transitie en alle veranderingen omtrent het produceren van energie en het gedrag van energie kan zijn de energie bundel.

Verschillende studies hebben gedragsveranderingen onderzocht en hebben onderzoek gedaan naar experimenten met nieuwe technologieën. Het blijkt dat de houding en het gedrag van consumenten veranderen. (Owens & Driffill, 2008) Uit onderzoek blijkt dat consumenten vaak niet op de hoogte of onvoldoende over hun energieverbruik en over energiebesparende mogelijkheden in hun huizen op de hoogte.
Energiebesparend gedrag is gerelateerd aan het huishoudelijke energie en kan worden onderverdeeld in twee categorieën: efficiëntie gedrag of investeringsgedrag en inperking gedrag. Investering gedrag is over het besteden van geld aan het verbeteren van de energie-

efficiëntie, zoals op isolatie. Inperkingsgedrag impliceert herhaalde inspanningen om het energieverbruik te verminderen, zoals het verlagen van de thermostaat. Contextuele factoren, kennis, motivatie, vaardigheden en sociaal-demografische variabelen kan energiebesparend gedrag te beïnvloeden (Han et al., 2013) (Abrahamse, et al., 2005). De energie bundel voor consumenten ontwikkelen is van belang om te begrijpen hoe consumenten zich gedragen en welke strategieën / effect bepaalde kenmerken hebben op hun gedrag.
Een energie bundel bestaat uit een aantal kenmerken die kan zorgen voor de energie-gedragsverandering van de consument. Energie bundel bestaat uit een aantal kenmerken. Dat kan zorgen voor de energie-gedragsverandering van de consument. In tabel 1 worden de kenmerken van de energiebundel weergegeven. Hoe kunnen consumenten worden beïnvloed en hoe kan een energie-bundel gebruik maken van de kenmerken van de consumenten om hun gedrag te veranderen?

	Attributes	Levels
Energy Bundle	**Tarief**	Vast
		4 dag delen
		Flexibel
	Controle	Geen
		Zelf controle
		Automatisch
	Advies	Geen
		Algemeen
		Persoonlijk
	Inzicht in energie verbruik	Jaarlijks
		Maandelijks
		Altijd
	Opslag	Nee
		Ja

Tabel 1 Energie bundel met attributen en attribute-levels

Elke eigenschap heeft zijn eigen waarde en bijdrage in de energie bundel. In samenwerking met Stedin is gezocht naar kenmerken die belangrijk zijn de consument, zodat de energie bundel van waarde kan zijn voor de consument en dat het mogelijk zorgt voor gedragsverandering. Ook heeft Stedin belang bij de energie bundel, maar dan de totale impact van de energie bundel kan van belang zijn voor Stedin. De energie bundel is verder ontwikkeld in het experimental design door middel van stated preference model. Door middel van een enquête is data verzameld over de consument, in de vorm van evaluatie set zijn de energie bundels door de consument beoordeld.

RESULTS

De gegevens uit de enquête zijn verzameld, beschreven en geanalyseerd door middel van een ordinale regressieanalyse. Voor dit onderzoek zijn 4 modellen geschat: het algemene model van de energie bundel, de verschillende voorkeuren tussen mannen en vrouwen voor de energie bundel, de bereidheid van consumenten om hun activiteiten te veranderingen in relatie tot de energie bundel en de bereidheid om ene activiteit van een huishouden aan te passen in relatie tot de energiebundel.

Het algemene model laat zien wat voorkeuren zijn van de consumenten op het gebied van energie bundel en is onderzocht aan de hand van welke attributen de consument hun keuzen maken. Uit de analyse blijkt dat de attributen: zelf controle en altijd inzicht in het energieverbruik, zorgen voor de meest positieve benadering van de energie bundel. Echter zorgen de attrubuten: automatische controle en geen opslag, ook voor een positieve benadering. Echter zijn deze waarde zeer klein en dus minder belangrijk zijn. Hoe groter de postitieve waarde van de verschillende attribute levels des te meer zal de energie bundel de consument aanspreken. Om te onderzoeken of er verschillen zijn tussen voor de voorkeuren van mannen en vrouwen is er een model geschat. Uit dit model kwam naar voren dat verschillen gebasseerd zijn op de attributen tarief en advies. Vrouwen baseren hun waardebepaling van de energie bundel onder andere op advies terwijl mannen juist naar het soort tarief kijken in plaats van naar advies. De andere attributen controle en inzichten geven bij zowel man als vrouw soort gelijk waardes aan. Er zit dus relatief weinig verschil tussen de voorkeuren van man en vrouw. De andere twee modellen richten zich op de activiteiten van consumenten. Een belangrijke vraag in het onderzoek was of de consument bereidt was hun activtieiten aan te passen aan de energie bundel. Dit is onderzocht in twee modellen, één voor de algemene activiteiten en één voor de huishoudelijke activiteiten. Uit het model over de algemene activiteiten (Werk, Studie, Sport, Hobby) kwam als conclusie dat de consumenten niet bereid zijn activiteiten aan te passen aan de hand van de voorgestelde energie bundels. Uit het model over de huishoudelijke activiteiten is te concluderen hoe consumenten reageren op de energie bundel met betrekking tot de activiteit wassen met wasmachine. Hieruit komt naar voren dat consumenten bereidt zijn zich aan te passen aan de energie bundel, daarbij zijn de attributen tarief en inzicht in energieverbruik belangrijk. Wanneer de energie bundel bestaat uit de attributen tarief, 4 dagdelen en jaarlijks inzicht in energie verbruik dan is de consumenten vaker bereidt om de activiteit wassen met wasmachine aan te passen aan de voorgesteld energie bundel.

CONCLUSIE EN DISCUSSIE

Dit onderzoek laat zien dat de ontwikkelde energie bundel van waarde kan zijn voor de consument en dat de energie bundel de consumenten aanspreekt. Het doel van de energie bundel was om te onderzoeken of consumenten bereidt zijn hun activiteiten aan te passen aan de energie bundel. Uit het onderzoek komt naar voren dat in de samengestelde bundel consumenten niet bereidt zijn om hun activiteiten aan te passen aan de energie bundel. Andere attributen kunnen wellicht wel zorgen dat consumenten bereid zullen zijn hun gedrag aan te passen, zoals het toevoegen van prijs of juist de ontvangen kortingen als de consument bereidt is om zich flexibel op te stellen. Dit zal nader moeten worden onderzocht.

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Ing. Maaike Schut

Geboren in 1990 in Heiloo. Maaike begon haar bouwkunde studies in Alkmaar in 2007, om als Bachelor of Built Environment af te studeren in 2011. Welwillend om verder te studeren, heeft Maaike besloten verder te richten op het managment aspect binnen de bouwkundige sector. Hieruit voortkomend heeft zij in 2015 de Master Construction Management and Engineering succesvol afgerond aan de Technische Universiteti in Eindhoven.

2007 – 2011	Bachelor of Built Environment (minor: Project- en Proces management
2009	Assistent werkvoorbereider bij Teerenstra Bouw bv in Heiloo
2010 – 2011	Assistent Projectmanger OIII Architect and IQNN vastgoed in Amsterdam
2011 – 2015	Master Construction Management and Engineering
2015 – Now	Projectcoordinatior bij Draaijer + Partners in Utrecht