Consumers' Preferences on Demand Response in Dutch Households.

A Stated choice experiment in the residential energy market.

Graduation thesis

Construction Management & Engineering

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Summary

Climate change is gaining more and more awareness over the past decades. Due to this awareness, renewable energy is becoming a major topic in scientific research. The share of renewable energy in the current energy mix is increasing and will increase even more in the coming decades. At the moment this share is about 6 percent of the total share of energy. Nevertheless, in 2020, this number must grow towards 14 percent and in 2023 even towards 16 percent to comply with European legislation. Traditional ways of generating energy are using fossil fuels like gas and coal. A lot of Dutch households now use these fuels to power their household applications, cars and heating. In contradiction to fossil fuels, renewable ways of generation like solar and wind are less predictable. Therefore, on the wholesale market of energy, the APX, a different value is given to electricity every hour of the day dependent on supply and demand. If more unpredictable energy is generated, these differences will grow. Supply can have surpluses in peak generation hours and demand has peak hours during the day. Therefore the grid needs to be balanced during peak demand and peak supply hours. One of the options is to store the energy in batteries when supply is high and use this energy when daily demand peaks occur. This way, the supply is balanced according to the demand. On the other hand, demand can also balance itself towards supply. There are different types of energy consumers which can contribute to this balancing. In this research, households are considered.

There are different possibilities for the balancing the electricity grid. Most possibilities aim on reducing peak usage. First of all, a total reduction of energy can lower the peak usage. Peak usage can also be shifted towards non-peak moments or peak values can be decreased by using less electricity during these peak moments. The total usage of electricity is probably going to grow due to an increasing share of electric vehicles and electric household heating. So ideally, the loads are shifted from peak moments towards non-peak moments. This can be realized with different programs. To realize most of these programs, smart metering is a boundary condition. By implementing smart meters in households, a smart grid is being realized giving energy suppliers the opportunity to offer such demand response programs. A popular program is the time-of-use program. In this program, different times of the day have a different energy price. For example, by night, the electricity is cheaper than during the day. Another program is direct load control. This program can activate or deactivate appliances from a distance based on the supply and demand balance of that moment. Due to these programs, electricity is used when the supply is high or when demand is low. That way, the grid will be levelled. Former research is showing that one of the boundary conditions to let households participate in demand response solutions is that energy usage shifting should be automated. Therefore home automation and smart metering are major opportunities for direct load control. To make an impact, high energy consuming appliances should be used. With a rise in the use of electric vehicles and electrical heating, new opportunities of balancing occur. Besides those appliances, the washing machine, dryer and dishwasher are large energy consumers. In this research the last three appliances are considered as household applications.

To determine the preference of energy consuming households, a choice experiment is executed where 190 energy consumers are consulted in a digital survey. These 190 energy consumers, had to choose between 2 different propositions which all had different levels of comfort restrictions in the categories of electric vehicle, heating and household applications.

As an advantage for the consumers, a financial reward is given for limiting these appliances. Next to a financial reward, there are costs to finance the automation which enables the activation or deactivation during peak and non-peak moments. As a last attribute in this survey, the length of a contract is considered. The contract length is in contradiction to the other attributes not found in demand response or energy literature but comes from innovation adaptation literature. In the adaptation of innovation, triability of a product plays a positive role. It is therefore expected that a long contract duration is of negative influence on the preference for a demand response system.

The data of this survey is analysed using a multinomial logit model, executed in the software program 'Nlogit'. This analysis is facilitating the research with the importance of the 6 main attributes. Next to the choice model, socio-demographic characteristics are asked which give insight in the heterogeneity of the model. The heterogeneity is verified with the Mixed logit method where after the nature of the heterogeneity is determined with a latent class model.

In the model estimation, using the multinomial logit model, consumers' preferences are measured according to the different levels of the six attributes, namely: Financial reward, comfort electric vehicle, comfort heating, comfort household applications, price and contract length. The major preference attribute is contract length. Within this attribute, a one month contract, a one year contract and a three year contract are all significant. The negative influence of a 3 year contract is the highest observed negative preference within this research. Relative to the highest financial reward of €100-150, this coefficient is three times as high. Out of the three comfort levels, household heating seems to have the lowest priority, then the charging of electric vehicles and as most disturbing is considered a limit on household application usage. These model estimations are not equally compatible for all socio-demographic groups. The mixed logit model shows that the model is heterogeneous which means that the standard deviation is significantly high. After testing the heterogeneity with an LC analysis, it can be concluded that young male people (26-35 y.o.) with low incomes (<€30.000) assess a limit on the time of use of household applications as less disturbing than the average energy user. This group on the other hand values long contract periods as a greater barrier than the average answerer. High incomes (>€40.000) and renters assess this contact period as less disturbing but assess the limit on household applications as more disturbing.

It can be concluded that the market of demand response within households is a heterogeneous market in which contract duration plays a major role. This is declarable due to the fast changing energy market with an accelerating penetration of renewable energy sources. To level demand and supply in the future on the demand side, households can play a supporting role. This role can be fulfilled when barriers for demand response propositions are taken away and benefits are created. One of the barriers now is the cost of energy management systems, which is perceived as twice as important as financial benefits. Other barriers are limits on usage of appliances and contract length.

SAMENVATTING

Klimaatverandering is een belangrijk onderwerp in de afgelopen jaren. Door deze aandacht voor klimaatverandering vindt er een transitie plaat van vervuilende energie naar hernieuwbare energie. Het aandeel van deze hernieuwbare energie is op dit moment slechts 6% in Nederland. Desalniettemin zal hernieuwbare energie op middellange termijn onze hoofdbron van energie worden. In 2020, zal 14% van de gebruikte energie uit hernieuwbare bronnen moeten komen. In 2023 wordt dit 16% om te voldoen aan Europese regelgeving. Traditionele vervuilende energie opwekking wordt vaak gedaan door middel van gas en kolencentrales. Deze bronnen zijn nog vaak gebruikt om ons te voorzien van energie voor het verwarmen van ons huishouden, het rijden van onze auto's en het voorzien van stroom voor huishoudelijke apparatuur. In tegenstelling tot vervuilende traditionele energie, is de opwek via hernieuwbare energie niet gemakkelijk voorspelbaar. Mede daardoor zijn er op de APX, de groothandel van energie, prijsverschillen voor elektriciteit per uur van de dag. Als een groter deel van de energie mix hernieuwbaar opgewekt wordt, worden deze verschillen groter. Tijdens aanbod overschotten kan zo de prijs dalen en tijdens een vraag overschot zal de prijs hoger worden. Daarom moet het aanbod en de vraag gebalanceerd worden. Een mogelijkheid om deze overschotten op te vangen is het installeren van batterijen. Een andere kant om tegen dit probleem aan te kijken is om de vraag te flexibiliseren. Dit kan op verschillende niveaus. In dit onderzoek zal deze vraag bij Nederlandse huishoudens worden neergelegd.

Het flexibiliseren van de vraag kan op verschillende manieren. Bij veel van deze manieren is het verlagen van pieken het hoofddoel. Een manier om deze pieken te verlagen is door het totale energieverbruik te verlagen. Het energieverbruik kan ook uitgespreid worden over de dag door piekverbruik te verplaatsen naar daluren. Als laatste optie is het ook mogelijk om piekverbruik te verminderen zonder op een ander moment deze energie te gebruiken. Het netto energiegebruik wordt hierdoor minder. Het gebruik van elektriciteit gaat de komende jaren waarschijnlijk alleen maar stijgen door een groei in elektrische auto's en elektrische verwarming. Het reduceren van het totale gebruik lijkt dus onwaarschijnlijk. De stijging van elektrische auto's en elektrisch verwarmen biedt wel kansen voor vraagsturing proposities. De meeste vraagsturing proposities vragen om een implementatie van de slimme meter. Door deze slimme meter kan het energiegebruik per kwartier afgelezen worden. Een welbekend programma is het tijd-van-verbruik programma, beter bekend als dag en nachtstroom. Deze propositie kan ook uitgebreid worden naar meerdere tijdsvlakken per dag. Een andere optie is de overgave van directe controle over bepaalde energie verbruikende apparaten. Zo zal een derde partij bepalen wanneer elektriciteit het voordeligst is en dan uw apparaten inschakelen. In deze programma's hoeft de energiegebruiker niet zelf rekening te houden met wanneer de wasmachine aangezet moet worden of de auto opgeladen moet worden. Voorgaand onderzoek laat zien dat deze automatisering als prettiger ervaren wordt dan het zelf plannen van elektriciteitsgebruik. In dit onderzoek zullen 3 elektriciteit gebruikende apparaten worden getest, namelijk: De elektrische auto, elektrisch verwarmen en huishoudelijke apparaten. Onder huishoudelijke apparaten wordt verstaan de wasmachine, vaatwasser en droger.

Om de voorkeuren van Nederlandse huishoudens te bepalen wordt een keuze experiment gedaan onder 190 energiegebruikers. Hier is een digitale enquête voor opgesteld. De 190 respondenten werden hier gevraag om een keuze te maken tussen twee proposities. Iedere propositie had verschillende niveaus van comfort in de drie comfort attributen elektrische auto, elektrisch verwarmen en huishoudelijke apparatuur. Naast een limit op comfort, had iedere propositie ook een financiële vergoeding. Deze varieert van 0 tot 150 euro per jaar. Naast een financiële vergoeding zijn er ook kosten verbonden aan de automatisering. Deze zijn doorgerekend als jaarlijkse kosten om vergelijkbaar te maken met de vergoeding. Als laatste factor is de contractduur meegenomen. Deze varieert van 1 maand tot 3 jaar. Deze laatste factor komt niet uit bestaande vraagsturing literatuur maar is gevonden in literatuur over innovatie succes factoren. Hierin staat dat probeerbaarheid van een product een positieve invloed heeft op succes van nieuwe producten. Daarom is verwacht dat een langere contractduur een negatieve invloed heeft op de keuze tussen proposities.

De gegevens van de enquête zijn geanalyseerd volgens de multinomial logit methode in het software programma 'Nlogit'. De analyse volgens deze methode geeft inzicht in de verschillen tussen de 6 factoren en de verschillende niveaus hierbinnen. Naast de multinomial logit methode zijn ook de mixel logit en latent class methode gebruikt. De mixed logt methode controleert de heterogeniteit van het model en de latent class methode classificeert de heterogeniteit in verschillende klassen. Hiermee onderzoekt de latent class methode de grond van heterogeniteit.

In de model waardering die is gemaakt met de multinomial logit methode, zijn de consumentenvoorkeuren op basis van de zes factoren bepaald. De meest bepalende factor in dit onderzoek blijkt contractduur te zijn. Deze factor bestond uit drie verschillende niveaus: 1 maand, 1 jaar en 3 jaar. Het niveau van een 3 jarig contract blijkt een negatieve invloed te hebben die 3 keer zo hoog is dan dat de hoogste financiële vergoeding positief is. Binnen de drie niveaus van limieten op comfort, blijkt dat respondenten het liefst inleveren op het comfort van verwarming. Vervolgens leveren ze het liefst comfort in op de elektrische auto en de huishoudelijke apparaten worden als het meest belastend ervaren.

De waarden van dit onderzoek gelden niet voor iedere individuele respondent of voor iedere respondentengroep. Het mixed logit model laat zien dat het model heterogeen is en dat er significante verschillen zijn tussen verschillende doelgroepen. Deze verschillen zijn uitgezocht door gebruik van de latent class methode. In deze methode is de totale groep onderverdeeld in twee klassen. Iedere socio demografische waarde heeft meer affiniteit met klasse 1 of klasse 2. In het model is duidelijk te zien dat jonge mannen (26-35 jaar oud) met lage inkomens (<€30.000) een limiet op huishoudelijke apparatuur als minder belastend ervaren dan de gemiddelde respondent. Aan de andere kant, vindt deze doelgroep een lange contractduur meer belastend dan de gemiddelde respondent. Hoge inkomens (>€40.000) en huurders vinden de contract periode juist minder belastend en vinden een limit op comfort in huishoudelijke apparatuur belangrijker.

De conclusie is dat de markt van vraagsturing een heterogene markt is waarin contract periode een belangrijke rol speelt. Dit is verklaarbaar door een snel veranderende energiemarkt met snelle implementatie van hernieuwbare energiebronnen. Om vraag en aanbod te kunnen balanceren, kunnen huishoudens een belangrijke rol spelen. Deze rol kan pas vervuld worden wanneer barrières voor implementatie weggehaald worden. Op dit moment zijn de belangrijkste barrières kosten voor het systeem, lange contractperiodes en limieten op het gebruik van elektrische apparaten.

ABSTRACT

The energy transition is causing a shift from fossil fuels towards more unpredictable renewable resources like wind and solar energy. Due to this flexibilization of the supply side of the energy market, the demand side should be more flexible as well. This is needed to level the electricity grid. Therefore, demand flexibilization is researched by looking at energy consumers' behaviour and preferences for demand response programs. With a 190 respondent choice experiment, the preferences in demand response programs are tested among Dutch households. Using the Multinomial logit methodology, the relative importance of the attributes and their levels which are found in literature are identified. Subsequently, the heterogeneity of the model is determined using a mixed logit model and the nature of this heterogeneity is determined with a latent class model. Six different attributes with each three levels are tested in this research, namely: financial reward, limiting comfort of electric vehicles, comfort in household heating and in household applications, price of an automation system and contract length. It seems that in general, contract length is the most important attribute. Due to the heterogeneity of the model, for young male people (26-35) with low incomes (<€30.000), a long contract length is even more disturbing than for the average respondent. For high incomes (>€40.000) and renters, a three year dedication is less disturbing. Nevertheless, a limit on household applications has a negative influence on decision making for this target group. The barrier of cost seems to be twice as high relative to the benefits of a financial reward, meaning that barriers in these programs seem to be more relevant than rewards. First step would therefore be to take away barriers before benefits are harvested.

GLOSSARY

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1. Introduction

Over the past decade, our energy supply has been switching from non-renewable resources towards renewable resources like wind and solar energy. Currently, still a large part of our energy supply is facilitated by non-renewable resources like coal, oil and gas. In the Netherlands the amount of energy generated by sustainable resources is only ±6% of the total energy usage (K. Schoots, M. Hekkenberg, 2016). This seems very little, but the amount is growing fast. In 2020, the Netherlands is supposed to have 14% of its energy consumption from renewable resources. In 2023, this amount is supposed to be 16% (SER, 2013). With the use of sustainable energy sources, new problems in our energy systems occur. In Germany for example, the sustainable energy production on a sunny and windy day is about 80% of the daily usage. During the day, there are times, there is an energy surplus. From the supply aspect renewable resources like wind and solar are hard to predict accurately. The supply surpluses therefore happen on certain times of day when supply is high and demand is low. This surplus is then sold to neighbouring countries. If in the whole of Europe, the share of sustainable energy is high enough, there will be congestions in the grid on high supply moments due to a high surplus that can't be transferred. On the opposite where low supply moments occurs, an energy shortage may happen. Hence, demand and supply of sustainable energy need to be matched better (Dekker & Kompier, n.d.).

1.1 Problem definition

According to Nourai, Sastry, & Walker (2010), the best solution for instability in the grid due to unpredictable sustainable energy is storing energy. The ideal storage is divided in different levels. Three levels are mentioned in this research, namely: Central, substation and community level. The storage mentioned in Nourai et al. (2010) is situated right in between the different transportation levels as mentioned in the research of Fera et. Al. (2016). The central battery should be situated at the highest level, just before the energy enters the high voltage transmission. The substation battery should be installed between high and medium voltage and at last on community level just before the low voltage grid. In this solution, the supply is adapted to the demand. This top-down approach looks similar to the current system with non-sustainable energy sources. In contraction to the prediction of Rifkin (2011), this system generates energy on central places. Expected is that sustainable energy will be generated decentral instead of the current central generation.

Another vision on shaping this new market is using smart technologies which level the grid using flexibility of energy usage (USEF Foundation, 2015). This vision is more in line with the vision of Rifkin (2011) and is a more demand based solution than the former supply based solution of (Nourai et al., 2010). With a growing demand of electricity, driven by heat pumps, EVs and other ways of electrical transport, this demand side flexibility becomes more and more important. Actually, the flexibility can be split up two types of flexibility. First of all, there is seasonal flexibility and secondly, there is daily flexibility.

Daily supply and demand are not always in balance. Recent research recognizes this problem and tries to find opportunities to make a better market match in the electricity sector (Waterson, 2017). The problem mentioned here is that wind energy is not easily predictable, which asks for quick response of either energy storage or different structures of energy markets. The predictability for wind and solar for the next day(s) is hard. Only within a shorter time, for example within a day, it is possible to predict wind and solar. So basically, supply needs to be predicted in real time to adapt demand to it.

The balancing of the grid can be beneficial for three parties. First of all, the Distribution System Operator (DSO) can more easily predict the local grid. Also the balance responsible party (BRP) and the Transmission System Operator (TSO) can profit of it. It is clear that for the DSO, the balancing of the grid has huge benefits. Per transformation house in a neighbourhood (± 400 inhabitants), a Net Present Value (NPV) of almost €40.000,- can be earned over 35 years (Barentsz, 2015). This NPV is based on the difference between strengthening the grid and implementing demand response. In the same research, also energy storage is considered. This option is always more expensive than smartening the grid. This calculation is done, presuming that the grid can be levelled completely with the use of Electric Vehicles (EV) and Heat Pumps (HP). At every moment of the day, energy has got a different price according to the APX day-ahead and spot-market. Therewith a financial benefit can be generated for the Balancing Responsible Party (BRP). These parties buy electricity from the day-ahead and spot-market and sell it to the energy suppliers. For the TSO, flexible demand can more easily balance the high voltage grid.

It is clear that the benefits of smart grids and demand response are huge and that implementation is even necessary for a stable reliable energy system. But the framework of demand response is not always clear yet. And the question remains if behavioural adaption is accepted among energy consumers. The Danish research (Schick & Gad, 2015) also mentions customer behaviour adaptation as the next step. The Dutch research (Energiekoplopers, 2016) examined the human behaviour in this topic within a pilot project. To get the ultimate result in demand response, a large part of the households need to adapt to this new energy system. It is therefore necessary to investigate the behaviour adaptation of the technologies for the general energy consumers to find out potential preferences on Demand Response propositions. Only with national adaptation of behaviour, the problems in the grid can be fixed. Therefore, key variables that influence adaptation need to be determined and their importance needs to be defined.

1.2 Research questions

The objective of this research is to examine the influences of demand response and financial incentives on the behaviour of residential occupants. To structurally analyse this influence, one main question and six sub questions are formulized.

Main question (MQ):

MQ1: *What are the key factors of acceptance of Demand Response among Dutch households in relation to an unpredictable supply?*

Sub questions (SQ):

Table 1: sub questions

Code:	*Question:*	*Methodology:*
SQ1:	In what way is the electricity market increasing or decreasing within the residential energy market.	Exploratory qualitative research
SQ2:	In what way can Demand Response contribute to the current energy transition?	Literature review
SQ3:	What are the key factors that influence energy behaviour of residential occupants?	Literature review / Exploratory qualitative research
SQ4:	What is the effect of a financial incentive on residential occupants' opinion on a Demand Response system?	Choice experiment
SQ5:	In what way can Demand Response (DR) products be implemented in a complex, changing energy market?	Choice experiment / In-depth qualitative research
SQ6:	In what way can flexibility in energy usage of households be implemented?	Validation with business cases

1.3 Research design

In the research design, the methodologies to answer the sub questions are split up in the tasks related to this methodology.

1.3.1 Scope

The research will be limited to residential occupants. Non-residential occupants often have different structures in the organization of their energy supply. For example, the investor or owner of the building can pay the energy bill or a company takes energy directly from the DSO. Residential occupants take their energy at an energy supplier most of the time. Another limitation is that only electricity is considered in this research. Above all, the energy transition is shifting from fossil fuels to sustainable power and therewith causing the trend of using electric power above direct fossil fuels.

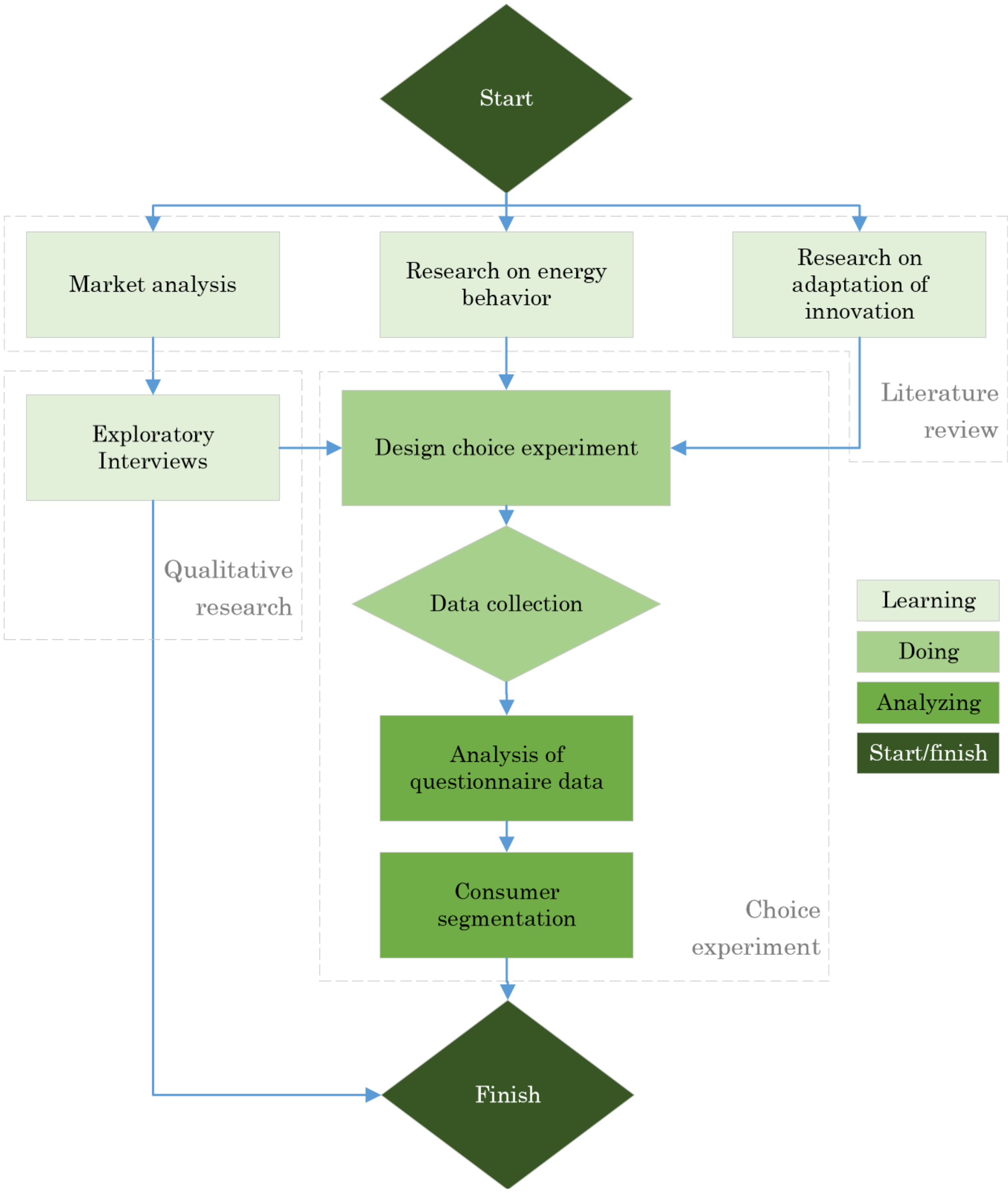


Figure 1: Research design

1.4 Relevance

1.4.1 Societal relevance

At the moment, energy usage peaks are twice a day, namely between 7:00 and 12:00 and between 17:00 and 20:00. This means that energy is worth more at those times (as seen in Figure 2). In order to manage the energy supply over the whole day, traditional energy sources as coals and gas are used. As you can imagine, sustainable energy sources in the Netherlands are not easily turned on and off as traditional energy sources due to their dependence of sun or wind. Therefore we need to find a way to get our power demand and supply levelled over the whole day. Many recent supply oriented research is done about this problem and smart grid solutions and energy storage are popular research fields. Another key thing to remember is that human behaviour can influence a large part of this usage. This part is a demand oriented solution.

1.4.2 Scientific relevance

According to existing literature, social research is the next step in demand response research (Barentsz, 2015; Energiekoplopers, 2016; Schick & Gad, 2015). In 2008, Vice & Al (2008) started to create awareness for smart grids. Out of the smart grid research, the research field of demand response was created, in which the technical part is mostly reviewed. A lot of research has been done finding methods to realize demand response, applying peak shaving at industrial sites and to implement smart meters (Lubach, 2013). The implementation of smart meters is currently happening in most households in European countries, indicating that the implementation of demand response can start in the residential market. The advantages on small and large scale are reviewed as well and a new market for trading flexibility is founded (Clementino, Teixeira, Soares, & Cunha, 2015; Nourai et al., 2010; USEF Foundation, 2015). To realize demand response for the residential market, different market research is needed. In 2016, the first researches in the social and implementation field are done (Broberg & Persson, 2016; Energiekoplopers, 2016; Schick & Gad, 2015). Future research in this field should focus on implementation and customer behavioural acceptance. In my thesis I will research the stimulating ways of influencing people to use energy in different time frames. This will be done by compensating energy consumers financially for shifting their energy usage.

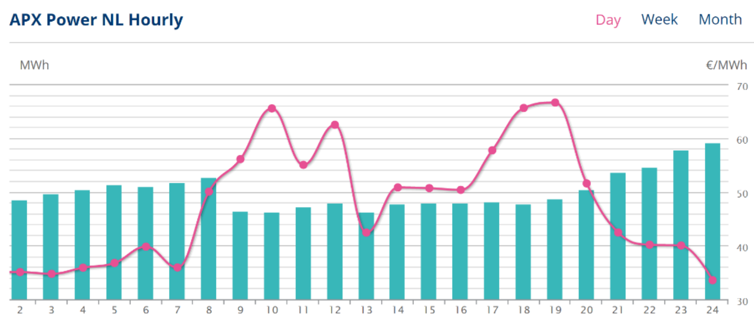


Figure 2: APX graph of a daily overview

1.5 Reading guide

In chapter 2, a summary of the Dutch energy market and the need for demand response is explained. In chapter 3, consumers' preferences that comes with demand response are analysed. Subsequently, the stated choice experiment is explained and executed in chapter 4. Chapter 5 will eventually give conclusions and recommendations.

2. Understanding Demand Response

2.1 Introduction

2.1.1 Scope and goals

This literature comprises 2 different parts. Chapter 2 answers sub question 2: *"In what way can Demand Response contribute to the current energy transition?"* And chapter 3 partly answers sub question 3: *"What are the key factors that influence energy behaviour of residential occupants?".* The two chapters interconnect in a way that the market analysis is defining the problem and equally important, chapter 3 searches for behavioural change attributes.

This literature review analyses the status of energy behaviour research. Within a fast changing market like the energy market, it is important to consider the date of research. For mutual relationships between parties and legislation, it is important to have literature from after 2007. In November 2006, the Netherlands adopted the WON (wet onafhankelijk netbeheer). Meaning that DSO's and Energy suppliers needed to be split. The research is conducted in the Netherlands, therefore the Dutch market is the most relevant research market for literature. Nevertheless, for the second part concerning the energy behaviour, lessons are learnt from worldwide literature from a larger time period.

A roadmap of this literature review is found in Figure 3. First the stakeholders and current energy market are analysed. Subsequently the energy transition is formulated and a vision with its legislation is explained for the problem. In the legislation part, current pricing models are included. In the final section, Demand Response (DR) is defined and DR programs are identified.

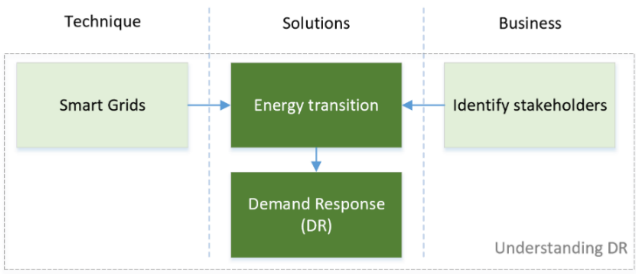


Figure 3: chapter outline

2.2 Identify stakeholders and markets

There are seven main players in the Dutch electricity industry as seen in Figure 4, namely the transmission system operator (TSO), the Distribution system operators (DSOs), the retailers, the energy generators, Measurement parties, BRPs and the consumer. Electricity flows from the generator to the consumer via the DSOs and where needed via the high-voltage lines of the TSO. The administrative supply is being facilitated by the retailers and the net is levelled by the TSO. An overview of the relations between these parties can be found in Figure 4 (Boots, 2011).

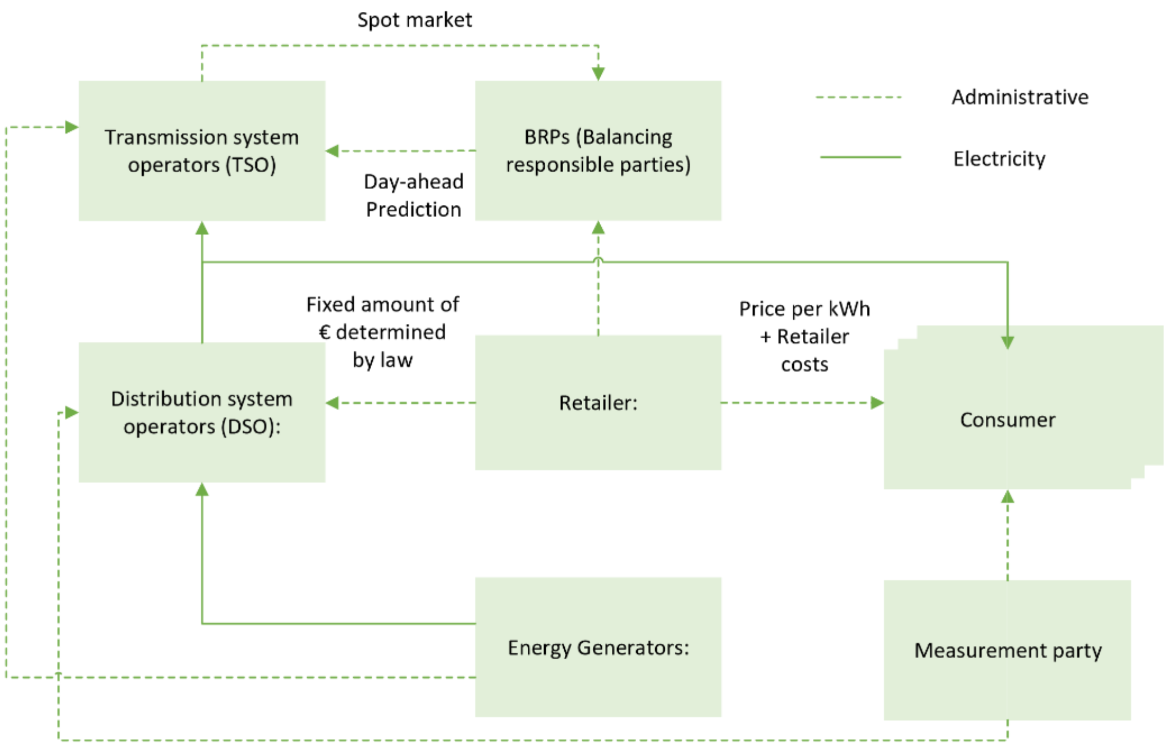


Figure 4: Market overview

2.2.1 Retailer

The energy usage data is transferred from the DSO towards the retailer. The retailer takes care of the administrative part of the supply. These companies buy their energy from the Balance Responsible Parties (BRP) which trade electricity from the different energy markets. In the Netherlands, more than 30 energy retailers are active. The biggest retailer in 2016 was Budget Energie with a 15% market share. Between 2013 and 2016, 10 new energy retailers started up (Verenging eigen huis, 2016). This shows that the market and the demand of consumers is changing. Some retailers are generating electricity themselves. For example NUON and Essent have their own energy generators but are retailers as well.

2.2.2 TSO

TenneT, the TSO, is the main player on the high-voltage grid. With about 22.000 km of high-voltage lines, TenneT is not only active in the Netherlands, but also in Germany and it connects European countries. The TSO transfers the energy from power plants, renewables and imported energy towards the grids of the DSOs. With this role, one of the most important responsibilities of a TSO is that the grid needs to be levelled. Electricity cannot directly be stored so the demand and supply need to be similar at every moment of the day. TenneT is fully owned by the Dutch ministry of finance (TenneT, 2016).

2.2.3 DSO and measurement party

The DSOs are the operators of the regional energy grids. Physically, this party is situated between the TSO and the end user. In the Netherlands there are 8 DSOs, namely: Cogas, Delta, Endinet, Enexis, Liander, RENDO, Stedin and Westland Infra (Energieleveranciers.nl, 2017). These parties all have their own operation area. Within these areas they make sure the energy flows from the high voltage grid, up to the meters of the households. The overview of the working areas of these DSOs in the Netherlands can be found in Figure 5. To provide the DSOs from correct reliable energy usage data, the external measurement parties measure the usage. External measurement parties can be part of the particular DSO or retailer. It can also be an independent party. The measurement parties need to comply to certain reliability measures and need to be checked and listed by TenneT, the TSO. The measurement parties need to be registered in the MV register (TenneT, 2016).

Figure 5: Overview of DSOs in the Netherlands

2.2.4 Generator

The energy generators is a bigger group of companies, cooperation's and individuals that generate power. In the Netherlands, this is mostly done using fossil fuels. The share of renewable energy sources in 2015 was 5,8% (K. Schoots, M. Hekkenberg, 2016). In surrounding countries, this renewable energy share is higher. Therefore a part of the energy used in the Netherlands, is generated in foreign countries and is imported and exported via the energy markets.

2.2.5 Consumer/prosumer

The client which is served by the market is called the consumer or the prosumer. This party is gaining bargaining power on the energy market through legislations that allow customers to switch between retailers (Kuiper, 2015). Another trend that is occurring at the moment is that customers are becoming generators. More and more households and companies are generating their own electricity. These self-generating consumers are called "prosumers" (Zhou, Yang, & Shao, 2016). This trend also gives customers a better bargaining position in the market.

2.2.6 Balancing responsible party (BRP)

The BRP is trading the electricity bought on the energy wholesale market, which is called the APX market. BRPs are trading with the retailers that have the consumers/prosumers as their clients. The BRP parties buy energy on the APX day-ahead market and level the usage and predictions with the intraday and spot market. Administratively, BRPs are standing between the APX energy markets and the energy suppliers. In the USEF framework, BRPs can easily level supply and demand using the flexibility of consumers/prosumers (Eid et al., 2016). If a BRP predicts the usage of its clients wrong, they pay a fine to the DSOs and TSO, who make costs for levelling the grid.

2.2.7 APX

Since 2008, European energy markets merged. The APX was created by merging the French Powernext SA and the German EEX AG. Together these markets became the APX Group. Nowadays, the day-ahead market and the spot market of APX are the trading platform of energy for the Netherlands, Germany, Belgium, UK, France, Austria, Switzerland and Luxembourg. These countries are accountable for half of the European electricity consumption (APX, 2017). In 2015, The European Commission has coupled all European energy markets. This is a next step to a European Energy Union (Eid et al., 2016).

2.3 Energy transition

Currently, the world is going through an energy transition. The concentration of CO_2 in the air is rising and a climate change is occurring due to this concentration of CO_2 (Lubach, 2013). Therefore it is of major importance to make a change from using fossil fuels towards using renewable energy as an energy source.

On the 12th of December 2015, the countries of the United Nations Framework Convention on Climate Change, also known as "the Convention", decided to act on climate change with a common goal. These 195 countries that signed the Paris Agreement, are agreeing on goals to prevent climate change in the world. The most important points in this Agreement are (The convention, 2015):

- The increase of average temperature in the world should stay below 2 ^{o}C, aiming for a maximum increase of 1,5 ^{o}C;
- The governments of these countries come together every 5 year to adjust their goals;
- The governments involved, report openly to each other and the public how well they are doing.

As a European contribution to the world's problem, Europe created more ambitious, more specific targets which are reported in the Europe 20-20-20 targets. The European target is that the CO_2 production will be reduced with 20%, that 20% of energy comes from renewables and an increase of energy efficiency of 20%. This reduction is part of the 20-20-20 EU targets. This agreement shows national targets for each participating county. For the Netherlands this means that we should reduce emissions with 16%, that we should increase renewable energy to 14% and have a maximum energy usage of 60,7 Mtoe (million Tonnes of Oil Equivalent) (Commission, 2015).

On national scale, the Netherlands contribute to this with the Energieakkoord. This agreement, signed by 47 (market) parties, has similar targets as the 20-20-20 agreement but is specifically dividing tasks to realize these goals (SER, 2013). At the moment especially the goal of 14% share of renewable energy sources is a major challenge for the Netherlands. In 2004, this percentage was 2%, in 2008 this was 3%, in 2012, 5% (Deloitte, 2015) and in 2015, this was 5,8% (K. Schoots, M. Hekkenberg, 2016). Before 2020, this amount is probably going to rise significantly, meaning that the grid will meet challenges.

To stimulate sustainable measures in the Netherlands, some subsidies and regulations are implemented. In this chapter, the postcoderoos regeling and salderingsregeling will be explained. Subsequently a vision of the energy transition will be defined.

2.3.1 Postcoderoos regeling

The ‘Postcoderoos regeling’ is a national subsidy in the Netherlands that stimulates local electricity generation. The subsidy is part of the ‘energieakkoord 2013’ which is an act to stimulate a more sustainable energy environment in the Netherlands. Due to the ‘postcoderoos regeling’, energy cooperation’s can produce and sell energy without having to pay the energy tax. The requirements to get this discount is that the electricity stays within the own 4-number postal code or in one of the neighbouring 4-number postal codes (SER, 2013). As seen in Figure 6 this energy tax can be up to 50% of the costs of the energy bill. The regulation will be active for at least four years, after that, the government will make a decision whether to continue or not with this discount.

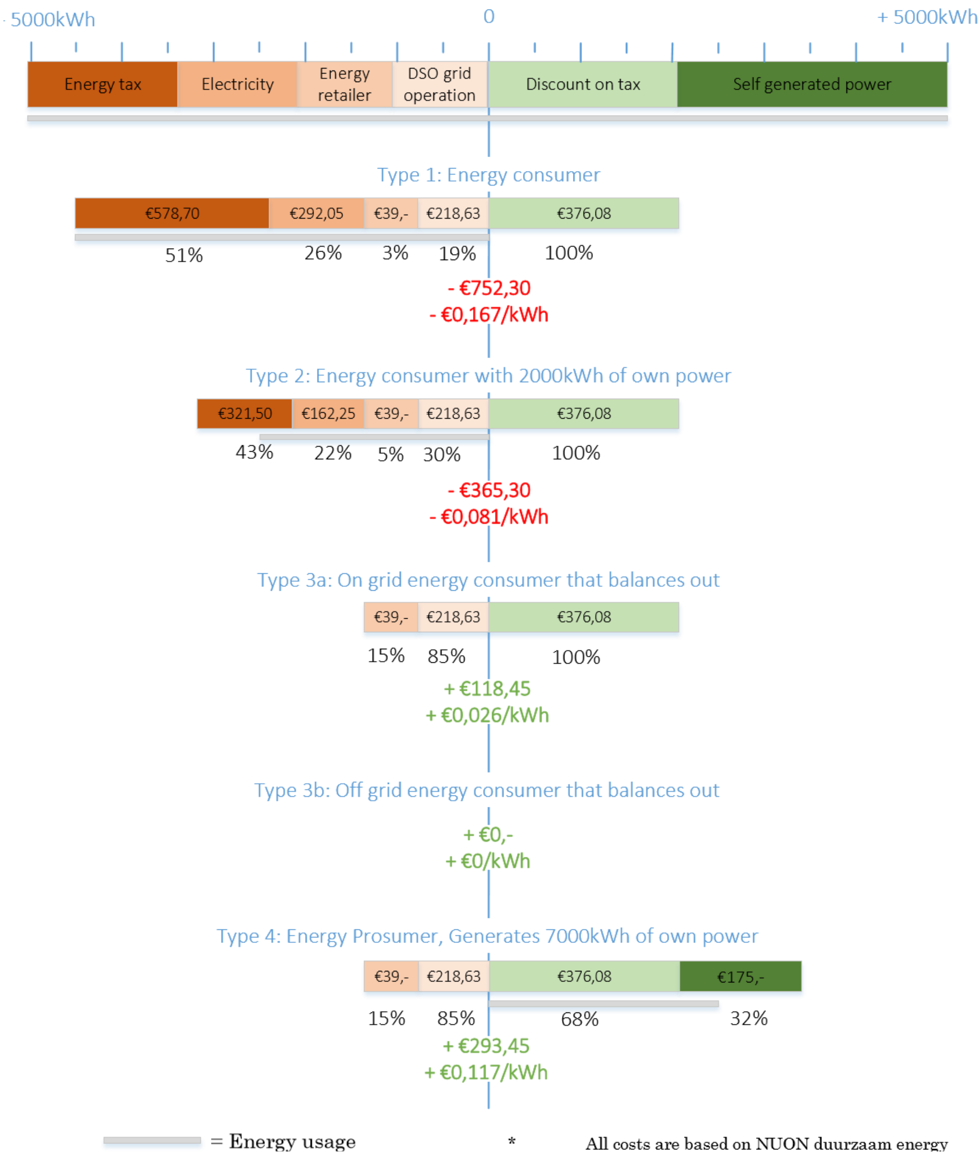


Figure 6: Energy costs of 4 diffent types of households

2.3.2 Salderen

'Salderen' means balancing. In this regulation, the balancing is applied on the energy bill. When a prosumer is generating a part of his energy locally, the prosumer does not have to pay tax over the part that is delivered back to the grid but used on another moment. To clarify this rule, an example of this rule is given: A prosumer consumes 4500 kWh per year. This same prosumer also generates 2000 kWh. 1000 kWh of this 2000 kWh is used immediately and 1000 kWh is sent back to the grid. On the energy bill of the prosumer the 2000 kWh will be deducted from the 4500 kWh. So that means that the prosumer has to pay his bill for 2500 kWh. This balancing rule is implemented on the 1st of January, 2014 and will continue till at least 2023 (Consuwijzer, 2016).

Out of the pricing model in Figure 6, it can be concluded that energy tax is a large part of the energy costs. In a large household, this percentage is 51%. The cost for the supplier is 3% plus a margin of the electricity itself and about 19% is going to the DSO. This means that 26% of the cost of electricity is the electricity itself. In type 2, 2000 kWh of electricity is generated by the household itself. This gives a reduction in price per kWh of 8,6 cents. When the power usage is similar to the generation, the percentages of costs for electricity get towards 0. Comparing type 3a and 3b, it can be stated that it is financially more feasible to stay connected to the grid than leaving the grid when all electricity is produced yourself. This situation is due to the discount of tax, which all households connected to the grid receive. So due to the 'salderingsregeling', 100% of the electricity *price* is received by the prosumer for the energy that is brought back into the grid. The value of the energy is only +- 26%. The other 74%, which include tax and operation costs are subsidized by the 'salderingsregeling'.

2.3.3 Think global, act local

Looking at the global, European and national measures, it is clear that the world is going through an energy transition. Some national legislation like the 'postcoderoosregeling' and subsidies for solar panels, stimulate local generation of energy. The vision of Rifkin (2011) is that energy will be produced locally by transforming buildings into micro power plants. The political promotion story is that it will contribute to a new, green economy. Instead of large costs, sustainability is an economic stimulant. Lots of new jobs will be created by a green industry. The transition from the 2nd to the 3rd industrial revolution can be summarized in 5 pillars:

1. Renewable energy;
2. Buildings as power plants;
3. Deploying hydrogen and other storage technologies (seasonal load shifting);
4. Using internet technology to transform the power grid;
5. Transitioning the transport fleet to electric, plug in and fuel cell vehicles.

The energy which is generated locally should be bought and sold on a smart network which he calls the energy internet.

In the roadmap of Rifkin (2016), which he made for the Metropole of Rotterdam and Den Haag (MRDH), these pillars are made more specific towards the Dutch situation, focussing on the greenport, the mainport and the dense population of the region. In this roadmap Rifkin is mentioning sharing the flexibility of off-shore wind parks, the harbour and the greenhouses. Furthermore, Rifkin is mentioning in his roadmap how the region can be less dependent on fossil fuels by using renewable energy sources like solar, wind and waste heat of the industries.

With this transition towards decentralized power generation and unpredictable energy generation, the need for energy storage is growing. In Nourai et al. (2010) question like 'what if a high penetration of renewable resources start to destabilize the grid?' And 'What if energy independent customers remain grid-connected and create a highly irregular demand of the grid?' are asked to consider energy storage. This energy storage could buffer peak supply and demand of electricity.

Looking at the business cases of energy storage, it is still a commercial undesirable option to store electricity. Only when these systems are linked to the spot market (APX) and the difference in hourly prices are big enough to get profit out of it, these business cases could become sound. These batteries should automatically buy when electricity on the APX is cheap and sell when it is expensive. The difference in €/kWh is the profit of operating such an energy battery. To do so, investments in ICT need to be made (Barentsz, 2015). Before these applications are available, investments in storage are public costs.

So summarized, energy generation is more decentralized than it used to be and grids come to have different functions. Where once, the energy came from one central point and floated to the customers, nowadays consumers turn into prosumers. This shift from national organized energy supply to regional energy supply needs a new distribution approach. Energy distribution networks need to have either a higher capacity or need to be designed smarter. The research field that is working on this topic is called Smart Grids (SG).

2.4 Smart grids (SG)

Implementing a smart grid includes the cooperation between the DSO and the consumer. Energy supply in the future is shifting from a demand oriented to a supply oriented market (Bijlsma, 2015). Nowadays, the DSO has the responsibility to make sure the prosumer is using the energy at the moment that supply is high to level the grid on a local scale. The customer is expected to take a more active role in the market, for example by implementing solar panels or managing their own energy usage. This is how the DSOs see the future of smart grids according to Bijlsma (2015).

Due to a significant rise of sustainable energy sources like solar and wind energy, the current electricity grid is in need for an upgrade. Where the energy system used to be flexible on the supply side, it is now depending on uncertain supply due to the unpredictability of wind and solar power. To manage the supply and demand on every moment of the day, SGs need to be installed.

2.4.1 Definition

But what is a smart grid?

In 2008, the term Smart Grid made its introduction in the market. The first literature about SGs is found from this year. According to Vice & Al (2008), the meaning of SGs was not defined yet at all. Anyway, Google and GE were promoting working on SGs. After Al Gore's 'an inconvenient truth', Google and GE saw that after changing to wind and solar energy, changes in the current power grid are needed. 9 years later, the definition of smart grids is evolved into a more or less clear definition. In 2012, Benjamin came with the following definition:

> *"In a smart grid, not only the production side is active; both producers and consumers participate in the balancing efforts. The consumer side can contribute by moving loads in time, e.g. by allowing local devices with large time constants to store more or less energy at convenient times, thereby adjusting the momentary consumption"* (Benjamin, 2012).

In 2015, Schick & Gad is still mentioning the two-way communication between supplier and consumer as a tool to monitor the national energy system in his definition.

> *Smart Grids are intelligent electricity systems with a two-way flow of digital communication between a supplier an a consumer* (Schick & Gad, 2015).

In 2017, the two-way communication is integrated in the definition and elaborated with its functions. The economic efficiency, quality, security and safety are mentioned as functions of the SG.

> *"smart grid is an electricity network that can cost-efficiently integrate the behaviour and actions of all users connected to it – generators, consumers and those that do both – in order to ensure economically efficient, sustainable power system with low losses and high levels of quality and security of supply and safety"* (Yolda, Önen, Muyeen, Vasilakos, & Alan, 2017)

The monitoring in the grid is the first step of SG's. The second step of SG networks is controlling the supply and demand in a cost effective, sustainable and qualitative manner (Schick & Gad, 2015).

The definition of smart grids is starting to become uniform but the research fields within smart grids are still very broad. Some research is done on the possibilities, some on implementation and a lot of research is aiming on the technical aspect (Benjamin, 2012; Qingbin Wang, 2016; Yolda et al., 2017). The research fields vary in expertise and in level of depth. Hence, it can be stated that *smart grids is an umbrella term for a variety of digital communicative solutions which are network oriented to realize a more sustainable, effective, efficient and a safer electricity grid*.

The first step in realizing a smart grid, is making the communication possible between all parties. This communication can be done using smart meters on household level and on company level.

2.4.2 Smart meter distribution

On household level, in November 2016, 25% of the Dutch households had a smart meter (Vringer & Dassen, 2016). About 15% of these households have an in-home display to visualize their energy usage. This means that 25%*15% = 3,75% of the Dutch energy market has access to their real time energy data. The awareness that is created by showing energy consumption, should save 3,5% of the energy bill for households. In the UK, this potential is being realized in the households that have these measures implemented. This potential is only reached when a display is installed and awareness is created at the consumers. Compared to other countries in the EU, the distribution progress of in-house displays is not going fast enough yet. If all

Dutch households would have an in-home display, a potential saving of 1.500.000.000 kWh per year can be realized. But most important in this research, it can level the unpredictability of solar and wind energy. (Vringer & Dassen, 2016).

Since the 26th of November, 2016, the law which enables individual-smart-meter-allocation (ISMA) is accepted. Therefore it is possible for DSOs to collect real time energy usage data from individual energy users. With this possibility, real time energy pricing becomes possible for energy suppliers. New grid levelling possibilities which are discussed in chapter 2.6 become possible with this extension on the energy law which is adopted in 2016 to a law that is active since 1998. (Rijksoverheid, 2017).

2.5 Demand response (DR)

2.5.1 Definition

SG is mentioning a 2-way communication system between demand and supply side to create an intelligent and efficient energy system. DR is a part of the SG system and goes into depth on the definition of SG. In DR, the behaviour of the energy user is influenced to reduce peaks and to reduce energy usage on peak pricing level times. In 2016, Zhou & Yang came with the following definition:

> *"Changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized" - (Zhou & Yang, 2016)*

Another thing they suggest is that there are two options to realize behavioural change. Firstly, it is possible to charge the energy users with real time pricing of wholesale markets. Another proposition is to incentivise usage shifting from peak towards non-peak moments. In Sweden, it is obligated for energy suppliers to offer real time energy pricing. Only 0,2% of the households signed a real time energy pricing contract (Broberg & Persson, 2016). In the Netherlands, the DSOs are since November 2016 obligated to give such data to energy suppliers who can facultatively offer these propositions (Rijksoverheid, 2017). Therefore it can be concluded that the demand for real time energy pricing is not that high yet. Another way of harvesting flexibility is Direct Load Control (DLC). DLC contracts are more appropriate for battery usage, heat control and car charging. A third party is allowed to steer the energy usage of a household. With this control, peak time energy usage is avoided which has a value for DSOs, BRPs and the TSO (Broberg & Persson, 2016).

The definition found below, is a broader definition of DR which includes home automation and activations from third parties in the DR definition:

> *"an external signal (price signal or activation) in order to provide a service within the energy system. The parameters used to characterise flexibility include the amount of power modulation, the duration, the rate of change, the response time, the location etc."* - (David Fischer, 2017)

What Fischer (2017) is adding to the words of Zhou & Yang (2016), is that the incentive does not need to be money based, it could also be an activation such as automation and external steering of usage. Taking this definition back to the core of the goal of DR, namely time shifting of end-consumers' electricity usage, the following definition will be used.

> *"The time-shifting of end-consumers' electricity usage based on the actual capacity and availability of the global, national and local grid which is stimulated by activations and/or incentives."*

2.5.2 Problem definition

The traditional energy system is managed throughout the supply side. This creates a hierarchical system where production of energy is flexible and is adjusted to the demand. With a lower predictability of the upcoming solar and wind energy, this flexibility of the supply declines. According to (Fera, Macchiaroli, Iannone, Miranda, & Riemma, 2016) there are three important reasons why the system is originally built up like that, namely:

1. Energy consumers are geographically distributed over large areas;
2. The control stations of energy flows had a limited interconnection capacity;
3. The production was entrusted to a few large power plants.

These power plants, were able to match supply with demand. Through different levels of voltage, the power floats from the generator via the transmission towards the distribution substations. From this point, the power is going to large users (businesses) and to distribution points for households. This generates 3 levels of voltage, namely: high, medium and low voltage transmission. This hierarchical system does have a lot of disadvantages in nowadays energy culture. First of all, the 3-step transmission creates a lot of joule losses. Energy is not always used locally and therefore needs to travel and be transmitted towards other voltage levels which causes losses. If energy can be used locally, these losses are limited. The second disadvantage is the inability to effectively manage the energy flows through the system especially when renewables are producing locally. Local renewable energy can then not always be used locally. Besides, response time in case of a black-out caused by congestion is too long and interruptions in the energy flow can hardly be detected.

On the lowest voltage transmission level, electricity congestions can be prevented which stimulates the reliability of the grid. According to Clementino et al. (2015), the solution for grid operation on micro scale is found in flexible usage and smart solutions. With smart management of aggregator parties, congestions and grid reinforcement on area scale can be prevented. In Clementino et al. (2015), a platform developed by Schneider Electric and ERDF, a large leading DSO in France, is explained. Their vision on smart energy is that different aggregators can offer their flexibility into an aggregator portal from where the data will be used in a distribution management system and in a data analysis platform. The distribution management system will manage the security, quality and supply of energy and the data analysis platform can monitor energy demand compared to weather conditions and other external factors. On area scale, Demand Response (DR) solutions based on flexibility of consumers can delay or prevent the need for grid reinforcement by DSOs. That will save money on the long term and keeps the grid reliable. The net present value of a DR system is higher than the net present value of reinforcement of the grid and as storing energy in batteries (Barentsz, 2015).

On the highest level, the most important concern is the levelling of the total supply and demand of the energy system. This means that the supply and demand of the grid need to be controlled in a different way. Not only the amount of energy generated is important here but especially the time of supply and demand need to match. If more supply and demand can be matched using smart solutions, less storage capacity needs to be installed for peaks in the grid. Storage capacity is not the most financially feasible option, hence it is not desired. Demand Response programs can offer better solutions.

2.6 DR programs

Basically, there are 3 ways to reduce these peaks, see: Figure 7. First of all, the total consumption of energy can be reduced. This will reduce peak and non-peak energy usage and is categorized as energy reduction. The second option is load shifting. In this solution, the usage on peak moments is shifted towards non-peak moments. E.g. your electrical vehicle will be charged at night instead of during the day. The third option is peak shaving. Peak shaving gives some discomfort in peak periods. E.g. on a warm summer, if demand peaks, your air conditioning will be turned off to save energy usage on a peak moment. Instead of an in-home temperature of 21˚C, the in-home temperature will go up to 24˚C (Dooley, 2012).

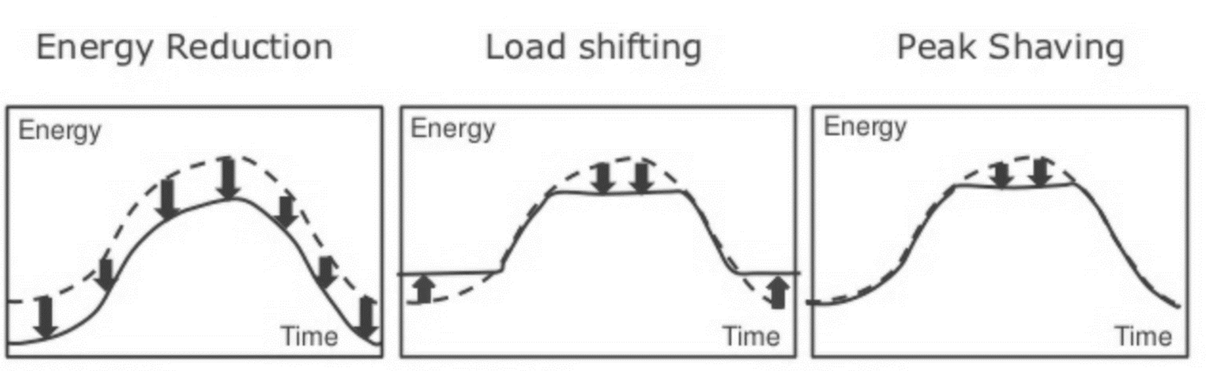


Figure 7: 3 different DR programs (Dooley, 2012)

For harvesting flexibility of energy users according to one of the 3 models of Dooley, different DR programs can be set up. In Figure 8 some of these options are sorted into two categories. The first category is incentive based programs and the second one is price-based programs (Zhou & Yang, 2016).

For the incentive-based possibilities (IBP), 4 different scenarios are worked out. The first one is Direct Load Control (DLC). In DLC programs, external utilities have the possibility to break down the energy usage. This could be on household level or on appliance level. This is most easily performed on heating/cooling appliances. Interruptible/curtailable programs are comparable, except for the fact that customers can take back control of their appliances. Most of these systems get an up-front incentive or discount with a contract which includes fines for not delivering the flexibility as promised. Demand bidding or payback programs are the most interactive form of incentive based flexibility. In this case, customers must bid on a market question for reduction of energy behaviour. In emergency DR customers do not have to do a bid but they get payed for every saved kWh in case of emergency (Albadi & El-Saadany, 2008).

Price-based programs (PBP) are different and do not calculate up-front incentives or rewards. PBPs are based on current value of energy on the wholesale market. This means that the tariffs for customers are not simply kWh*€, but are dependent on the time of usage. The aim of these programs is to flatten the energy usage curves during the day. To realize these programs, smart meters are needed and data needs to be generated on the timing of electricity usage per household. There are some different models within PBPs. Time-of-use (TOU) rates are the most common rates in this category. These programs start on a 2-tariff program; peak and off-peak tariffs, but could also have more time-blocks. Critical peak pricing(CPP) is comparable with TOU pricing. The difference is that in CPP, a certain amount of moments per year can be defined as the peak hours. During these hours the rates differ from the standard TOU or flat pricing. Real-time pricing (RTP) looks at the wholesale electricity market and charges the real-time energy tariffs to customers. To realize this option, smart meter allocation needs to be implemented (Albadi & El-Saadany, 2008).

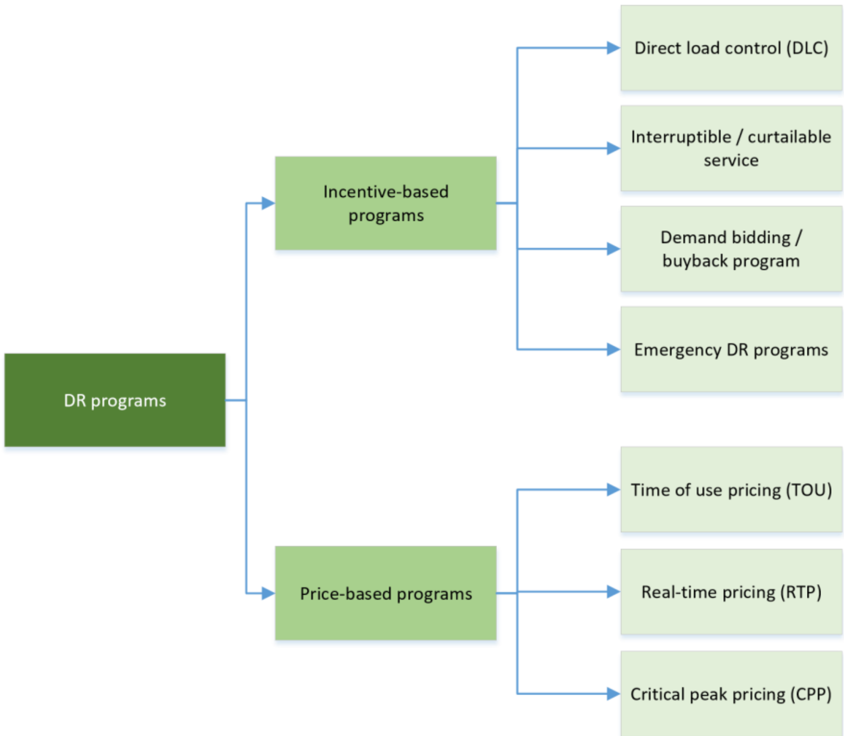


Figure 8: Different DR harvesting programs

The opportunities based on incentives can be based on giving away control of certain appliances. The most viable appliances on a household level are the EV and the heat pump. On a larger scale, giving away control of big industrial plants' energy usage can contribute as a battery. This business development is recently taking place at different parties in the electricity supply chain (Senfal, 2017). For household appliances and household energy usage, flexible energy pricing could be more convenient. As a result, people will be more aware of the timing of their energy usage and will possibly shift it. Home applications with timers and smart devices can help energy users shifting their time of usage.

3.Behavioural change

Implementing one of these possible DR propositions, clearly needs cooperation of households. The new technologies and propositions need to be adapted within households. In this chapter, behavioural change factors are discussed. Some research is based on energy savings behaviour (Gölz & Hahnel, 2016; Ohler & Billger, 2014; Yang, Zhang, & Zhao, 2016) and some research is based on previous demand response adaptation experiments (Broberg & Persson, 2016; Energiekoplopers, 2016; Schick & Gad, 2015; Yang et al., 2016; Zhou et al., 2016). In this chapter not only energy behaviour adaptation is considered but also general behavioural change is analysed. In the first part, literature on energy behavioural change will be consulted. In the second part, demand response behavioural change is considered and in the final part, the theory of Rogers (1995) is discussed.

3.1 Energy behaviour

Ohler & Billger (2014) state that energy behaviour is most often done out of self-preservation rather that from a social or ecological perspective. Energy costs seem to have a bigger influence on adaptation of behaviour than social responsibility. This American research considers a 2 piece definition on self-preservation. The first piece is energy cost control and the second part is comfort. Another notable finding is that social impact is merely considered important when energy usage is compared to neighbours or made public. Gölz & Hahnel (2016) are doubting if the right incentives are used by Ohler & Billger (2014). They claim that not only financial incentives and comfort are internal movers, other attributes are important as well. Gölz & Hahnel (2016) claim that learning about energy saving and having fun are important attributes next to avoiding inconvenience and controlling costs. But most importantly they claim that different groups of people have different reasons. Even if a majority of the consumers claim to be triggered by cost control, there is still a group of people that values learning to save energy more. This can then be considered a niche market.

Gölz & Hahnel (2016) claim that self-defined goals by households are often not met. Solutions for this problem should not only be found in social studies. Technical solutions like reminders, failure prediction and automation could be an answer to this problem. The research of Eid et al. (2016) elaborates on this external control and divides it into different categories. Energy saving and energy control measures can do this in three different ways: controlling, semi-controlling and indirect signal. Control means here that an external party is controlling energy usage of a household or puts limitations to the usage. Semi-control means that a household can predefine their preferences. An example of semi-control is heating less when nobody is home or at night. Indirect signals could mean monitoring of the energy usage and create awareness.

The research of Yang et al. (2016) points out that it is the socio-demographic characteristics of people that make the difference in energy decisions. Yang et al. (2016) only considers socio-demographics in environmental responsibility. But there are more researches which consider socio-demographics next to main influential attributes (Arts, Frambach, & Bijmolt, 2011; Energiekoplopers, 2016; Ohler & Billger, 2014; Zhou & Yang, 2016).

3.2 Demand Response behaviour

According to Energiekoplopers (2016), curiosity towards flex propositions is generated by having an inspiring story. This story needs to contain information about the necessity of DR and make people aware that they help building a solid energy system. This is the first step of getting people towards changing their energy behaviour. Another argument is that there should be no investment. Besides, the organisation should be trustworthy and the appliances should have a low complexity. Zhou & Yang (2016) consider the economic paradigm in a different way. They claim that people can rationalize choices and that a maximum profit is the first psychological decision system. A boundary condition of this assumption is that the consumer is informed correctly and sufficient about the contract that they are engaging. A compensation for the discomfort that is perceived seems to be the leading relative advantage in most social experiments (Broberg & Persson, 2016; Energiekoplopers, 2016; Zhou & Yang, 2016). But relative advantage does not always seem to play the leading role. According to the research of Broberg & Persson (2016), the financial reward should be irrationally high compared to the potential savings. Their conclusion is therefore that flex propositions are not desired at all. But if flexibility in energy behaviour would be obligated, the first control that people would give away is household heating from Monday-Friday, dependent on the presence of the household occupant. Thakur & Chakraborty (2016) are suggesting that TOU propositions with an adequate difference between prices in times of the day can reduce peak usage of energy consumers. In this TOU proposition, the price of energy increases at peak moments of the day and decreases on non-peak moments. Energiekoplopers (2016) and Broberg & Person (2016) both assume that financial rewards are not the way to enter the market at the moment. Schick & Gad (2015) sees that the awareness is not high enough yet. This argument is in line with the arguments of Energiekoplopers (2016) and Broberg & Person.

There are three main application groups which can be used for DR, namely: Household applications, (PH)EV and thermal applications (Althaher, Member, Mancarella, & Member, 2015; Hu & Li, 2013; Shao, Pipattanasomporn, & Rahman, 2012). Some other applications are considered as critical for example light and computers (Althaher et al., 2015). These three researches all mention that an automated system is desired to execute a solid proposition. Household applications can consist of washing machine, dryer and dishwasher (Hu & Li, 2013). The research of Althaher et al. (2015), also considers an oven and the iron as household applications. Nevertheless, they split those two applications in a different category named curtailable. Curtailable applications are considered to be the last resort because they are not desired to be influenced.

The fact that social studies in this field are less agreeing on behavioural factors than energy saving literature means that the research gap is higher in social studies in Demand Response than in energy behaviour. This makes it interesting to not only look at current literature on Demand Response and energy behaviour but also look at the broader aspect of adaptation of innovations.

3.3 Rogers' five

In 1995, Rogers' diffusion of innovation was published where he discusses that not only relative advantage is a factor of behavioural change. Later on this research is confirmed with researches of Arts, Frambach, & Bijmolt (2011) and Vasseur & Kemp (2015). According to Arts et al., (2011), there are 6 factors that influence consumer innovation adaptation. The 6 factors of diffusion of innovation are:

- Relative advantage;

- Compatibility;

- Complexity;

- Triability;

- Observability;

- Uncertainty.

Arts et al., (2011) suggested that there is one more factor that is important for the adaptation of innovation than in Rogers (1995) research. That factor is *uncertainty*. The factors that are found in this literature review, only compel with 4 out of 6 factors of the diffusion of innovation. The factors triability and uncertainty are not discussed.

A wide range of possible attributes is found in literature. These can be found, sorted along the factors of Rogers in Table 2.

As seen in Table 2, the intention attributes of triability and uncertainty are not covered in the factors that are found in literature. In the research of Arts et al. (2011), the attribute triability has a positive correlation and uncertainty has a negative correlation for intention. An overview of the gathered factors and socio-demographics can be found in Table 2. Further details about these researches are found in Table 3.

Table 2: Overview of different factors according to Rogers' five

	Factors (Supply)																			
	Relative advantage	Financial reward	Rewards (awards/prizes)	Free products	Energy cost concern	Faster charging and charging by self-generated power	Having fun	Sustainability	Compatibility	Avoiding inconvenience	Comfort Concern	Complexity	Low complexity	Triability	Observability	Social Responsibility	Learning to save electricity	Feedback (benchmark, current usage, energy label)	Controlling and reducing cost	Uncertainty
<u>Literature:</u>																				
A. M. Ohler, S.M. Billger (2014)					x						x					x				
S. Gölz, U. Hahnel (2016)							x			x							x		x	
Energiekoplopers (2016)		x						x					x							
K. Zhou, S. Yang (2016)			x	x														x		
S. Yang, Y. Zhang, D. Zhao (2016)																				
V. Vasseur, R. Kemp (2015)	x								x			x		x	x					x
J.W.C. Arts, R.T. Frambach, T.H.A. Bijmolt	x								x			x		x	x					x
Schick & Gad (2015)		x				x										x		x		

Table 3: Consulted research and their lessons learnt

Author:	Country / region	Subject	Methodology	Socio-demographics	Preference factors
(Ohler & Billger, 2014)	US	Electricity reduction behavior	Empirical data vs. socio-demographics	Income, household characteristics, dwelling characteristics, gender, education, age	Comfort concern, Energy cost concern, social responsibility
(Gölz & Hahnel, 2016)	Switzerland	Energy saving with energy insights	Empirical data vs. socio-demographics	Gender, Employment	Having fun, Learning to save energy, controlling and reducing costs, avoiding inconvenience
(Energiekoplopers, 2016)	Netherlands	Demand response preferences	Stated choice and qualitative	Type of company, In pilot project / out of pilot project	Sustainability, Financial reward, Compatibility, no complexity
(Zhou & Yang, 2016)	China	Demand response, Different ICT solutions	Literature study	attitude	Technological progress, Rewards, Free products, Feedback (benchmark, current usage etc.)
(Yang et al., 2016)	China	Direct and indirect Energy-saving behavior		Gender, Age, Education level, Household income, Marital status	environmental responsibility
(Schick & Gad, 2015)	Denmark	Flexible and inflexible energy engagements			Reward, Faster charging and charging by self-generated power, Social responsibility, Feedback
(Broberg & Persson, 2016)	Sweden	Demand response in smart grids	Choice experiment	Age, Retirees, Gender, Income, Household size, Children <12, type of house, heating	External control of heating, External control of domestic electricity, External control in extreme cases, information, Compensation
(Althaher et al., 2015)	UK	Automated demand response	Modelling		Washing machine control, Electric vehicle control, oven, iron, thermal applications, critical applications (light, computer)
(Shao et al., 2012)	US	EV in DR with consumers' choice			HVAC, Water heater, clothes dryer, EV

3.4 Discussion

In the energy market, the supply of electricity was always adaptable to the demand. With a shifting from burning fossil fuels towards the generation using solar and wind energy, this supply gets more unstable and less predictable. Besides, the energy generation is not taking place on one central location, but nowadays, lots of buildings act as little power plants. Hence, to monitor all these generation locations, a smart grid needs to be implemented. Which gives the possibilities to monitor and control energy behaviour. Demand response programs, are a package of possibilities to control this energy behaviour. This can be done in different ways. Some programs are incentive-based and others are price-based programs. In incentive-based programs, peak shaving and load shifting will have economic value. This value is allocated towards the aggregator or towards the flexible prosumer. In price-based programs, this value is captured by additionally charging energy peak usage. The difference between peak shaving and load shifting, is that in peak shaving, the usage of peak moments will be reduced. In load shifting, this usage is moved towards non-peak moments. Meaning that when peak-shaving is realized, the total energy usage is reduced. In load shifting, the total energy usage stays the same. Different programs have different consequences on the energy usage. Some will realize peak shaving, some will realize load shifting.

To implement such a smart grid and to realize demand response programs, smart meters need to be distributed and home automation needs to be installed. In the current situation, this is not the standard yet. Therefore, realizing these ideal appliances, often needs an investment at the start.

In the adaptation of new technologies, Rogers' theory of adaptation of innovation, states that there are 5 important factors: relative advantage, compatibility, complexity, triability and observability. According to the theory of Arts et. al (2011), there is one more factor which is uncertainty. In the literature that is found, all behavioural change factors are sorted among these 6 factors. It is concluded that only 4 of the 6 factors of adaptation of innovation are analysed in previous literature. Triability and uncertainty are not considered in any previous literature on adaptation of demand response.

4. Choice experiment design

4.1 Introduction

To answer the research questions defined in chapter 1, a mixture between quantitative and qualitative research will be executed. First of all an exploratory qualitative research will give insights in the energy market where after a quantitative research will give insight in the demand side of the energy market. The exploratory interviews will answer SQ1: “In what way is the electricity market increasing or decreasing within the residential energy market.” and SQ3: “What are the key factors that influence energy behaviour of residential occupants?”. Besides the exploratory interviews will give input for the attribute choice of the choice experiment. The choice experiment that is executed will answer SQ4 and partly SQ5. Meaning it will answer the following questions: “What is the effect of a financial incentive to change residential occupants opinion on a Demand Response system?” and “In what way can Demand Response (DR) products be implemented in a complex, changing energy market?”. Table 4 gives an overview of what research question is answered and in which research.

Table 4: Overview of sub questions and their methodology

Code:	*Question:*	*Methodology:*
SQ1:	In what way is the electricity market increasing or decreasing within the residential energy market.	Exploratory qualitative research
SQ2:	In what way can Demand Response contribute to the current energy transition?	Literature review
SQ3:	What are the key factors that influence energy behaviour of residential occupants?	Literature review / Exploratory qualitative research
SQ4:	What is the effect of a financial incentive to change residential occupants opinion on a Demand Response system?	Choice experiment
SQ5:	In what way can Demand Response (DR) products be implemented in a complex, changing energy market?	Choice experiment / Business cases
SQ6:	In what way can flexibility in energy usage of households be implemented?	Validation with business cases

4.2 Exploratory qualitative research

The questionnaire made for the choice experiment, is based on both literature and an exploratory qualitative research which were done in an early stage of the process. The basics of qualitative research is observing and participating. The goal is to get an idea what experts think about the qualities and barriers of DR. The qualities are defined in the value, the characteristics of the market and the core of the research (Baarda, de Goede, 2001). These qualities will be researched using expert interviews at different stakeholders in the energy market. The exploratory interviews will answer SQ1: "In what way is the electricity market increasing or decreasing within the residential energy market." and contribute to SQ3: "What are the key factors that influence energy behaviour of residential occupants?".

4.2.1 Sampling

In qualitative research it is important to choose the right sample of the population. It is not possible to interview everyone, so a sampling is desired. There are 3 main methods to determine the sample, namely: Purposive sampling, Quota sampling and Snowball sampling.

Purposive sampling can be explained as follows: Prior to the research, a sample size is determined depending on time and resources available and the study's objective. The section of the sample will be done using characteristics of people.

Quote sampling is similar to purposive sampling. The difference between the two is that with quote sampling, the sizes and proportions of subsamples are more specific. Meaning that to realize a comparison in two or more groups, an equal amount of people need to be interviewed in each group. If the amount of people is not an important criteria but a guideline, purposive sampling is more popular than quote sampling.

The last sampling method is the snowball sampling: With this method, the network of interviewees is used to get to new parties or people to interview. The interview plan is adapted and formed during the interviews. This method is often used to discover 'hidden populations', which means groups that are not directly accessible by the researcher (International, 2011).

For the exploratory qualitative research, Purposive Sampling is chosen. The characteristics of the people chosen to interview are type of company and function. Snowball sampling is not used because the cooperating company's network is sufficient to fulfil the amount of required interviews. Quote sampling seems to be too complex for exploratory research.

For the exploratory research, 5 experts of different companies are interviewed whereof one DSO, two energy suppliers, one (energy) start-ups and one consultancy firm. In Table 5 the people of these companies which are interviewed can be found.

4.2.2 Structure

During the interviews, the general interview guide approach is used (Turner, 2010). In this approach a determined list of questions is made. Nevertheless the interviewer is allowed to change the questions or find new questions based on the previous answers of the interviewees. In general, the interview starts with a 5-minutes presentation of the interviewer about the subject and the research plan. Subsequently, this presentation can be discussed. After the discussion, the pre-defined questions are asked. To the first two interviews, the question of SQ1 is asked: "In what way is the electricity market increasing or decreasing within the residential energy market?". Each next interview is based on the knowledge that is gained during the previous interviews and further progress in the literature review.

Table 5: list of interviewees

Person	**Company**	**Type of company**	**Function**
George Trienekens	EXE (spin-off alliander)	DSO	New business manager
Martijn van Drunen	NUON	Energy supplier	Director solutions development
Jan-Willem Heinen	Cohere energy solutions B.V.	Start-up	CEO
Peter Ahcin	SINTEF Energi	Consultant	Scientist
Arjan de Jong	NUON	Energy supplier	Innovation manager

4.2.3 Results

One thing all five interviewees agree on is that the usage of electricity will rise in the next couple of years. With a rise in EVs and heat pumps, the share of electricity in the total energy mix will increase. In return, the use of gas and fuel will decline. An EV and a heat pump are contributing both as much to the electricity consumption as a whole household (J. Heinen, personal communication, January 12, 2017). Energy efficiency of electric appliances cannot level this growth. Because the electricity usage is that high on EVs and heat pumps, these seem to be the ideal chances for DR.

Secondly, the interviewees all had a particular knowledge about flexibility and grid instability. The solutions for it were not very clear yet. For example, G. Trienekens (personal communication, November 29, 2016) thinks that the value of flexibility will rise and that business cases will be sound very soon. On the other hand, A. de Jong (personal communication, January 12, 2017) and M. van Drunen (personal communication, December 5, 2016) claim that the consumer will not be interested in such a proposition. This is due to the lack of interest in energy. Consumers care about the fact that they have electricity and gas. Where it comes from or how the market looks like, is not of a high importance. The most easy solution for the levelling of the grid came from P. Ahcin (personal communication, January 5, 2017), who is a researcher at SINTEF Energi. This Norwegian company contributes to a European research which analyses the EV usage of 3 different cities across Europe among other things. The name of this research is Desent. One reason they investigate this, is to find out the potential for EVs as an electricity battery. In Norway, they do not have the problem of unpredictable renewable energy. A large part of the demanded flexibility can be generated by fast response hydro generators. This is a renewable source which has a very short response time and can give electricity whenever needed. In Norway smart meters did not get implemented yet due to this reason.

An important statement A. de Jong (personal communication, January 12, 2017) is making is the trust of consumers in an unproven concept. If there is no ability to show what DR can do in practice, most consumers will not trust it. Therefore triability is an important factor. This is for example also seen in the newspaper market, where paying per article seems to get more popular than 2-year contracts with one newspaper. This triability will therefore also be considered in the stated choice experiment.

In an interview with G. Trienekens (personal communication, November 29, 2016), the position of the aggregator within the market is defined. This position will be comparable with the position of the retailer. The difference is that the aggregator needs to balance his activities between 3 different parties next to the consumer, namely: the BRP, the DSO and the TSO. A elaborated scheme of this market can be found in Figure 9. The ideal situation is to sell this value via a specific flexibility market. A market like USEF could fulfil this challenge (USEF Foundation, 2015).

An elaborated overview of the interviews can be found inAppendix I: Exploratory interviews.

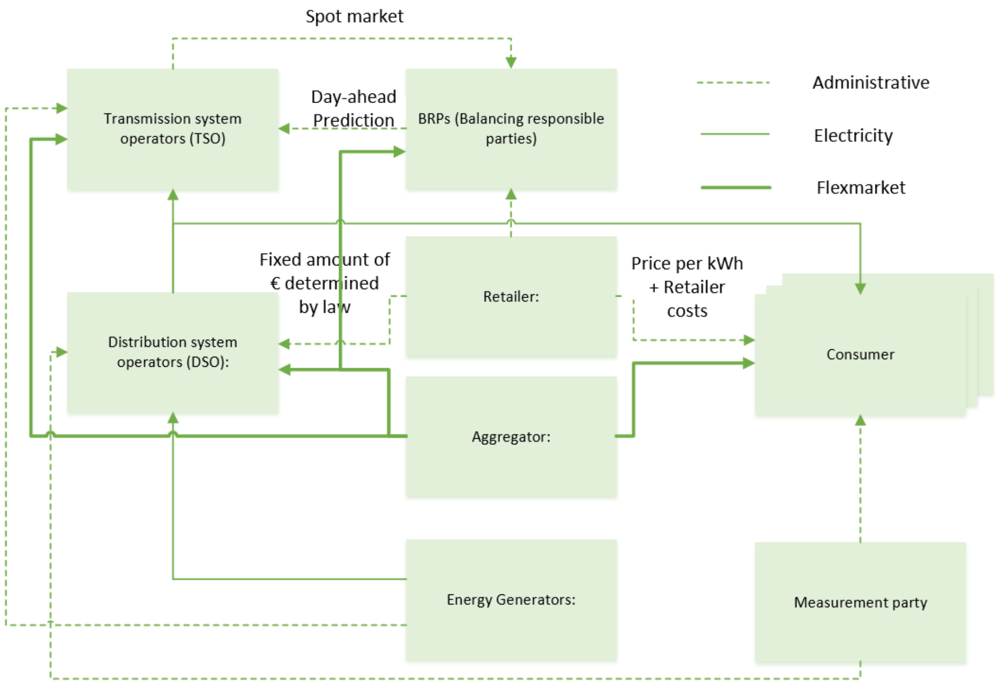


Figure 9: Market overview with aggregator

4.3 Choice experiment design

The aim of the experimental design is to find factors that influence consumers' choice preference and answer SQ4: "What is the effect of a financial incentive to change residential occupants opinion on a Demand Response system?" and partly SQ5: "In what way can Demand Response (DR) products be implemented in a complex, changing energy market?". The questionnaire consists of three parts. First of all, the socio-demographics of the respondents are asked, followed up by the choice experiment and finally there are three more open questions. The full questionnaire setup can be found in Appendix II: Questionnaire. The questions in the questionnaire will mainly focus on financial incentives. The stated preference (SP) experiment design was executed as a traditional choice experiment. In a choice experiment, a number of options are given where the respondents were invited to choose among the options given (Hess & Rose, 2009). In this case, there are two generated options and a third option which is 'no preference'.

Table 6: Attributes of literature and interviews input

	Attributes																							
	Relative advantage	Financial reward	Rewards (awards/prizes)	Free products	Energy cost concern	Independency	Faster charging and charging by self-generated power	Having fun	Sustainability	Compatibility	Avoiding inconvenience	Comfort Concern	Complexity	Low complexity	1 energy and flex supplier or seperate supplier and aggregator	Triability	Price of the system	Observability	Social Responsibility	Learning to save electricity	Feedback (benchmark, current usage, energy label)	Controlling and reducing cost	Uncertainty	Stay in control of appliance usage
Literature:																								
A. M. Ohler, S.M. Billger (2014)					x							x							x					
S. Gölz, U. Hahnel (2016)								x			x									x		x		
Energiekoplopers (2016)		x							x															
K. Zhou, S. Yang (2016)			x	x																	x			
S. Yang, Y. Zhang, D. Zhao (2016)																								
V. Vasseur, R. Kemp (2015)	x									x			x			x		x					x	
J.W.C. Arts, R.T. Frambach, T.H.A. Bijmolt	x									x			x			x		x					x	
Schick & Gad (2015)		x					x												x		x			
Interviews:																								
Peter Ahcin (Sintef, Norway)		x																						
George Trienekens (Liander, EXE)		x															x							
Jan-Willem Heinen (Maxem, energy management system)		x		x			x				x				x						x			x
Martijn van Drunen (NUON)		x																						
Arjan de Jong (NUON)						x											x							

4.3.1 Attributes & Levels

The attributes for the experiment are defined using the literature review and the exploratory interviews. There is a clear boundary between socio-demographic categories and attributes for the choice experiment. First, the attributes are determined and secondly, the socio-demographics will be defined.

Looking at the attributes for the stated choice experiment, a division of 6 main categories is made. These categories are found in earlier research of Arts et al., (2011) and Vasseur & Kemp (2015). These categories are found in follow-up research on the original Rogers' five. In chapter 3, the attributes from literature are discussed. This chapter will discuss the attributes that are chosen. Looking at previous literature, most attributes can be categorized under relative advantage. Some other attributes that were found can be categorized under observability, complexity and compatibility. Less obvious arguments, according to literature, are triability and uncertainty. To make a decision on the chosen attributes, this should be taken into consideration. A proven attribute in energy behaviour changing literature is financial reward. This will be a good basis to compare other attributes with. Looking at the interviews and the vision of the people that are interviewed, these categories do seem relevant. Therefore, for the attributes, a mixture is made of attributes from current literature and attributes from interviews for a complete analysis. To understand the underlying assumptions, all attributes are explained in this section.

Financial reward

In the two executed choice experiments in DR that are explained in the literature, financial reward was an important attribute (Broberg & Persson, 2016; Energiekoplopers, 2016). Financial triggers seem to be the most effective relative advantage looking at energy literature. Financial reward is easily measured and easily judged by the answerer. Besides, in all interviews, the financial part is mentioned. For the levels, calculations and market values are considered for financial reward and costs which can be found back in Appendix II: Questionnaire.

Comfort EV

Next to financial personal gain, personal gain can also be translated into comfort (Ohler & Billger, 2014). In this case, comfort is taken away in limiting charging of the Electric Vehicle. In the current situation people can charge their vehicle whenever they want. In the new suggested situation is asked if the answerer is willing to not charge his/her car at certain times of the day to avoid loading at peak hours. In contradiction to Shao et al. (2012), who presumes that there is a possibility to turn off charging in peak hours, in this case a limit is set on peak hour charging. The different levels are based on daily peak pricing of electricity. The evening peak is between 17:00 and 21:00. During the day, energy is generally more expensive than during the night. So another limit is set from 5:00 to 21:00.

Comfort heat

Another comfort limitation which is found in literature is on heating/cooling systems (Althaher et al., 2015; Broberg & Persson, 2016; Hu & Li, 2013). There the limit on comfort is set on residential heating. With algorithms, heating can be adjusted to the daily energy price. This can have impact on the comfort level. If full control is given away, the temperature can swing between temperatures or not be shifted to the right temperature when demanded. This discomfort contains a temperature difference of 1,5 or 2,5˚C. The current situation of well insulated households is an unstable temperature which varies 0,5˚C with the demanded temperature. The reason that this comfort attribute does not have the same levels as comfort EV and comfort Household is that the temperature differences are more tangible for the answerers.

Comfort household

Household appliances can also be used for load shifting. If large power consuming applications are used on non-peak moments instead of peak moments, this can contribute towards a more levelled grid (Althaher et al., 2015; Hu & Li, 2013). This is degraded into the same levels as comfort EV to make it comparable.

Price

To set a limit on EV, heat and household applications, a certain level of home automation needs to be applied. This home automation could be either application specific automation or total home automation. Application of this automation costs money. In this case, a contract on applications is assumed as financing option. That means that there are no initial costs but the applications will be paid over a couple of months/years (J. Heinen, personal communication, January 12, 2017). This price will be considered as a yearly amount to make it compatible with the financial reward and varies from €0 to €96.

Contract length.

Contract length is related to the fact that price is expressed as a contract. Besides it is related to the triability factor that is found in (Arts et al., 2011) as one of the factors for adaptation of innovation. Levels vary from 1 month to 3 years with as a middle long length 1 year. The three levels are not in one consistent line in terms of equal steps. This is done to make it more logical and understandable in the choice experiment.

Table 7: attribute and level selection

Attribute:	**Level:**
Financial reward	€0-50 /year €50-100 /year €100-150 /year
Comfort EV	Charges always EV doesn't charge 17:00-21:00 EV doesn't charge 5:00-21:00
Comfort heat	Variation with indicated temp. +-0,5˚C Variation with indicated temp. +-1,5˚C Variation with indicated temp. +-2,5˚C
Comfort household	Always available No household app. 17:00-21:00 No household app. 5:00-21:00
Price	Cost = €96,-/year Cost = €48,-/year Free
Contract duration	1 month contract 1 year contract 3 year contract

4.3.2 Factorial design

For a full factorial design, $\#Levels^{\#Atttributes}$ choice sets can be generated. Meaning that 3^6 = 729, choice sets will be generated in a full factorial design. This only contains the possible choice sets of attributes and not yet the possible combinations of sets. This amount of choice sets is too much for an experiment of this size. Due to the limited time frame and reachable respondents, a fractional design is used. In a fractional design, a subset of the full fractional design is assumed to represent the possible combinations in a subset of choice sets (Hensher, Rose, & Greene, 2015).

4.3.3 Orthogonal array vs. fractional factorial design

There are two possible designs that are considered as a fractional design, the orthogonal array and the fractional factorial design (Hensher et al., 2015).

The fractional factorial design is chosen in this case. The design is consists of 27 choice sets. These choice sets will all be compared to each other in a 3-option choice. Out of these 3 options, 2 options are choice sets and the third option is no preference as can be seen in Figure 10.

Factor:	**Flexible energy system 1**	**Flexible energy system 2**	**No preference**
Financial reward:	€0-50	€50-100	
Comfort EV:	EV doesn't charge 17:00-21:00	Charges always	
Comfort heat:	Variation with indicated temp. +-0,5˚C	Variation with indicated temp. +-1,5˚C	
Comfort household:	No household app. 5:00-21:00	No household app. 17:00-21:00	
Price:	Cost = €96,-/year	Free	
Contract duration:	1 year contract	3 year contract	
Choice:	◯	◯	◯

Figure 10: example of choicesets

4.3.4 Sample size

According to the rule of thumb of Orme (1998), the sample size has to match at least the formula as presented in equation (I). In this formula:

n = number of respondents

t = number of tasks

a = number of alternatives per task (not including the "none")

c = number of "analysis cells"

$$n = \frac{500 * c}{t * a} \qquad \text{(I)}$$

In this case it means that c is the maximum number of levels within any attribute, which is 3. The number of tasks (t), will be 9 and the number of alternatives per task (not including the "none" (a) is 2. This rule of thumb calculation results in a number of respondents of 83.

$$n = \frac{500 * 3}{9 * 2} = 83 \quad \text{(II)}$$

Generally, for a conjoint analysis, 150 to 1200 respondents are needed. This seems quite a large range of numbers. Basically that is because it is dependent on a couple of factors. First of all, if subgroups need to be determined, the amount of people within the subgroup need to be sufficient. Here the 83 people minimum applies per subgroup. Assuming a category has 3 subgroups, a minimum of 83*3 = 249 respondents is needed to have a fundamental outcome within 3 category socio-demographic groups (Orme, 1998).

4.3.5 Testing

When the design is finished, the design is tested. For this testing, 5 people tried to make their decisions on the choice experiment. During this testing 3 things were important:

- Can you make up your decision?
- Do you understand what it means?
- Would you finish it, or is it too complex?

After the first 3 tests, the textual explanation of certain elements is improved to make it easier to understand and decide. This way, the probability of misunderstanding is decreased. At the 4th and 5th test, the survey was clear and fulfilled in the above standing criteria.

4.3.6 Questionnaire distribution

Data is collected by spreading an online questionnaire using the Berg system. This web based system is designed by the TU/e to spread choice experiments' surveys. Target group in this research is any energy consumer. This creates the possibility to share the questionnaire link on social media, ask people personally and use digital marketing appliances of Alba Concepts. This makes it unclear how many people are approached to fill in the questionnaire. Expected is that at least 5000 people saw the posts on social media and the newsletter of Alba Concepts. Besides, there are about 100 people that were personally approached via e-mail, whatsapp and facebook messenger.

4.3.7 Descriptive analyses

Out of the +- 5000 people reached, 440 people opened the questionnaire. Of those 440 people, 213 people got past the socio-demographics and ended up in the choice experiment. Out of the 213, 190 people finished the choice experiment. After the choice experiment there are 3 more questions. In these 3 questions, 14 people left the questionnaire. These 14 people are still considered in the analysis. So eventually 176 people finished the whole questionnaire but for the choice experiment analysis, 190 questionnaires could be consulted. For the following descriptive analysis, these 190 questionnaires are considered.

Of these 190 different persons, 132 were male. This is a percentage of 69%. In total 52% has bought a house and 48% is renting. About half of the renters pay their own energy bill. In age, there is a peak in the age category of 23-27. This is due to the fact that the researcher is in this age range and has used his personal network for the questionnaires. The average age of the respondents is 33 and the range is 18-67. The innovativeness graph of people looks like

Rogers' bell curve of the diffusion of innovations and therefore seems representative for society. 19% of the respondents have affinity with flexible energy usage. The income has a peak below €20.000 per year, between €30.001 and €40.000 per year and one above €50.000 per year. Reason for this can be that a lot of students were involved and that 49% of the respondents had an academic background. 45% of the respondents did not have any smart devices in his/her household and the most popular smart devise is a smart washing machine with timer function. 75% owns a car and only 10 percent of the respondents owns a hybrid/EV. 7% of the respondents has kids below 6 years old and 37% of the people have students or pupils in their household. Geographically, a lot of respondents are from Eindhoven and Venray. This can be declared because Venray is the place of birth of the researcher and Eindhoven the city he studies. So again this shows that a large part of the respondents come from the personal network of the researcher.

The choice division of option 1, 2 and no preference is respectively 48%, 45% and 8%. Furthermore, all 27 sets of attributes are asked in total between 119 and 139 times. All attributes are asked between 1109 and 1166 times. More detailed graphs and statistics can be found in Appendix III: analyses.

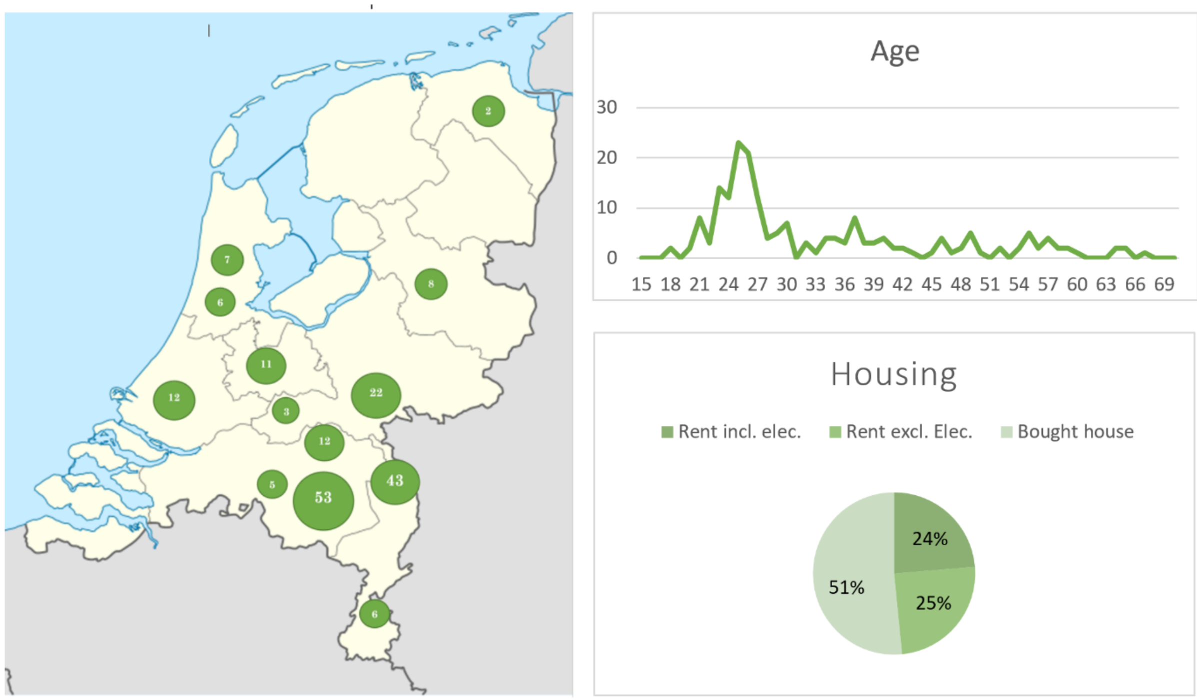


Figure 11: Descriptives of survey population

4.4 Multinomial Logit

4.4.1 Effect coding

The difference between dummy or effect coding is that in effect coding, the last value in the newly coded variables can have a -1 instead of a 0 as utility factor (Hensher et al., 2015). The advantage of this utility factor is that the last value will have a unique value instead of 0. In this case, effect coding is used. This means that a 3 level variable will be recoded into a 2 level variable. The third level, which is not considered in this analysis is determined using the negative sum of the two remaining levels. The sum of the 3 levels must be 0. This means that X1C = -(X1A+X1B).

Table 8: effect coding

Attribute	Level no	Levels	Coding
Financial reward	1	€0 - 50,- /year	(-1,-1)
	2	€50 - 100,- /year	(1,0)
	3	€100 - 150,- /year	(0,1)
Comfort EV	1	Charges always	(-1,-1)
	2	EV doesn't charge 17:00-21:00	(1,0)
	3	EV doesn't charge 5:00-21:00:00	(0,1)
Comfort Heat	1	Variation with indicated temp +/- 0,5°C	(-1,-1)
	2	Variation with indicated temp +/- 1,5°C	(1,0)
	3	Variation with indicated temp +/- 2,5°C	(0,1)
Comfort Household	1	Always available	(-1,-1)
	2	No household app. 17:00-21:00	(1,0)
	3	No household app. 5:00-21:00	(0,1)
Price	1	Cost = €96,- /year	(1,0)
	2	Cost = €48,- /year	(0,1)
	3	Free	(-1,-1)
Contract	1	1 month contract	(-1,-1)
	2	1 year contract	(1,0)
	3	3 year contract	(0,1)

4.4.2 Hypothesis

To determine the effect coding of the different levels, the level which is closest to the current situation of most people, is considered to be the base case. The reason for this is that the other two levels are most important. Base case levels have a lower chance of significant answers. The base case is coded with (-1,-1). In Table 8 can be seen which assumptions are made considering this base case.

The expectations are that the following attributes will be inclining in coefficients: Financial reward and price. The attributes that are probably declining in coefficient are: comfort EV, comfort heat, comfort Household and contract. In the interpretations, these hypothesis are tested.

Assumed in the results, is that a significance of more than 95%, means that the result is representative. A significance of >90% means that the results are probably representative. A significance lower than 90% means that the result is not significant.

4.5 Equations, assumptions and models

4.5.1 Multinomial logit

Contributing a Multinomial logit (MNL), the utility factor, U_{nsj} of the different attributes is analyzed. To do so, equation III is applied. This formula calculates the observable utility, V_{nsj} and adds ε_{nsj} as a stochastic error component.

$$U_{nsj} = V_{nsj} + \varepsilon_{nsj} \tag{III}$$

The observed utility can be defined as the sum of the parameter representing the weight of attribute j, β_j multiplied by the score of alternative s on attribute j of individual n as seen in equation IV (Hensher et al., 2015).

$$V_{nsj} = \sum_{j} \beta_j * x_{nsj} \tag{IV}$$

4.5.2 Mixed Logit

During the mixed logit analysis, the standard deviation of the random parameters is calculated. It is assumed in this calculation that the random parameters have a normal distribution. To calculate the utilities and the standard deviation, Halton draws are used.

4.5.3 Latent class logit

Assumed is that a minimum of 2 and a maximum of 5 classes will be used. With this assumption, Bayesian Information Criterion (BIC) calculations are made to determine the best fit for this model. The formula for the BIC is as follows (Feng, Arentze, & Timmermans, 2013):

$$BIC = -2LL + 2K \tag{V}$$

Where LL is the log likelihood of the model and K is the amount of parameters in the model. With this formula and the log likelihoods of the Nlogit models, this calculation is made for the amount of classes 2-5. The lowest BIC value has the most reliable model.

5. Model estimations and analysis

5.1 Multinomial logit (MNL)

After the data analysis according to the MNL method, the outcomes as seen in Figure 12 are generated. The green bars are the coefficients that are at least 95% significant the orange bars are at least 90% significant and the red bars have a lower significance. The complete input and results as generated in Nlogit can be found in Appendix IV: Data analysis. The goodness of fit of the MNL model is 0,1551 and that of the MNL+ is 0,1856. The differences in the models is that in the MNL model, only random parameters are tested. In the MNL+, the socio-demographics are estimated next to the random parameters. In the next paragraph, the mixed logit will be discussed to determine the heterogeneity of the model. The nature of this heterogeneity will be researched in the latent class analysis.

Financial Reward

In the financial reward attribute, only the highest level (€100-150) is significant. This level is positive, meaning that this level has a positive influence on one's choice. The coefficient for this value is 0,239. Compared to other highest coefficients in other attributes this is not very high. This attribute therefore seems not to be the most important attribute which can have 2 main reasons: First of all, it could be that the financial reward is not high enough. Secondly, it could be that money is not a very important trigger to adapt to a more flexible system. The second level in this attribute is €50-€100 per year. The coefficient of this level is almost neutral, namely: 0,013. This level is not significant so it is only used as an indication of importance. The reason that this level is almost neutral is probably because there are also costs in particular systems. According to Energiekoplopers (2016), the importance of financial reward is not as big as expected in the beginning of the research. The outcome of this research shows that the importance is not too high.

Comfort EV

In the attribute comfort EV, all three levels have a significance of at least 90%. Meaning that answerers have a clear opinion about this attribute. As the hypothesis has mentioned, the unlimited charging option has customers' preference. The coefficient for unlimited charging is 0,28533. This is higher than the coefficient of the highest financial reward. Due to the randomness of parameters, it can be concluded that no EV charging restrictions have a higher importance then a financial reward of €100-150 per year. On the other hand, a restriction of only charging between 21:00 and 5:00h, has a lower impact on decision making than €100-150 euro per year. Both levels with a restriction, the level of not charging between 17:00 and 21:00 and the restriction between 5:00 and 21:00 have a negative influence on decision making. Reason for that is that both restrictions are a decrease in EV charging comfort with the current situation.

Comfort heat

For heating, only the least favorable coefficient is >95% significant. According to the hypothesis, this level (desired temperature +- 2,5 °C) should have a negative impact on the decision making. The coefficient for this level as calculated is -0,138. This is lower than financial reward and comfort EV. This means that customers prefer to give away some comfort in their household heating than in charging their EV. 2 out of 3 levels are not significant and the measuring unit is not the same as comfort household and comfort EV. Therefore, this conclusion is questionable. It can be concluded on the other hand, that with a financial incentive of €100-150, the positive influence on relative probability is higher than the negative influence of a warmth difference of 2,5˚C with the desired temperature.

Comfort household

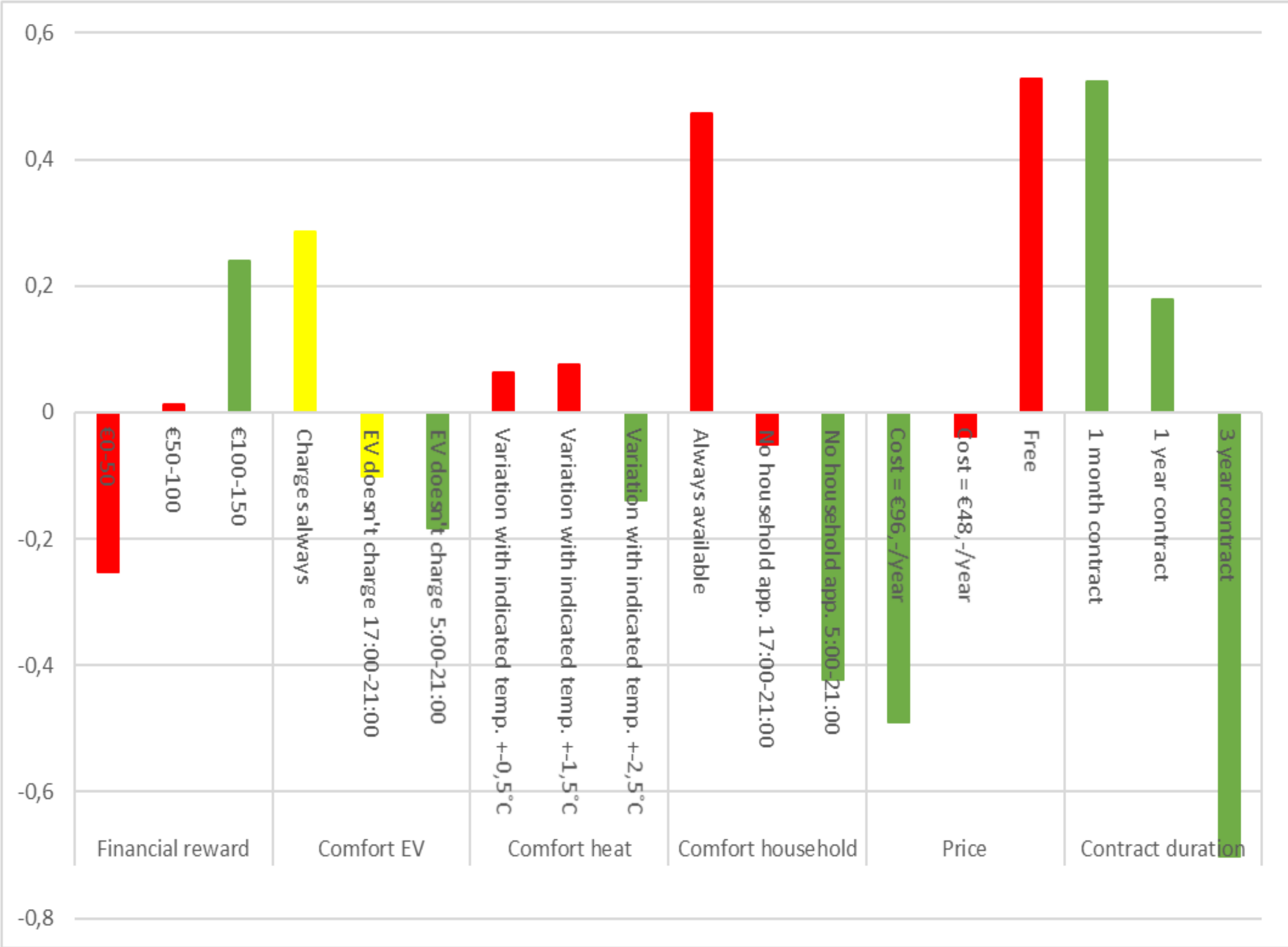
Giving in on comfort of the usage of household appliances is in all cases negative. Only the coefficient of unlimited usage has a positive impact on customer’s decisions. Irrespectively the low significance of 2 out of 3 levels, the hypothesis can be confirmed due to the fact that the highest limit on usage has a coefficient of -0,4216. This significant coefficient is higher than the other two comfort attributes. Hence, it can be concluded that limiting household applications comfort is the least preferred limit in the three comfort factors EV’s, Heating and household appliances. The negative influence of a limit on the comfort of household applications from 5:00 to 21:00h is higher than the positive influence on earning €100-150. The attribute of household comfort is therefore of a higher influence than the attribute of financial reward assuming these limits and rewards.

Price

The price of the system has rather high coefficients. Therefore it can be concluded that the price is more important than financial rewards. Price is also more important than the individual comfort attributes. As suggested in the hypothesis, the most expensive level has the lowest coefficient. This coefficient is -0,48964 and is significant. The coefficient of the level “free” is not significant, but as expected is positive. The fact that the price is twice as important as the financial reward is not new. In the research of Gourville (2006) this phenomena is analyzed. In his research it seems that sellers want twice the price for the same product as buyers want to pay. Furthermore, not a lot of people are willing to take a bet for €100,- if they have a 50% chance (Gourville, 2006). Concluded: Risks are always heavier perceived than rewards.

Contract

Contract length seems to be the most determining attribute. All levels are significant and the negative impact of a 3-year contract is -0,70306. The coefficient for a monthly contract is 0,5237. It can be concluded with more than 95% certainty that the length of contract is the most important variable. According to the hypothesis, a shorter length of contract has a positive influence on decision making. This attribute is based on the triability factor of (Arts et al., 2011). For new innovations, it is important for consumers to have trust in a certain product or service. This trust can be realized by showing that a product works. A shorter contract period gives a better opportunity to try the product.



< 90%, >90%, > 95% significant

Figure 12: Coefficients of attributes' levels.

Table 9: MNL outcomes

	MNL	MNL+
	coeff.	coeff.
Main attributes		
€50-100	.013	.057
€100-150	.238***	.320***
EV doesn't charge 17:00-21:00	-.101*	-.133*
EV doesn't charge 5:00-21:00	-.183***	-.208***
Variation with indicated temp. +-1,5˚C	.076	.066
Variation with indicated temp. +-2,5˚C	-.138**	-.113
No household app. 17:00-21:00	-.049	-.047
No household app. 5:00-21:00	-.421***	-.453***
Cost = €96,-/year	-.489***	-.605***
Cost = €48,-/year	-.037	.036
1 year contract	.179***	.229***
3 year contract	-.703***	-.797***
Interactions		
AGE_25-35 * €100-150		-.149*
AGE_25-35 * household app 17-21		.189**
AGE_25-35 * 1 year contract		.152*
AGE_25-35 * 3 year contract		-.224**
AGE_>35 * var with ind. Temp. +-2,5˚C		.206**
AGE_>35 * household app 17-21		-.201**
Rent excl. elec. * EV 17-21		.155*
Rent excl. elec. * household app 17-21		-.144*
Bought house * EV 17-21		-.188*
Bought house * household app 17-21		.179*
Child * €100-150		-.183**
Discount <€30 * €100-150		.154*
Discount <€30 * cost=€96		-.183*
Discount <€30 * cost=€48		.197**
Discount >€30 * var. With ind. Temp +- 1,5˚C		.150*
Discount >€30 * 3 year contract		-.172*
Sample size	1710	1710
LL0	-1557.9359	-1557.9359
LLß	-1383.1	-1268.8
R^2	.1551	.1856

* = 90%, ** = 95%, *** = 99% significant

5.2 Interactions

Looking at the interactions, differences in socio-demographic groups can be identified. First of all, the financial reward of €100-150 plays a different role in decision making for people with children <6 years old and people who desire a discount of <€30 euros per month. For the people who desire a discount of less than €30, financial rewards have a positive influence on decision making. For people with children under 6, this is of less importance than the average answerer as can be seen in the diagrams in Figure 13. For the comfort EV, the limit on charging between 17:00-21:00h, has a divergent value for energy users with a bought house. For this group, the limit on comfort is perceived as more negative. The perceived comfort limit in household heating is divergent for people older than 35. They claim to have a positive relevant probability for the highest limit on comfort. The difference in value for the average group and people older than 35 is ± 0,2. This difference is not too big and indicated that comfort in household heating is probably not too important for potential DR users. The middle level of having a limit on the usage of household applications, has a variety of different opinions. First of all, people from the age of 26-35 have a significant different opinion than people from the age of 35 and older. People from the age 26-35 have a perceived positive importance of almost 0,2. For the age of 35 and older, not using household applications between 17:00-21:00h is perceived as negative. The difference is more than 0,4, which is an important difference. Furthermore, people with a rental house have a negative value for this limit on household applications while on the other side, people with a bought house, have a positive coefficient for this limit. Looking at the cost of a system, answerers who indicate that they desire a monthly discount of <€30,- find it more disturbing to pay €96,- /year. On the other hand they consider it more positive than the average answerer to pay €48,-. The group which has a desired discount of >€30,- finds it more distracting to have a long contract of 3 years. The group of people between the age of 26 and 35 also find it more distracting if the contract length is 3 years. For a one year contract, this group is more positive than the average respondent. A summary of these statistics can be found in Figure 13. Table 9 is a summary of the analysis with main attributes, socio-demographics and interrelated iterations. The full table can be found in Appendix IV: Data analysis.

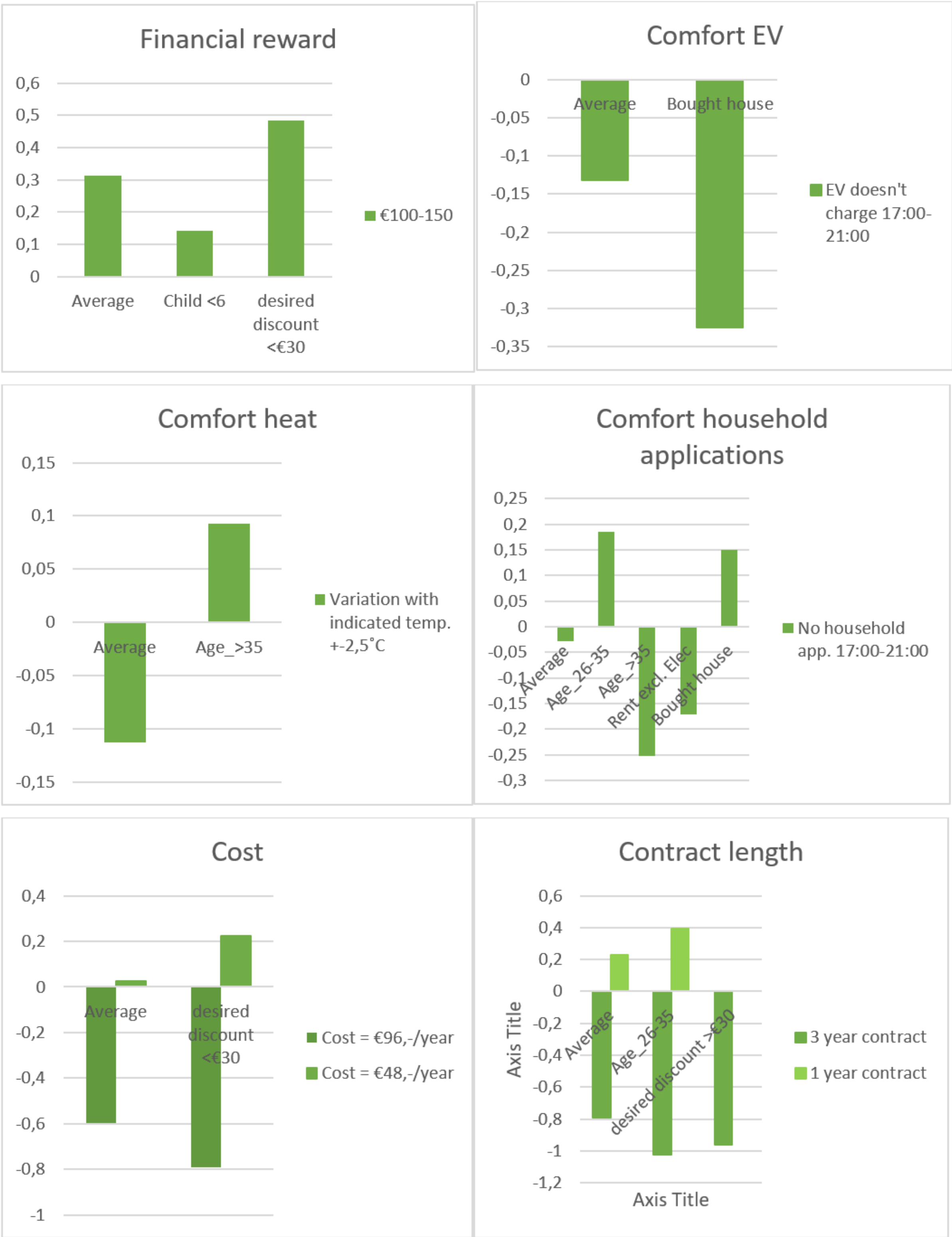


Figure 13: Overview of significant interactions

5.3 Results of Mixed Logit model

To capture the heterogeneity of respondents in influential attributes, a mixed logit (ML) analysis is used. This method, also known as Random Parameter Logit (RPLogit), considers the variable levels as random individual parameters (Hensher et al., 2015). First, a Multinomial Logit (MNL) model is used to determine the estimates of the variable levels. With 10.000 halton shuffle draws, the RPLogit analysis is conducted in the Nlogit software package. The random parameters that are used, are the levels of the attributes in the choice experiment. The nonrandom parameters in this case are the socio-demographics. The socio-demographics are divided into 2 or 3 level attributes and can be found in Table 11. This table also shows the coefficients of these socio-demographics when analyzed in the ML model. These socio-demographics are effect coded to be analyzed. The socio-demographic value of EVs and hybrids is not taken into consideration in this analysis due to the fact that there were not enough respondents driving EVs or hybrids. The levels of highest finished study are not big enough either. 80% of the answerers were highly educated. This attribute will therefore be a limitation in this research.

5.3.1 Socio-demographics

Table 10: Significance matrix

	X1A	X1B***
AGE1**		**
AGE2		

After analyzing the main model with random and non-random parameters, a selection of further analyzed socio-demographic relations is made. There are 4 socio-demographics with significant values. These are: age, ownership of dwelling, children under 6 in household and desire discount on bill. For every significant socio-demographic, the relationships with attributes are analyzed as can be seen in Table 10. If there is any match in significance, all combinations of the table are analyzed in the interrelated coefficient mixed logit model. All attributes will be individually multiplied by the socio-demographic. In this example there will be 4 relations that are tested: X1A*AGE1, X1A*AGE2, X1B*AGE1 and X1B*AGE2. All main attributes have a significant level, therefore it can be concluded that the 4 socio-demographics age, ownership of dwelling, children <6 in household and desired discount will be checked with all levels of main attributes in an interrelated coefficients model.

For the interrelated coefficients model, another MNL model and ML model is generated. The second model consists of a complete model with the added values as described before. The 'socio-demographics * main attributes' are considered in that model. All significant values of the ML model can be found in Table 11. The total overview of the calculations can be found in Appendix IV: Data analysis.

Table 11: Mixed logit outcomes

Attribute	Mixed logit		
	Coeff.		*st. dev.*
Main attributes			
€50-100	0,1297		.00284
€100-150	0,53693	***	.62208***
EV doesn't charge 17:00-21:00	-0,17237		.53864***
EV doesn't charge 5:00-21:00	-0,32137	***	.40206**
Variation with indicated temp. +-1,5˚C	0,08475		.11889
Variation with indicated temp. +-2,5˚C	-0,18021		.78313***
No household app. 17:00-21:00	-0,05985		.28984
No household app. 5:00-21:00	-0,67426	***	.64457***
Cost = €96,-/year	-0,91743	***	.76671***
Cost = €48,-/year	0,1105		.00013
1 year contract	0,33061	***	.33889*
3 year contract	-1,18828	***	.78394***
Socio-demographics			
Male	-.08322		
Age 26-35	-.64244	**	
Age >35	.40450		
3-4 person household	-.30466		
>4 person household	-.13392		
House	-.38978		
Rent excl. elect.	-.47873	*	
Bought house	.46029		
Medium affinity	.11066		
High affinity	-.07577		
Innovators / early adaptors	-.17456		
Late majority / laggards	.12024		
Income <€30.000	-.12799		
Income >€40.000	-.03160		
Children <6	1.35395	***	
Students and pupils	.03164		
Energy bill <€100	-.21136		
Energy bill >€100	.16025		
Desired discount <€30	.87136	***	
Desired discount >€30	.07907		
No car	-.17193		
1 car	-.41115		
No car available	-.32794		
1 car available	.31843		
Interactions			
AGE 26-35 * €100-150	-0,24715	*	
AGE 26-35 * household app 17-21	0,29489	**	
AGE >35 * var with ind. Temp. +-2,5˚C	0,40251	**	
AGE >35 * household app 17-21	-0,25779	*	
Bought house * €50-100	0,25918	*	
Bought house * household app 17-21	0,34583	**	
Children <6 * €100-150	-0,33978	**	
Discount <€30 * cost=€96	-0,29459	*	
Discount <€30 * cost=€48	0,30295	**	
Discount >€30 * var. With ind. Temp +- 1,5˚C	0,31102	**	

5.3.2 Hetero- / homogeneity

The standard deviation of the main attributes is analyzed in a mixed logit model. Dependent on the significance of the standard deviation, the heterogeneity can be determined. In Table 11 the results of this analysis are found. The meaning of the standard deviation is that choices vary between the average coefficient and plus or minus one standard deviation. If there is a large significant difference between the coefficient minus one and plus one, it means that the model is heterogeneous. The attributes contract duration and comfort EV are significantly heterogeneous. The levels of cost = €96,- , the household applications comfort 5-21:00 , temperature comfort +-2,5˚C and the highest financial reward are heterogeneous as well. The height and the influence of the heterogeneity can be found in Figure 14. The green bars represent a coefficient with a significant standard deviation. Red bars represent a non-significant standard deviation. Looking at this model, it is clear that there is a lot of difference in preferences. Further research on the nature of this heterogeneity is done in the LC model of chapter 5.4.

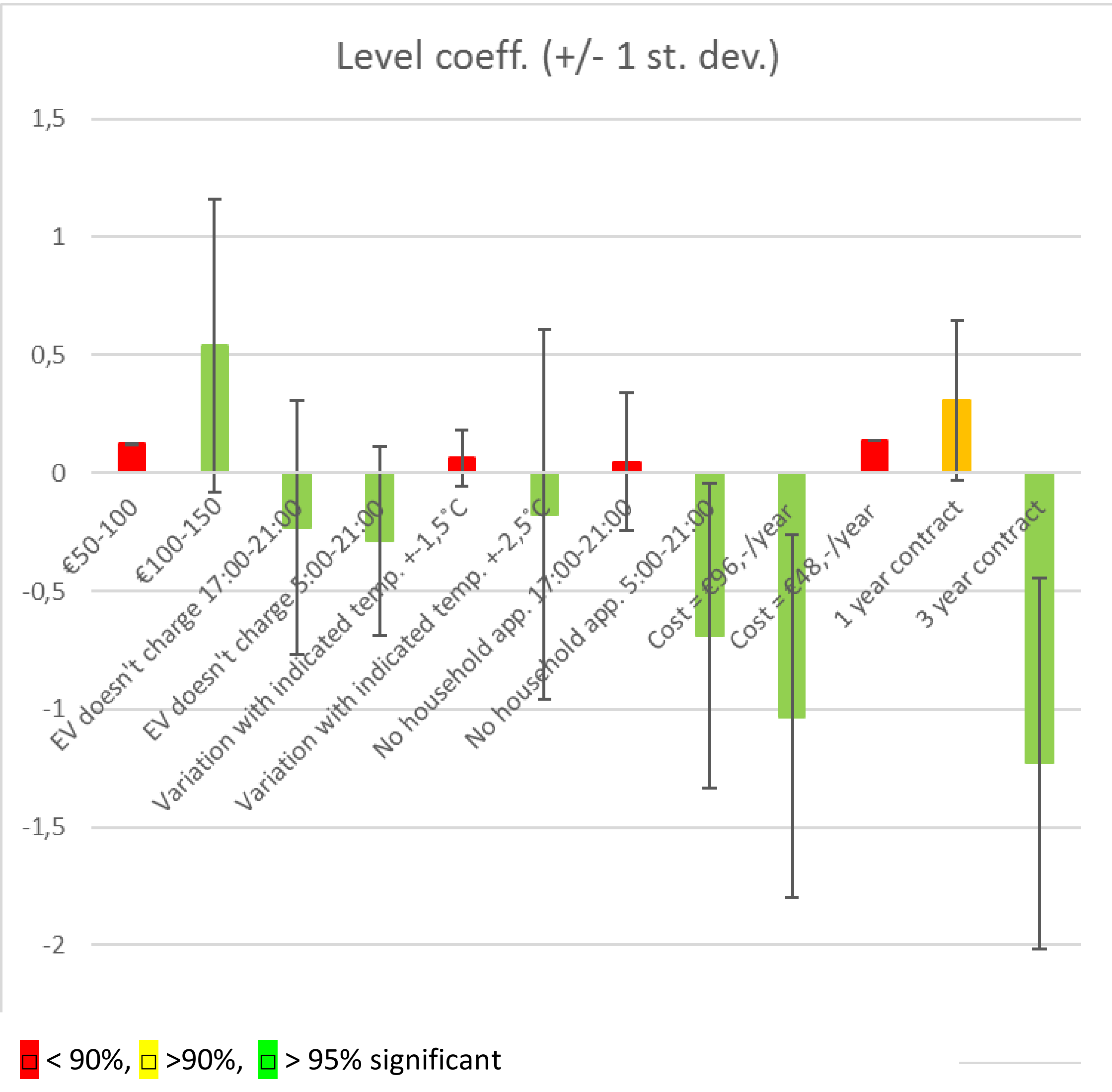


Figure 14: Level of coefficients with their standard deviation

5.4 LC logit

To get a better grip on the heterogeneity of the model, a Latent class (LC) analysis is executed. In this LC analysis, the total outcome of the research is divided into a certain amount of classes. The socio-demographics will have a closer relationship with one of the classes. The coefficients of the main iterations per class differ. Hence, LC analyses can be conclusive on the heterogeneity of certain models (Feng et al., 2013). For the LC logit model, the same effect coded data is inserted in Nlogit as with the main iteration analysis of the MNL.

5.4.1 Classes

Table 12: BIC calculations

	2 classes	3 classes	4 classes	5 classes
BIC	2804,983	2701,228	2615,633	2548,771

The five class model seems to be the most reliable model with this data set as can be seen in Table 12. When looking into depth towards the outcome of this model, there seem to be no significant values for the socio-demographics as can be seen in Appendix IV: Data analysis. Meaning that no conclusions can be drawn. Instead of the 5 class model, the 2 class model is used for conclusions. This model, which seems less reliable than the 5 class model gives more significant values and can therefore draw more reliable conclusions than the 5 class model. The 2 class model still has a R^2 value of 0,2662. This makes the 2 class model sufficient reliable according to the goodness-of-fit rule.

5.4.2 Results

In the 2 class model, the levels of 3 year contract and limit on household applications 5:00-21:00 are significant in both classes. Meaning that conclusions are drawn on these levels. The difference in classes is significant for 6 out of 12 members. The following members have a significant value: male, age 26-30, rent excl. elec., bought house, income <€30.000 and income >€40.000.

The members of rent excl. elec. and income >€40.000 are significant positive in class 1. Therefore these members relate more to class 1. This means that for these members, the limit on household applications between 5:00-21:00h has more negative impact on the decision making for a DR system. Furthermore, a contract length of 3 years has less negative impact on these households' decision making. For the other members: Male, age 25-35, bought house and income <30.000, the opposite is true. They value the limit on household appliances between 5:00-21:00h less negative and the contract length of 3 years as more negative than the members of class 1 as can be seen in Table 13. The differences of class 1, class 2 and the MNL and ML analysis are visualized in Figure 15.

The outcome of the value for people within the ages of 26 and 35 for contract length is comparable with the outcome of the MNL interaction value. Therefore it is confirmed that according to this data the preference for 26-35 year old to enter into a 3-year contract is lower than the average respondent. So to address this age category with a proposition should be done with short contract and therefore a high triability. People with a high wage >€40.000 value a long contract as less disturbing. Limits on household applications are the other way around.

Table 13: LC outcomes

Latent class model	Class1	Class2
Attribute	Coeff.	Coeff.
Main attributes		
€50-100	.04754	-.05412
€100-150	.33502***	-.04332
EV doesn't charge 17:00-21:00	-.23779***	.19697
EV doesn't charge 5:00-21:00	-.21752***	-.18582
Variation with indicated temp. +-1,5˚C	.19764***	-.16636
Variation with indicated temp. +-2,5˚C	-.27445***	.15433
No household app. 17:00-21:00	-.09888	.10724
No household app. 5:00-21:00	-.54620***	-.26005**
Cost = €96,-/year	-.71059***	.01163
Cost = €48,-/year	-.01875	-.13632
1 year contract	.08453	.44575***
3 year contract	-.68393***	-1.00670***
Members		
Male	-1.26688*	
AGE_25-35	-2.62378**	
AGE2_>35	-.36829	
House	-125.459	
Rent excl. elec.	1.90908*	
Bought house	-2.05002**	
Income <€30.000	-2.38808*	
Income >€40.000	2.84529***	
Children <6	-.71988	
Students in househ.	.02877	
Energy bill <€100	-1,178758	

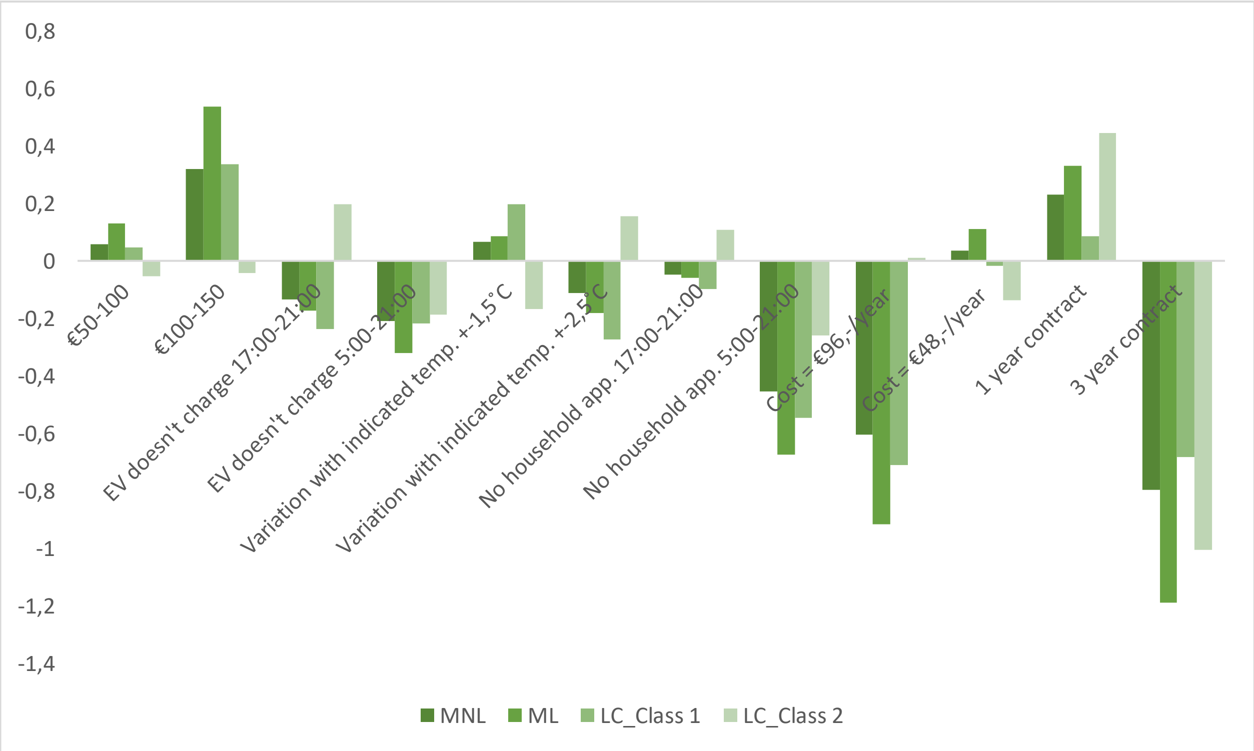


Figure 15: Summary MNL, ML and LC class 1 and 2

5.5 Conclusion

Out of the stated choice experiment, a clear conclusion can be drawn that contract length is the most important factor amongst other for adaptation of a Demand Response system as defined in the research. A contract length of 3 years shows the highest negative relevant probability. The second most important factor is price of the system. A higher price has a negative preference for the choice of Demand Response systems. It has a more negative influence on adaptation than financial reward which has a positive influence. This effect is a known effect within literature. Risks weigh higher than potential reward in general. In the Netherlands, based on this system the same theory applies. Of the three comfort levels, heating seems the be the first thing people want to give up comfort on. The second thing is their EV and at last they want to give up comfort in household applications.

5.5.1 Discussion

To conclude the analyses that are done on this stated choice experiment, it can be stated that there are still some barriers in the adaptation of DR. One of the barriers found in this research is the contract length in relation to the costs of DR activating applications. To realize flexibility, a certain degree of automation or semi-automation needs to be achieved. To do so, an investment needs to be made in home automation/charging automation. To get a return on this investment, a certain time of dedication is expected. This stated choice experiment shows that this dedication shaped in a contract length now seems to be one of the main barriers. Another barrier is comfort. In the comfort levels EV and household this is assumed to be fully controlled with a limit on time of usage. The comfort limit for household applications weighs higher than the limit on EV charging. Comfort barriers test the compatibility with the current lifestyle of people. Furthermore it is noted that financial reward weights less heavy than expected. The barriers that must be overcome, weigh twice as much as the potential gain. This theory is not new. Especially for new innovations this theory applies because the awareness must be created to gain the trust of consumers. The financial gains are at the moment relatively limited due to the market value of flexibility. In future research, also soft factors like contributing to a sustainable system, flexibility feedback and free products should be measured for relative advantage. Besides that, the identification and importance of the different advantages should be visualized. This research is limited to Dutch consumers with a relative high education. Nevertheless, the lessons learnt can be taken into consideration at future research in other countries or in other social groups. Furthermore, in the mixed logit analysis, the heterogeneity of the model is proven which creates grouping of preferences. After testing the heterogeneity with an LC analysis, it can be concluded that young male people (25-35 y.o.) with low incomes (<€30.000) assess a limit on the time of use of household applications as less disturbing than the average energy user. This class on the other hand values long contract periods as a greater barrier than the average answerer. High incomes (>€40.000) and renters assess this contact period as less disturbing but assess the limit on household applications as more disturbing.

6. Conclusion

6.1 Scientific relevance

As a contribution to existing literature, this research focusses specifically on the Dutch market. As an addition to the current academic status this research mentions two new factors of adaptation in the demand response (DR) market. The attributes price of a DR system and contract length are added. In addition, this research tests the heterogeneity of DR adaptation. The start of a consumers' segmentation is made which can be extended by further literature. In the answered main and sub questions, the scientific progress is explained.

MQ: What are the key factors of acceptance of Demand Response among Dutch households in relation to an unpredictable supply?

The key factors of acceptance of DR are in this research defined as an advantage in the form of a financial incentive and barriers which could keep energy consumers from engaging in a DR proposition. These barriers are a limit on household comfort, monthly/yearly costs and a certain engagement period. A deeper explanation of these factors is discussed in answering the sub questions.

SQ1: In what way is the electricity market increasing or decreasing within the residential energy market.

On one hand, household applications are getting more efficient and energy saving is a hot topic. On the other hand, the use of fossil fuels needs to be downgraded. At the moment it seems leading that a shift is taking place from using fossil fuels towards using electricity which can be produced in a renewable way with solar and wind. That would mean that the electricity use has a large potential to grow in energy mix share. The main drivers for this conclusion are that electric vehicles and heat pumps are upcoming. So the role of electricity within the residential energy market is that the quantity will probably incline in the coming years.

SQ2: In what way can Demand Response contribute to the current energy transition?

The current electricity market is growing and the share of renewable energy within this electricity market is growing quickly as well. Wind and solar energy are unpredictable which makes the supply of electricity less adaptable to the demand. There are two sides where the solution for this unbalance can be found. First of all, it can be found in making the supply flexible again or it can be managed by adapting the demand side. A lot of the initiatives which adapt demand can be scaled under Demand Response. It is not only a contribution to this problem, but it is a necessity to be able to continue increasing the share of renewable energy in the energy mix.

SQ3: What are the key factors that influence energy behaviour of residential occupants?

To stimulate people to change their energy behaviour the following factors are important: Compensating for positive behaviour, avoiding inconvenience, avoiding costs, create awareness and teach people what behaviour is desired.

SQ4: What is the effect of a financial incentive to change residential occupants opinion on a Demand Response system?

A financial incentive as a reward has a relative low impact. The negative impact of investment costs is significantly higher. Keeping costs low, or have no costs at all is more important than incentivise demand response propositions. The significance of a financial incentive is therefore limited.

SQ5: In what way can Demand Response (DR) products be implemented in a complex, changing energy market?

To implement demand response products in the current market, the market should be segmented. First of all in usage of EV and heat pump but also on socio-demographic characteristics. It seems that the current potential market is relatively heterogeneous. This makes it hard to make a proposition fit for all, but on the other hand creates opportunities to create niche markets. As seen in the outcome of the choice experiment, people from different socio-demographic groups have different preferences. In this research this is divided into two groups. For these two groups, two different propositions would work. If the group was divided into more groups, even more different propositions could be identified. With the different propositions, all socio-demographic groups can be served.

SQ6: In what way can flexibility in energy usage of households be implemented?

As a first step, more social research needs to be done on intention and behaviour. This particular research contributes to the intentional reaction of consumers. To really implement flexibility in energy usage, more studies should be done on the segmentation of the market. With a clear segmentation, the needs of consumers can be filled with good trustable propositions. Furthermore, the unrevealed barriers for success of flexible energy usage should be investigated. This research contributes to these barriers with giving contract length as a barrier next to the earlier revealed barriers of cost and restrictions on comfort. These barriers should be taken away to implement energy flexibility in households. Furthermore relative advantages should be either a higher financial incentive or other advantages.

6.2 Societal relevance

The current electricity system is facing daily balancing challenges in supply and demand due to the unpredictability of solar and wind energy. The share of these renewable energy sources is growing quickly and is expected to be doubled in 3 years (14% in 2020). The growth of the share of renewables in the electricity mix means a higher unpredictability of the supply. Therefore, flexibility in demand will be more and more relevant. There are 3 levels where the advantages will be noticed: First of all, the levelling of the Dutch national grid gets easier. Secondly, managing local grids on the lowest voltage level gets more accessible. As a third level, a financial advantage can be created by BRPs buying electricity from the wholesale market (APX). This research gives insight in how to realize this flexibility of demand using demand response propositions. On one hand, the current market and the possibilities are visualized and on the other hand the social acceptance of such possibilities is analysed with a choice experiment. The research gained insight in the relevance of the adaptation factors of demand response.

6.3 Recommendations

The possible follow-up research fields can be split up in 2 categories: broadening and in-depth research.
Starting with broadening research:

- the commercial benefits of DR propositions should be visualized and the possibilities of harvesting these benefits need further research.

- Value propositions should be better defined and business cases of these propositions need to be calculated
- The barriers of adaptation should be defined before these barriers can be taken away. Visualizing the barriers and their influence on stagnation of DR technology.
- Defining the position of DR in the innovation curve looking at comparable techniques like solar.

The in-depth research that is needed could consist of:

- Analyses of non-financial triggers and their additional value to financial triggers.
- Further research in the nature of heterogeneity of the target group.
- Research the adaptation of DR products in the car charging industry.
- Research the potential of built-in DR solutions of heat pump products.
- Specifications of preferences on limits on household applications. Which applications can be controlled by demand response and in what way.

The research field of DR is maturing. It once started with technical research and visions on how the grid should look like. Nowadays, social studies get more important in this research field and implementation is slowly taking off. This asks for a shift in type of research. Therefore implementation research of technologies should be embraced. To implement the technologies, first of all, the barriers need to be taken away and advantages need to be defined.

As a last research field, pilot projects, product innovations and start-ups are taking off. What does the current market of different products look like? And how does the potential or future market look like? Research on finding the gaps and possibilities could contribute to a growth of implementation.

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Appendix I: Exploratory interviews

Interview I

Naam: George Trienekens

Bedrijf: Liander (EXE)

Functie: New Business Manager

Date: November 29, 2016

Introductie:

Stijn doet presentatie intermediate colloquium.

Algemene opmerkingen:

- Flexibiliteit wordt steeds meer waard. Voorbeeld uit Duitsland waar de energieprijs af en toe al negatief is. Daar levert het dus geld op om je accu op te laden.
- Verband flexibele energieprijs en onderling energie handelen is dat er door de flexibele energieprijzen een besef komt dat energie niet altijd dezelfde waarde heeft. Hierdoor zetten klanten zich sneller af tegen vaste energieprijzen van maatschappijen.
- Om de waarde van flexibiliteit te verzilveren moet je het *allocatieproces* goed in de gate hebben. "het aflezen van de slimme meter per kwartier/uur". VEH en Qurrent doen dit al in een wijk. Dit heeft niet alleen te maken met day-ahead voorspelling maar ook met de afrekening.
- Wasmachine en vaatwasser is op het moment geen groot deel van de energierekening gekeken naar puur de energieprijs excl. Belastingen en netbeheerkosten. Percentage is zo klein dat er geen businesscases uit te halen zijn. Uitzondering hierop is een warmtepomp en een EV.
- Alliander kijkt momenteel alleen naar grotere klanten, daar valt meer te halen.
- Volgens George gaat de trend van flexibele energieprijzen nu echt beginnen. De vragen zijn, wat doet de prijs en wat heeft men er voor over.
- De energieprijs gaat omlaag door goedkope stroom uit Duitsland en de bouw van te veel kolencentrales. Als de kolencentrales moeten sluiten gaat de energieprijs omhoog.

- Zal de gasmarkt binnenkort overgenomen worden door de elektriciteitsmarkt? Of zal deze nog wel even blijven bestaan? Zo ja, dat betekent dus dat de elektriciteitsvraag omhoog zal gaan? zo nee, hoezo niet?

Ja, vooral door warmtepomp, EV etc.

Het zou ook niet raar zijn als iedereen dadelijk zelf voor al zijn energie moet gaan betalen. Op je werk voor eigen energie betalen en thuis.

Alliander denkt ook na over mensen die elektrisch rijden en zelf thuis energie opwekken. Ze willen dat je de energie die je thuis opwekt, op je werk kan gebruiken om je auto op te laden.

De gasmarkt gaat wel verdwijnen, vooral bij nieuwbouw is dit makkelijk. Bij bestaande bouw blijft dat moeilijk. De belasting gaat wel omhoog op gas en minder op elektriciteit.

- Waarom is flexibele vraag belangrijk voor de energietransitie?

Ja, omdat op macroniveau flexibele prijzen bijdraagt aan het handhaven van een goedkoop energiesysteem. Opslag en dubbele productie is duurder dan de vraagkant veranderen.

- Hoe dragen powermatcher, REX (Realtime Energy eXchange) en Alliander hier aan bij?

REX maakt het mogelijk om peer-to-peer te handelen in energie. Verdere mogelijkheden die ze mogelijk willen maken is dat je met een aantal apparaten collectief slim gaat handelen, dat je de energie van je oma kan gebruiken etc. Het is dan niet meer alleen aan de grote partijen voorbehouden om mee te doen aan het ingewikkelde spel, maar nieuwe spelers kunnen zo de markt ook betreden met bijvoorbeeld ideeën als flexibele energieprijzen.

Powermatcher is een open-source platform van een nieuwe alliance van TNO, alliander, CGI en nog een aantal partijen. Powermatcher gaat er vanuit dat alle apparaten gekoppeld zijn en dat op het moment zelf energie in wordt gekocht. Vooral gericht op de toekomst.

REX is een tool gemaakt op basis van powermatcher en is geschikter voor het ‘nu’. Met REX kun je day-ahead inkopen en vervolgens een groep met apparaten aansturen zodat ze precies gebruiken wat je in hebt gekocht. Je veroorzaakt dus geen disbalans en dat is iets waard. Als je wil, kan je ook wel disbalans veroorzaken en daar kun je weer geld mee verdienen.

Stijn: mag Alliander daar mee bezig zijn volgens de energiewet?

Ja dat mag. Alliander mag niet direct handelen, leveren of produceren. Ze verkopen tools en dat mag.

- Als een speler in de markt slimmer met het net om kan gaan en het net minder belast, is het dan mogelijk om korting te krijgen op de aansluitkosten?

De aansluitkosten zijn gelijk voor iedereen met een aansluiting. Dit wordt betaald aan de leverancier en die betaalt dat door aan de netbeheerder. Verder kan het zo zijn dat de leverancier of zijn PV partij slim inkoopt de dag van tevoren en dit zorgt voor minder extra kosten, dat ziet de klant uiteindelijk dus wel terug. Als TenneT weinig onbalanskosten heeft, hoeft er minder doorgerekend te worden naar de marktpartijen.

Vroeger waren aansluitkosten nog semi-variabel. Nu is het een vast bedrag. Netbeheerder is er wel mee bezig om te kijken naar variabele tarieven. Voor iedere gebruiker is het bedrag hetzelfde, dit wordt gewoon doorgerekend door de leverancier.

Congestiemanagement (filevorming in het net). De netbeheerder mag je niet belonen voor het tegengaan van congestie. De discussie is nu wel bezig om te kijken of dit mogelijk is.

- Welke apparaten kunnen efficiënter ingezet worden in huishoudens?

EV en warmtepomp

Het slim opladen van auto's en op den duur ook terug leveren van energie door auto's. De autofabrikanten houden dit echter nog tegen omdat de batterij daar snel van kapot gaat, van steeds opladen en terug leveren.

Een aantal dagen geleden is afgesproken in Nederland dat alle netbeheerders flexibele prijzen mogelijk moeten maken. Iedere energiemaatschappij kan hierdoor zijn eigen waarde propositie invoeren.

Data krijgen van de pilot is niet mogelijk wegens privacy wet. Data als verdienmodel kan alleen als van tevoren afgesproken is dat de maatschappij de data mag gebruiken van de gebruiker.

Met behulp van de open data van Liander en de APX kun je de berekening maken wat er te besparen valt.

IoT trend zorgt er wel voor dat apparaten uiteindelijk al allemaal connected zijn. Als dit zo is, dan kan een softwarepakket ook nog iets met energie doen in die connectie. Op die manier kunnen bijvoorbeeld 1000 koelkasten samen gebundeld worden en kan daar flexibiliteit gecreëerd worden.

- Hoe veel verwacht u dat een huishouden daarmee kan besparen?

4500 kWh per huishouden is 4,5 mW. Wat is de prijs van 1 mW? €30-€70. Dat betekent dat een huishouden tussen de €135 en €315 uitgeeft per jaar. De beparing hierop zal dus minimaal zijn. George ziet hier nog geen businesscases in.

Een warmtepomp gebruikt hetzelfde als een huishouden. Dit kost ongeveer 175 euro per jaar aan energie. Hierin zal waarschijnlijk meer te behalen zijn en kan tot wel 100 euro bespaard worden. Met auto's hetzelfde.

De prijs is nu vrij vlak en laag, dus het is moeilijker dan vroeger.

Onbalans markt van TenneT, hier valt ook geld aan te verdienen. Uitzoekwerk.

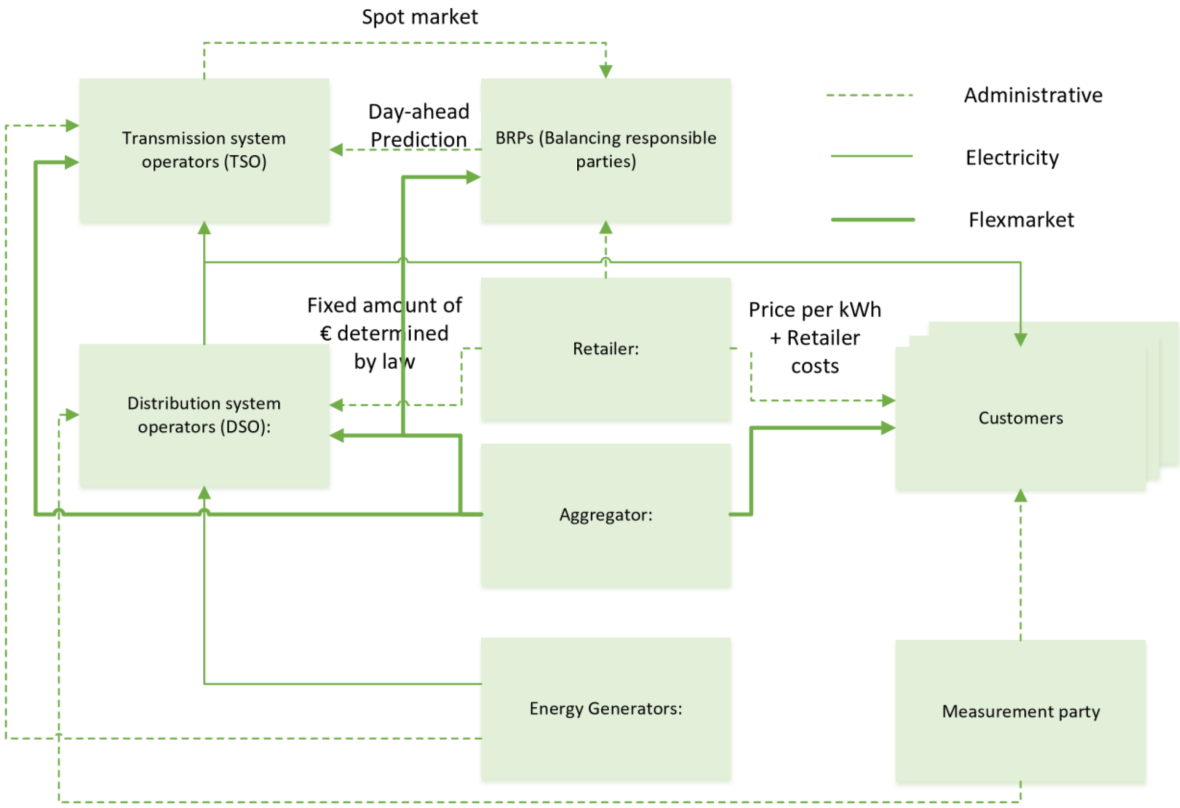
Elektriciteit is de enige commodity waar je niet van tevoren een afspraak maakt en die precies na komt. Als ik koffiebonen bestel bij jou, dan spreken we af dat ik 100 kilo bonen wil en dat jij die volgende week levert voor een bepaald bedrag.

Energie moet in balans worden gehouden. Dat zorgt ervoor dat de deals vaak niet precies nagekomen kunnen worden en dat het verschil in vraag of aanbod achteraf afgerekend wordt. Er is nog geen opslag, wel kan de kolencentrale harder of zachter wat het toch flexibel maakt.

De prijzen van opslag dalen ook. Dus het is niet ondenkbaar dat binnenkort opslag wel rendabel en betaalbaar is.

- En wat is het verwachte effect op het net?

Het gaat een groot verschil maken voor het net. Prioriteit ligt momenteel echter bij het gas en elektriciteitsdilemma. EXE is ingericht voor toekomstplannen van het bedrijf.


Spot market
Transmission system operators (TSO)
Day-ahead Prediction
BRPs (Balancing responsible parties)
Administrative
Electricity
Flexmarket
Fixed amount of € determined by law
Retailer:
Price per kWh + Retailer costs
Customers
Distribution system operators (DSO):
Aggregator:
Energy Generators:
Measurement party

Interview II

Naam:	Martijn van Drunen
Bedrijf:	NUON
Functie:	Director Solutions Development
Date:	December 5, 2016

- Zal de gasmarkt binnenkort overgenomen worden door de elektriciteitsmarkt? Of zal deze nog wel even blijven bestaan?

De transitie van energie van gas naar elektriciteit is een traag proces dat nog jaren zal duren om door te voeren. Nieuwbouw is vaak wel al gerealiseerd in 'all-electric', de transitie van bestaande bebouwing is echter lastiger. Daarnaast zijn warmtenetten ook een belangrijke vorm van energie.

Zo ja, dat betekent dus dat de elektriciteitsvraag omhoog zal gaan?

zo nee, hoezo niet?

De elektriciteitsvraag zal vooral omhoog gaan door de overname van elektrische auto's in vergelijking met benzine gedreven auto's. Een elektrische auto verbruikt ongeveer even veel elektriciteit als een huishouden. Stel ieder huishouden heeft dus een elektrische auto, dan verdubbelt het energieverbruik van huishoudens.

- Waarom is flexibele vraag belangrijk voor de energietransitie?

In combinatie met slimme woningen hebben flexibele energieprijzen een kans. Over het algemeen is er weinig besef van energiezuinigheid en wil de klant gewoon stroom en gas hebben. De mens is niet bereid om zijn gedrag aan te passen voor een paar 10'tjes die er te halen zijn. Om een gedragsverschil te realiseren moeten klanten kortingen rond de 200 euro op hun energierekening krijgen. Flexibele energieprijzen worden pas interessant als de salderingsregeling weg valt, wat in 2020 pas gebeurt, of als woningen volledig smart zijn ingericht. De kleine doelgroep die nu een smart home heeft, is niet groot genoeg voor een nieuwe service.

- Is NUON al bezig met dynamische prijsvorming op basis van vraag en aanbod?

Er is een pakket op de markt gekomen vorige week dat auto's opladen helpt: Voordeelladen. Hiermee wordt je auto niet meteen opgeladen als hij aan de stroom hangt maar wordt gevraagd om hem snachts op te laden.

- Welke apparaten kunnen efficiënter aangestuurd worden door flexibele energieprijzen?

De wasmachine en de droger zijn lastiger dan de vaatwasser. Mensen willen niet dat hun wasmachine aanstaat als ze er niet zijn, de was gaat stinken als hij te lang in de wasmachine zit. Mensen willen ook niet dat hun droger aan staat als ze niet thuis zijn omdat het apparaat veiligheidsrisico's heeft. De vaatwasser is geschikter, dat maakt niet uit wanneer die aan staat. Verder zou de elektrische auto veel flexibiliteit toe kunnen voegen. Bij de vraag of een warmtepomp ook waarde kan toevoegen zei Martijn dat een warmtepomp nog zo weinig gebruikt wordt en dat mensen daar nog niet klaar voor zijn.

- Hoe veel verwacht u dat een huishouden daarmee kan besparen?

Een paar 10'tjes, en om mensen echt aan te sporen tot iets, heb je een incentive nodig van rond de 200 euro.

- Is het interessant voor NUON om zulke pakketten aan te bieden aan hun klanten? Zo ja, waarom dan?

Nee, nog niet interessant. De financiële incentive is nog niet hoog genoeg te krijgen en de doelgroep is te klein (smart homes).

- Wat is nu het verdienmodel van NUON, en wat kan dat veranderen door flexibele energieprijzen?

Het huidige verdienmodel van NUON wordt nog bekeken als aantal verkochte kWh's * marge. Deze marge wordt behaald door slim in te kopen op de APX. Verder heeft NUON een vast tarief per maand/jaar. Recente verdienmodellen van innovatieve energieleveranciers hebben vaak alleen het vaste tarief en berekenen de verkochte kWh's 1 op 1 door aan de energieopwekker. Dit wordt vaak gedaan in duurzame gevallen.

Interview III

Naam:	Jan-Willem Heinen
Bedrijf:	Cohere energy solutions B.V.
Functie:	CEO
Date:	January 12, 2017

Introductie:

Maxem is energy manager die elektriciteit meet en stuur. Hij meet je hoofdaansluiting, dus je zonnepanelen en huisgebruik. En hij stuurt je warmtepomp, EV en thuisbatterij aan.

Met Maxum kun je je auto 50% sneller opladen op je huidige aansluiting. De maxum stuurt je verbruik naar de 3x 25A grens. Dus je auto laadt sneller op als er verder minder verbruikt wordt in huis en je netaansluiting zit altijd veilig omdat je auto trager oplaadt als er meer verbruikt wordt in huis. Dit wordt dynamisch per seconde geregeld. Dit geldt niet alleen voor de auto maar ook voor de warmtepomp.

Dit bespaart dus geld omdat een normale netaansluiting van 3x25A voldoet en er geen aansluiting van 3x35A genomen hoeft te worden. Verder geeft de Maxum inzicht in je energieverbruik in je huis.

Het systeem werkt niet alleen voor huishoudens maar ook voor kantoren. In een kantoor wordt meer verbruikt binnen, en vaak ook meer aan het opladen van elektrische auto's. Verder zijn er grotere kwantiteiten aan zonne-energie.

"uitleg kantoorpand energiemanagement systeem."

Warmtepompen worden gemaakt op 90% van de benodigde capaciteit. Als je ze zou maken op 100% van de benodigde capaciteit, dan heb je een 3x zo grote pomp nodig. Dit is echter alleen nodig bij -10 graden celcius. Voor deze laatste 10% kun je dus beter een ander goedkoop alternatief gebruiken. Verder is het gewenst een warmtepomp zo gelijkmatig mogelijk te laten draaien. Een warmtepomp heeft opslag nodig dus om gelijkmatig te kunnen draaien. De opslag is een watervat dat water rond de 60 graden bewaart. Hier doorheen zit je CV installatie.

Met de juiste mengkranen en verwarmingen kan een warmtepomp dus altijd contant blijven draaien.

Voordelen Maxum op laagste niveau (consument): Geen zwaardere aansluiting, sneller laden, op de zon laden

Voordelen 2 niveau's hoger (leverancier, netbeheerder): Flexibiliteit onttrekken bij huishoudens.

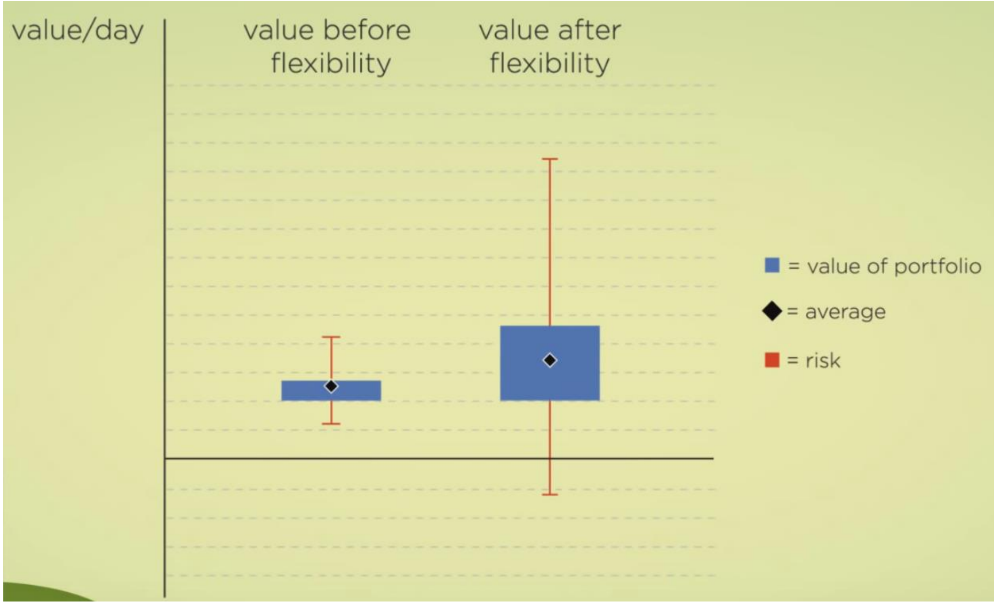
Verkoopt Maxum naast een verkoop aan de klant van een pakket ook de flex die uit een Maxum getrokken wordt?

Jan-Willem: BRP is de energiemaatschappij. Zij kopen energie in. Dit doen ze op 2 manieren, op de markt die per seconde gaat (onbalansmarkt) en op de markt die per kwartier gaat (day-ahead market).

De flexibiliteit moet vrij gemaakt worden en de gebruiken moet daar iets over te zeggen hebben. Daarvoor heb je een interfase nodig, zoals een app.

Maxum heeft dat, en is daarom een aggregator.

In het filmpje van Energiekoplopers: https://www.youtube.com/watch?v=_MhzidkVCFo is het volgende plaatje te zien:



De waarde van een portfolio van klanten is groter nadat de flexibiliteit is onttrokken. Het risico is echter groter geworden dit kan ook negatief uitpakken door onder de grenswaarde te gaan. Dit risico uit zich als er vanuit gegaan wordt dat een oplaadtaak uitgesteld kan worden en de verantwoordelijke partij belemmert het uitstellen van de oplaadtaak.

- Wat zal meer waard worden op den duur? kWh'en of flexibiliteit in gebruik?

kWh's blijven altijd meer waard. Flexibiliteit is rond de €70,- waard per huishouden per jaar. Met de elektrische auto (tesla) wordt dit meer en gaat dit richting de €170,- .

een huishouden heeft 3x25 ampere. Wat inhoud dat een huishouden 17,2 kW kan trekken. (75*230). Tesla model S laadt op met 22 kW maximaal. Over het algemeen gebruikt een huishouden rond de 2 kW.

Wanneer Tesla opgeladen wordt, kan hij tot 17,2 kW trekken. Dat betekent dus dat hij 9 huishoudens aan energie verbruikt op de piek. Tesla wordt als voorbeeld gebruikt omdat zij hoge laadcapaciteit hebben en hoge laadsnelheid. Verder zijn Tesla's altijd in dezelfde wijken te vinden, dus er staan er meerdere per wijk. Dit zorgt voor problemen voor de netbeheerder op lokaal niveau. Een warmtepomp en een huishouden hebben een piek van rond de 2 kW. Dit betekent dat er een flex is van ongeveer 2 kW. Bij een Tesla is deze flex al rond de 16kW. Dit is dus een aanzienlijk verschil. Maxus zorgt ervoor dat de maximal 17,2 kW gebruikt wordt. Dit is dus goed voor de klant, maar minder goed voor de netbeheerders.

Wat Maxus dus doet, is het verkopen van het maximalen van gebruik van energie per huishouden om vervolgens naar de netbeheerder te gaan om een vergoeding te vragen voor de flexibiliteit.

De elektrische auto gaat een grote invloed hebben hierop, maar de flex wordt niet duurder dan de kWh's. Verhouding: €150,- tot €1200,- per jaar.

Wat Maxus nog extra doet is goodies geven. Zoals een energie management systeem. Dit is het incentive dat zij gebruiken om de flex van je huishouden te onttrekken. Een toon inruilen voor flexibiliteit. JW verwacht dat niemand het erg vindt om zijn flexibiliteit in te leveren.

Er is een verschil tussen delayed charging en het managen van de snelheid van het laden.

De gebruiker zal het waarschijnlijk niet erg vinden om het verlaten van opladen over te laten aan het net, als hij maar een knop heeft om te bepalen dat *tenzij hij het wil* de auto op een later moment oplaadt.

- Is er naast een financiële incentive nog een andere manier om ervoor te zorgen dat huishoudens hun gedrag aanpassen?

Goodies! Toons, gadgets, nest. Gratis weggeven.

- Welke apparaten kunnen efficiënter aangestuurd worden door smart grid oplossingen en flexibele energieprijzen?

EV

- Wat verbruikt een elektrische rijder per jaar aan zijn auto?

5000 kWh voor een Tesla (is veel)

Huishouden met Tesla model x en BMW i3 = 5500

- Verkopen jullie de flexibiliteit die je zelf genereert met de laadpalen via de USEF of iets vergelijkbaars?

Nog niet.

- Zijn er veel van dit soort smart grid initiatieven?

Maxum is een van de weinige die EVs mee neemt en proclameert zichzelf als energy manager.

- Stel er zou een leverancier zijn met flexibele energieprijzen, zou je deze dan aanraden voor Maxem gebruikers en zou je dit inprogrammeren in het systeem?

Senfal en Peeeks doen dit al. JW ziet het zo dat in de toekomst je een energieleverancier hebt en een energy manager. Die twee zijn dan niet per see verbonden.

- Zou je geinteresseerd zijn in het gedrag van de gebruiker? Hoe veel flexibiliteit hij over wil laten aan het systeem en welke controle hij zelf wil houden?

Pilots zijn het middel om dingen te meten betreft energie gedrag.

- Wat is het meest interessante om nu te weten in deze ontwikkeling?

Sowieso heel relevant onderwerp. Vooral met betrekking tot EV en warmtepomp.

De technische aansluiting is goed te realiseren. JW heeft meer problemen met het zien van de business modellen van de verschillende partijen. Veel partijen hebben botsende modellen. Lader, Maxum, leverancier hebben clashende business modellen. Daarnaast is daarbij de wens van de gebruiker niet meegenomen.

Iedere partij wil in principe de flex ontsluiten van zijn eigen product of klant. Wat JW het interessante zou vinden in mijn verslag is het zien hoe deze business modellen naast elkaar liggen en waar ze clashen. Ook hoe de verschillende partijen er over denken.

Het USEF framework is een platform, maar de partijen zullen hun positie in de markt moeten vinden om het optimale hier uit te halen. Nu wil iedereen verdienen op de flex van gebruikers. Laadpunten zijn bijvoorbeeld niet meer dan laadpunten, wat ze nu doen is ook voor energy managers spelen, hetzelfde geldt voor warmtepompen. Het is de vraag of een fabrikant de energy manager moet worden, of de energy manager dat moet doen of dat het de leverancier is.

Binnen Nederland zijn laadpuntfabrikanten vrij machtig. Het is een goed idee om eens naar het buitenland te kijken wie daar de flex onttrekt. In Duitsland en Frankrijk is dat heel anders.

- De huidige energieleveranciers zijn vrij stug in deze transitie, en dat is begrijpelijk omdat ze er niet direct voordeel uit halen.

JW: Er komen steeds meer start-ups die hier wel verschil in willen maken en bezig zijn om de grote jongens er uit te concurreren. Zij kunnen wel de flex verzilveren door goed met klanten om te gaan.

Een groot deel van vraag en aanbod wordt ook opgelost door huidige ‘batterijen’ zoals grote vries ruimtes, noodaggregaten, etc.

Interview IV

Naam:	Peter Ahcin
Bedrijf:	SINTEF Energi AS
Functie:	Scientist
Date:	January 5th, 2017

How does the market of energy flexibility in Norway look like?

The thing with the demand response by households is that it doesn't really exist. The first problem until now has been the billing. Some countries already have a lot of smart meters, but some, like Norway, still don't. Without it you cannot correctly evaluate the response. The even more important problem is that the benefits when divided over many customers are very low. In Norway the problem is even more acute since it has a lot of flexible capacity in the form of fast response hydro generators. Additional hydro power capacity in future would be very cheap to add – Norway has one of the lowest costs of new installed capacity at 1000-1500 EUR/kW. It also has very strict environmental regulation which could mean that it might in future try to develop this market. But until 2019 when smart meters are introduced, this will not happen.

Which parties are involved?

For now it is only some suppliers and network operators running pilot projects.

Do customers give away their flexibility? And if so, do they get anything in return?

I think they do communicate it, or rather it is the pilot operator that knows it better than the customers themselves. From what I have seen they do get some benefits, but it is mostly technological enthusiasts that participate in this.

Is there awareness among customers in Norway regarding their flexibility?

No. Demand response will be a hard sell in Norway. The potential savings are actually higher than in most places, but so are incomes and as a share of total electricity expenses the amounts are too insignificant for a Norwegian household. Here's a figure: 20-50 EUR per year. The average net salary is about 3400 EUR and the average household spends about 1200-2000 EUR on electricity per year.

Is there anything that I am forgetting in my story around flexible energy usage?

Maybe a few trends to think about. Storage will be ever cheaper. I personally would prefer a DSO installing some centralized storage on a congested line to dozens or hundreds of customers having to be flexible. But we'll see what happens.

DSOs are introducing time of use tariffs. Most of the benefit of demand response is actually in distribution investment deferral. If DSOs can price these tariffs correctly it might promote demand response to some extent.

Demand response for households has been around for a very long time and it still has not caught on. There is a reason for it. The benefits are just too low. However, some new product and service combos might work. In Germany Sonnenbatterie offers its customers a battery+PV system with reduced electricity rates if they allow it to use their battery. Sonnenbatterie then acts as an aggregator on the balancing market. Customers feel like they are sharing the electricity and getting some benefit for it. But it has to be a packaged deal it seems.

Interview V

Naam:	Arjan de Jong
Bedrijf:	NUON
Functie:	Innovation manager
Date:	January 12th, 2017

- Is een flexibele vraag belangrijk voor de energietransitie en zo ja, waarom dan?

Gaan we wel flexibele vraag krijgen? Kijkende naar consumentengedrag en betrokkenheid van consumenten bij energie. Mocht je de vraag kunnen flexibiliseren, dan draag je bij aan een beter gemanagede en duurzamere energiemarkt. Maar het is lastig om er te komen.

Arjan vraag zich af, wie zou die rol moeten spelen?

Flexibele vraag zal vanuit de energieleverancier geregeld moeten worden. Echter kijkt de energieleverancier anders naar de energiemarkt dan de netbeheerder.

- Is er naast een financiële incentive nog een andere manier om ervoor te zorgen dat huishoudens hun gedrag aanpassen?

Nee, financiële incentives zijn nu de enige manier. Er zijn wel mensen die geinteresseerd zijn in verduurzaming, namelijk ongeveer 10%. De vraag is echter of deze 10% al wil handelen hiernaar.

In Spanje is de slimme meter uitgerold en hier is vervolgens een propositie aangehangen waarbij je beloond werd voor het verplaatsen van het energieverbruik. Dit is geflopt. Het was te ingewikkeld en mensen willen hun gedrag er niet voor aanpassen.

De burger kan niet verantwoordelijk gemaakt worden voor de complexe energiemarkt.

Na een vraag over huisdemotica zegt Arjan: Niemand is geïnteresseerd in huisdemotica.

Nederlanders zijn risicomijdende mensen, dus de angst dat de auto 's ochtends niet opgeladen is, is groot en een belangrijke trigger.

Huisdemotica kan alleen misschien opkomen uit google home en Alexa. Tot nu toe werkt dit allemaal nog niet goed.

- Is Senfal al in bedrijf? Of is het slechts een pilot / marketing test?

Senfal is alleen beschikbaar voor B2B. Nog niet voor B2C.

B2B is gemakkelijker te porren dan B2C. 6 miljoen huishoudens zijn moeilijk in beweging te brengen.

- Zijn de eerste klanten vooral tech-enthousiastelingen, of biedt het ook al genoeg voordelen voor de early majority?

- Welke apparaten kunnen efficiënter aangestuurd worden door smart grid oplossingen als flexibele energieprijzen of de verkoop van flexibiliteit?

Wasmachine en droger. Dit bestaat al met dag en nachtstroom. EV, Vaatwasser. Eigenlijk alles. Alleen heeft iedere categorie andere bronnen nodig. Klant moet 100% garantie hebben dat alles goed gaat.

Nieuwe mogelijkheden zijn in opkomst om jezelf af te scheiden van het net. Bijvoorbeeld geïntegreerde zonnepanelen en batterijen. Daarnaast kan de auto als batterij worden gebruikt. Hierdoor krijg je een onafhankelijkheid van het net.

Op het moment is er veel wantrouwen in de (groene) energiemarkt. Daardoor wordt onafhankelijkheid een groter argument voor de klant.

Probeerbaarheid is een belangrijke factor in consumentenkeuzes. Niet alleen in energie maar ook bij bijvoorbeeld de krant lezen.

- Gaat huisautomatisering in energetische apparaten het verschil maken in de vraag naar flexibele energieprijzen en de verkoop van flexibiliteit? (klant hoeft op deze manier niet na te denken over wanneer hij verbruikt)

- Als meer en meer mensen elektrisch gaan rijden en als er meer warmtepompen geïnstalleerd worden, gaat het energieverbruik van Nederland dan niet heel snel omhoog?

- En daarbij de meerwaarde van flexibiliteit?

Ja, het energieverbruik gaat zeker omhoog. Echter, de technologie staat ook niet stil.

Een van de grootste problemen nu, is de bouwwereld. Veel gebouwen zijn “schijn-duurzaam”. Veel zonnepanelen staan nu op het oosten. Op het oosten heb je nog minder dan 50% van de capaciteit dan bij zonnepanelen op het zuiden. West + oost = zuid. En west wekt meer op dan oost.

Verder is het esthetische aspect van zonnepanelen ook een groot punt op de agenda. Zonnepanelen zoals nu geplaatst op daken, passen niet goed bij het algemeen geaccepteerde straatbeeld. En dat terwijl het ook geïmplementeerd zou kunnen zijn.

Bouwbedrijven zijn geen helpende partij in de energietransitie.

- Voor wie is een kWh flexibiliteit iets waard?

- Hoe zou je de relatie beschrijven tussen de netbeheerder en de energie leverancier?

Er is geen relatie tussen de twee. Er is geen haat en nijd, maar er is ook geen goede samenwerking.

- In hoeverre denk je dat een gebruiker zijn tijd van verbruik en controle uit handen wil geven (overgenomen wil worden door het smart grid)?

Als klanten niks merken in hun dagelijkse leven, is het geen enkel probleem. En niet alleen het feit dat het geen negatief effect voor de klant heeft, maar ook de klant overtuigen dat het geen negatief effect gaat hebben.

Je zou het echter altijd moeten vertellen dat de kans bestaat dat je auto langzamer oplaadt of dat het een graad kouder is in je woning.

- Wat voor partijen zijn op dit moment actief binnen het flexibiliteitsvraagstuk?

Energieleverancier, netbeheerders, installatiebedrijven, grote bedrijven (haven Amsterdam), overheden.

- Zullen we altijd flexibel aanbod moeten blijven houden? Of kan de flexibiliteit van de vraag genoeg inspelen op de flexibiliteit van duurzame energie?

Wie heeft er een flexibiliteitsprobleem? En wie is verantwoordelijk? De klant zou daar niet lastig mee gevallen moeten worden. Energieleveranciers zouden een beter portfolio moeten hebben van duurzame bronnen die altijd werken.

Onbalanskosten zijn zo laag dat het niet relevant is. En daarnaast maakt het de klant ook niet uit.

Verdienmodel NUON is kWh*# plus een deel administratiekosten. Het optimaliseren van de bedrijfsvoering en service kan deze kosten drukken. Bijvoorbeeld chatpods die je administratieve vragen beheerst.

- Wat kan mijn onderzoek voor een energieleverancier als NUON betekenen?

Arjan heeft interesse in het onderzoek en denkt dat het erg veel waarde heeft. Vooral als het onderzoek nog niet is gedaan, is het een waardevol stuk.

- Kunnen jullie helpen aan het verspreiden van de enquête?

Arjan gaat er achteraan en gaat rondvragen of het mogelijk is om de enquête te verspreiden onder NUON klanten.

Appendix II: Questionnaire

Introduction

Beste respondent,

Voor mijn master thesis op de Technische Universiteit Eindhoven, (studie: Bouwkunde) heb ik jullie hulp hard nodig. Dus hartelijk dank voor het openen en verder invullen van deze enquête.

Deze enquête gaat over uw huidige en toekomstige elektriciteitsgebruik. Een belangrijk element voor een duurzaam energiesysteem is de timing van gebruik van duurzaam opgewekte energie.

Het doel van mijn onderzoek is er achter zien te komen in hoeverre u controle door derden over uw energiegebruik toelaat en wat daar tegenover zou moeten staan.

Het eerste deel van de enquête betreft uw algemene gegevens: geslacht, inkomen en affiniteit etc. Vervolgens mag u een keuze experiment doen waarbij u kiest tussen een aantal situaties.

Deze enquête duurt +- 10 minuten.

Dit onderzoek is in samenwerking met Alba Concepts.

Heeft u vragen bij het invullen of wilt u op de hoogte gehouden worden van de onderzoeksresultaten. Neem dan contact op met mij: Stijn van Enckevort, stijnvane@gmail.com.

Wat is uw geslacht?

- Man
- Vrouw

Wat is uw leeftijd?

Wat is uw hoogst genoten opleiding?

- Basisschool/Lagere school
- Voorbereidend middelbaar beroepsonderwijs (v(m)bo, lts, lbo, huishoudschool)
- Middelbaar algemeen voortgezet onderwijs (mavo, (m)ulo)
- Middelbaar beroepsonderwijs (mbo, mts)
- Hoger algemeen en voorbereidend wetenschappelijk onderwijs (havo, vwo, hbs)
- Hoger beroepsonderwijs (hbo, pabo, hts, heao)
- Wetenschappelijk onderwijs (universiteit, gepromoveerd)

Wat is uw jaarlijkse bruto inkomen?

- Minder dan €20.000 per jaar
- €20.001 - €30.000 per jaar
- €30.001 - €40.000 per jaar
- €40.001 - €50.000 per jaar
- Meer dan €50.000 per jaar
- Dat weet ik niet/zeg ik liever niet

Wat is uw 4-cijferige postcode? (zonder letters)

De volgende vragen gaan over uw woonsituatie

Type woning:

- Vrijstaande woning
- 2-onder-1-kap
- Hoekwoning
- Tussenwoning
- Appartement
- Studio
- Gedeelde woning
- Overige

Woont u in een huur- of koophuis?

- Huur (incl. elektra)
- Huur (excl. elektra)
- Koop

Wat is de samenstelling van uw huishouden?

- 1-persoons huishouden
- 2-persoons huishouden
- 3-persoons huishouden
- 4-persoons huishouden
- >4-persoons huishouden
- Gedeelde woning

Hoeveel kinderen jonger dan 6 jaar wonen er bij u.

Hoeveel (basis)scholieren/studenten wonen er bij u? (naast uzelf)

Hoeveel auto's bezit uw huishouden?

- Geen
- 1 auto
- 2 auto's
- 3 auto's
- >3 auto's

Hoeveel auto's heeft u persoonlijk tot uw beschikking?

- Ik heb nooit een auto ter beschikking
- Ik heb vaak 1 auto ter beschikking
- Ik heb altijd 1 auto ter beschikking
- Ik heb vaak 2 auto's ter beschikking
- Ik heb altijd 2 auto's ter beschikking

Is (een van) uw auto('s) elektrisch aangedreven?

- Nee
- Ja, hybride
- Ja, volledig elektrisch

De volgende vragen gaan over uw interessegebied en kennisniveau

Definitie flexibel energiegebruik: Het op afstand laten beïnvloeden van uw elektriciteitsgebruik op basis van de beschikbare elektriciteit in het net. (Geen piek - dal tarief)

Bent u bekend met flexibele energie en het verhandelen hiervan?

- Ik ben niet bekend met energie flexibiliteit
- Ik heb wel eens van flexibel energiegebruik gehoord
- Ik ben bekend met het fenomeen flexibele energieprijzen en het verhandelen van flexibiliteit
- Ik ben expert in flexibel energie gebruik

Hoe hoog is uw (technologische) innovatiedrang?

- Ik heb altijd de nieuwste gadgets
- Ik heb de nieuwste gadgets altijd vrij snel
- Ik ga mee met de tijd op technologie gebied
- Ik schaf technologie aan twee modellen later als alles optimaal werkt
- Ik ga niet met technologie trends mee

Welke slimme apparaten heeft u in huis? (meerdere antwoorden mogelijk)

- Slimme meter
- Energiemanagement systeem: inzicht + aansturing (bijv. TOON)
- Energiemanagement systeem: alleen inzicht
- Warmtepomp
- Overige elektrische verwarming
- Oplader elektrische auto
- Slimme wasmachine (op afstand bedienbaar)
- Slimme wasmachine (met timer)
- Slimme vaatwasser (op afstand bedienbaar)
- Slimme vaatwasser (met timer)
- PV panelen
- Zonneboiler
- Thuis batterij >2kWh (bijv. Tesla powerwall)
- Geen van bovenstaande

Choice experiment

De enquête gaat nu verder met het keuze experiment.

In de volgende 9 vragen wordt u gevraagd om te kiezen tussen twee situaties. De situaties die geschetst worden, zijn steeds een combinatie van de factoren als in de tabel hieronder beschreven. Kies hierbij voor de keuze die u het beste bevalt.

Stel:

U krijgt een systeem in uw woning dat uw energiegebruik gaat monitoren en sturen. Het systeem is een klein kastje dat geplaatst wordt in uw meterkast. Dit systeem zit aangesloten op de oplader van uw elektrische auto, beheert uw verwarming en kan uw huishoudelijke apparaten (wasmachine, droger & vaatwasser) sturen. Het geeft u via een app of website informatie over uw elektriciteitsgebruik. Vergelijk het met een TOON, nest o.i.d.

Met dit kastje kunt u ook nog geld verdienen zonder per saldo minder te verbruiken. De prijs van elektriciteit heeft namelijk op ieder moment van de dag een andere waarde. Als u maximaal elektriciteit kunt gebruiken op het moment dat elektriciteit goedkoop is, bespaart u geld. Het gebruik van energie wordt automatisch aangestuurd door dit systeem en het kost u geen extra moeite.

Het systeem kost €0,- tot €8,- per maand, afhankelijk van de duur van uw contract. Dit kan u jaarlijks tot wel €150,- opleveren.

Voor de volgende vragen moet u aannemen dat:
- Het systeem er sowieso komt (samen bijdragen aan een duurzamere wereld)
- U in bezit bent van een elektrische auto
- Uw huis elektrisch verwarmd wordt

Mocht u geen keuze kunnen maken tussen beide situaties, kies dan "geen voorkeur"

Hieronder ziet u een overzicht van de toegepaste factoren.

Als u met de muis over een factor gaat, ziet u een korte toelichting. Deze toelichting zal ook beschikbaar zijn bij de keuze experimenten.

Kies het alternatief dat het beste in uw situatie past.

Deze keuze is niet afhankelijk van eventuele eerdere keuzes gemaakt en wordt willekeurig gegenereerd.

Probeer u voor te stellen dat u een elektrische auto hebt en elektrisch verwarmt.

Als u met de muis over een factor gaat, ziet u een korte uitleg

Factor	Flexibel energiesysteem 1	Flexibel energiesysteem 2	Geen voorkeur
Financiële vergoeding (voor u)	€100-150 per jaar	€50-100 per jaar	
Opladen elektrische auto	Laadt altijd op	Laadt alleen op tussen 21:00 en 5:00u	
Elektrisch verwarmen woning	Gewenste temperatuur +/- 0,5°C	Gewenste temperatuur +/- 0,5°C	
Gebruik wasmachine + droger + vaatwasser:	Alleen gebruik tussen 21:00 en 5:00u	Geen gebruik tussen 17:00 en 21:00u	
Prijs voor aansturingssysteem:	Gratis	€8,- per maand/€96,- per jaar	
Contractperiode:	Maandelijks opzegbaar	Maandelijks opzegbaar	
Uw keuze	○	○	○

Wat betaalt u per maand ongeveer aan energie (gas+elektra)?

Voor welke korting zou u uw energiegebruik flexibeler inrichten? (antwoord in euro's per maand)

Gewenste contactpartijen voor een flexibel energiesysteem? (meerdere antwoorden mogelijk)

- ☐ Gemeente
- ☐ Netbeheerder
- ☐ Energieleverancier
- ☐ Batterij leverancier
- ☐ Auto oplader leverancier
- ☐ Installateur
- ☐ Start-up
- ☐ Financiële partij
- ☐ Energiemanagement systeem leverancier
- ☐ Derde partij

Anders, nl:

Hoe zou u uw energiemanagement systeem willen verkrijgen? (En daarmee de mogelijkheid tot een flexibel energiesysteem en inzicht)

- ○ Koop
- ○ Financial lease; (maandelijkse aflossing, apparaat is uiteindelijk in bezit)
- ○ Operational lease; (Maandelijkse huur, apparaat en onderhoud/updates blijft verantwoordelijkheid van leverancier)
- ○ Kosteloos
- ○ Ik wil geen energiemanagement systeem

Overview social demographics

Geslacht	Man Vrouw
Leeftijd	12–24 jaar 25–39 jaar 40–64 jaar >65 jaar
Hoogst genoten opleiding	Basisschool/Lagere school Voorbereidend middelbaar beroepsonderwijs (v(m)bo, lts, lbo, huishoudschool) Middelbaar algemeen voortgezet onderwijs (mavo, (m)ulo) Middelbaar beroepsonderwijs (mbo, mts) Hoger algemeen en voorbereidend wetenschappelijk onderwijs (havo, vwo, hbs) Hoger beroepsonderwijs (hbo, pabo, hts, heao) Wetenschappelijk onderwijs (universiteit, gepromoveerd)
Bruto inkomen	<€20.000 €20.000 - €30.000 €30.001 - €40.000 €40.001 - €50.000 > €50.000 Dat weet ik niet/zeg ik liever niet
Wat is uw 4-cijferige postcode	
Stedelijkheid	Zeer sterk stedelijk Sterk stedelijk Matig stedelijk Weinig stedelijk Niet stedelijk
Huur/Koop huis	Huur (incl. elektra) Huur (excl. Elektra) Koop
Huishouden	1-persoons huishouden 2-persoons huishouden 3-persoons huishouden 4-persoons huishouden >4-persoons huishouden Gedeelde woning

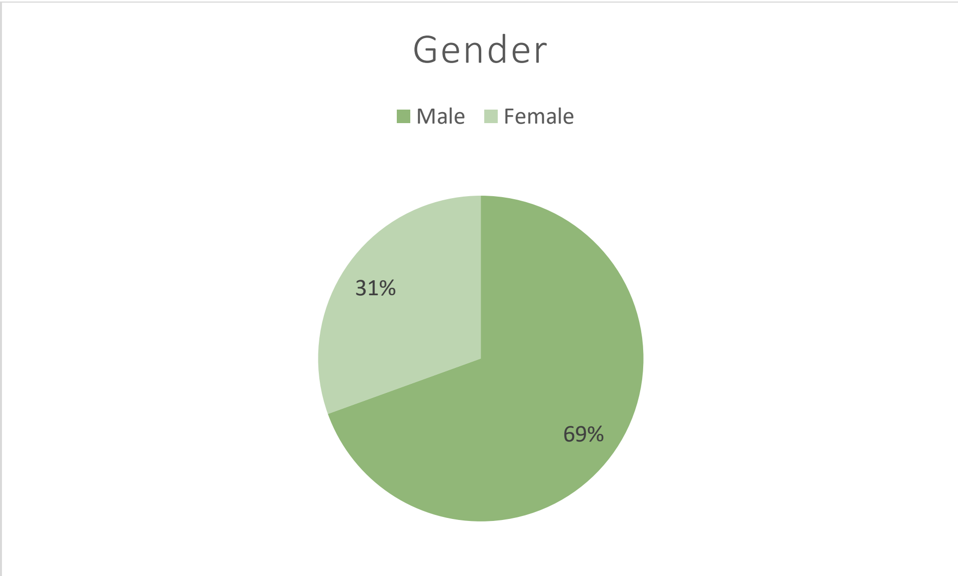
Autobezit (huishouden)	Geen 1 auto 2 auto's 3 auto's >3 auto's
Beschikbaarheid auto	Ik heb nooit een auto ter beschikking Ik heb vaak 1 auto ter beschikking Ik heb altijd 1 auto ter beschikking Ik heb vaak 2 auto's ter beschikking Ik heb altijd 2 auto's ter beschikking
Is (een van) uw auto('s) elektrisch	Nee Ja, Hybride Ja, Volledig elektrisch
Bekend met energie flexibiliteit	Ik ben niet bekend met flexibel energie gebruik Ik heb wel eens van flexibel energiegebruik gehoord Ik ben bekend met het fenomeen flexibele energieprijzen en het verhandelen van flexibiliteit Ik ben expert in flexibel energie gebruik
Innovatiedrang	Ik heb altijd de nieuwste gadgets Ik heb de nieuwste gadgets altijd vrij snel Ik ga mee met de tijd op technologie gebied Ik schaf technologie aan twee modellen later als alles optimaal werkt Ik ga niet met technologie trends mee

Financial incentive calculation

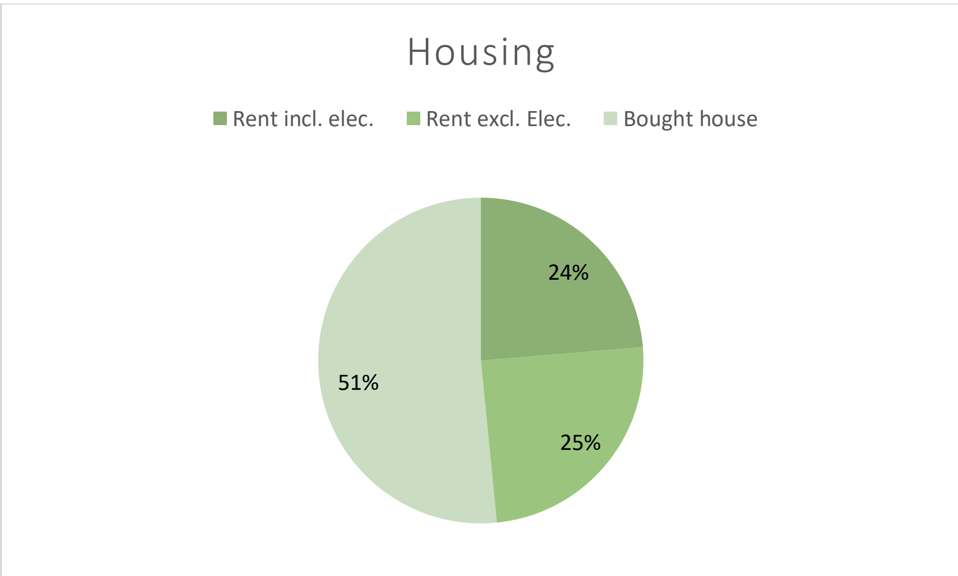
VAT	0,13	€/kWh	
energy costs	0,05	€/kWh	
Difference peak-nonpeak	0,022	€/kWh	https://fritts.nl/moet-weten-flexibele-energietarieven/
Yearly energy usage household	3500	kWh	
Max profit on difference	€ 77,00		
yearly usage EV	3000	kWh	http://zerauto.nl/hoeveel-energie-verbruikt-een-elektrische-auto/
(for 15.000 km)			
Max profit on difference	€ 66,00		
yearly usage HP	5500	kWh	https://www.warmtepomp-info.nl/rekenen/
Max profit on difference	€ 121,00		
Sum max profit on difference	€ 264,00		
Discount on profit	50%		
	€ 132,00		

Appendix III: Descriptive analyses

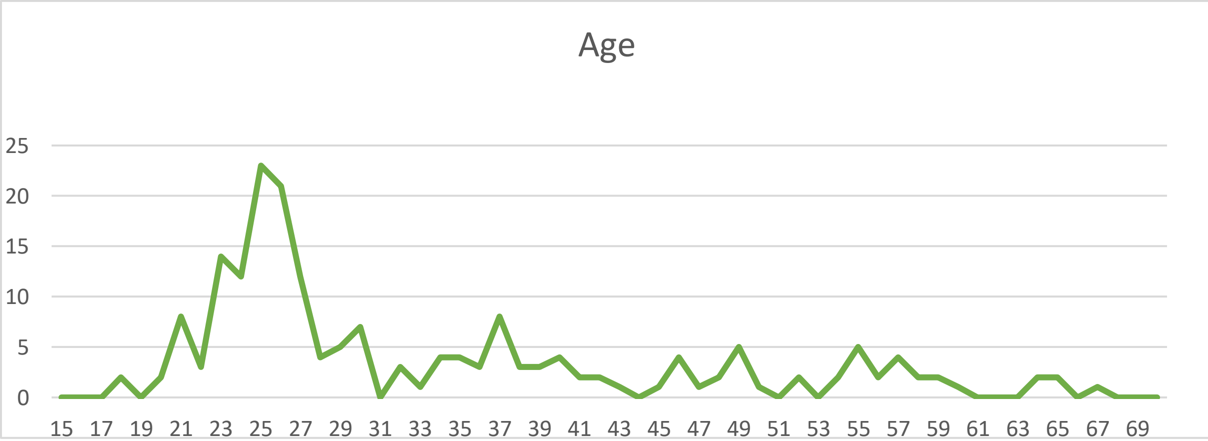
Gender:



Rent/bought:



Age:


Age
25
20
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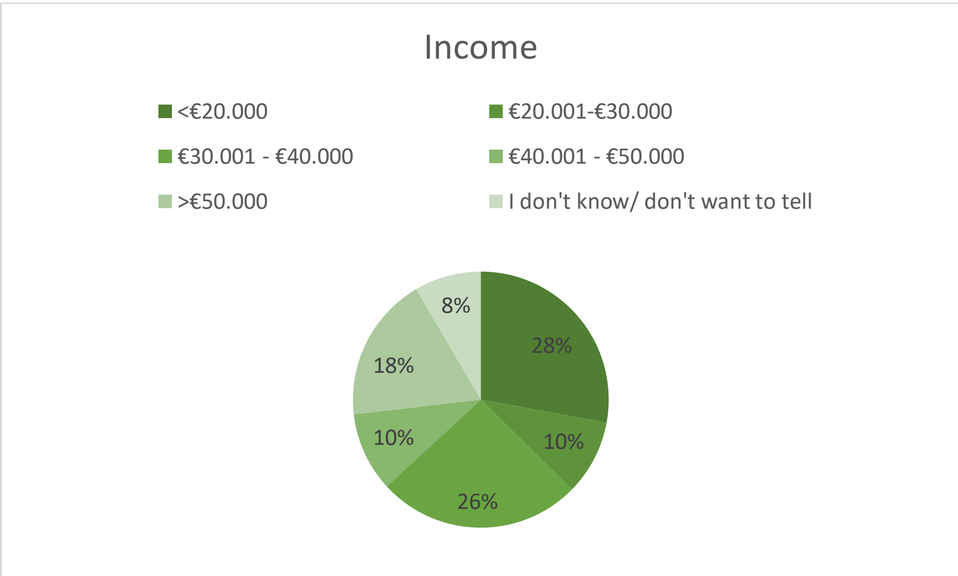
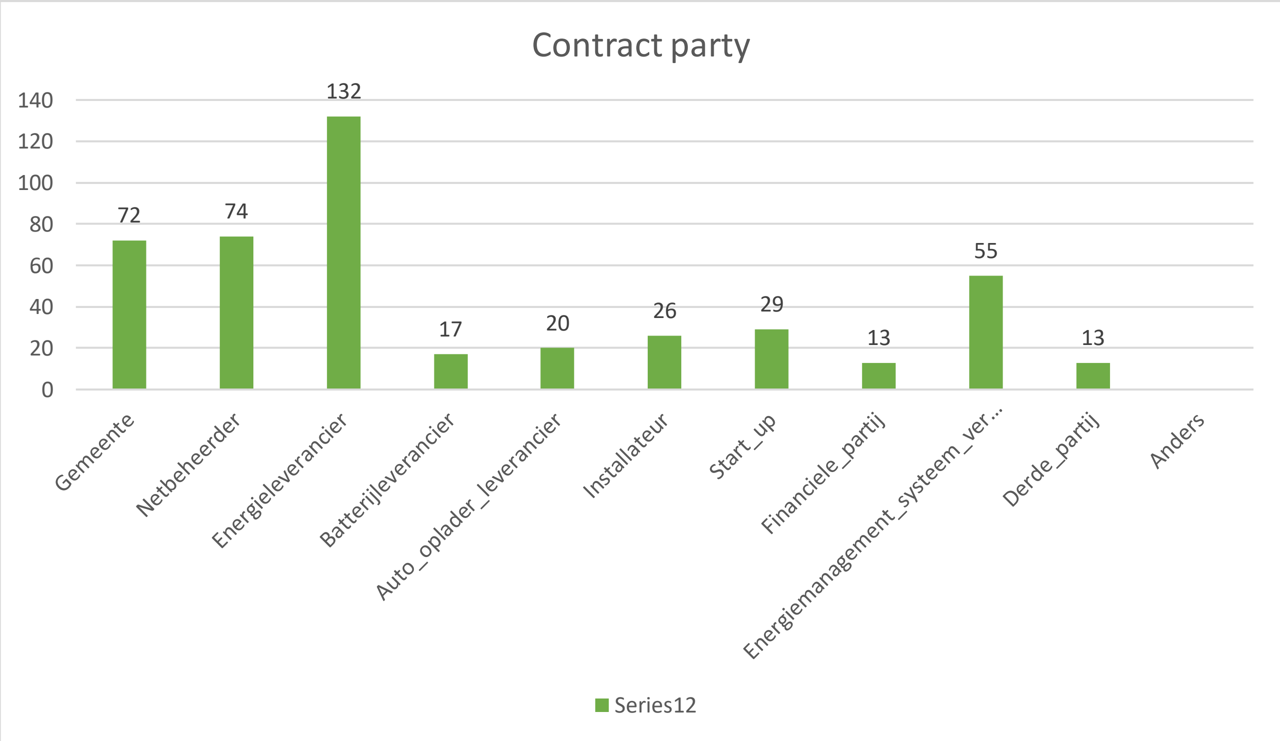
0
15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69

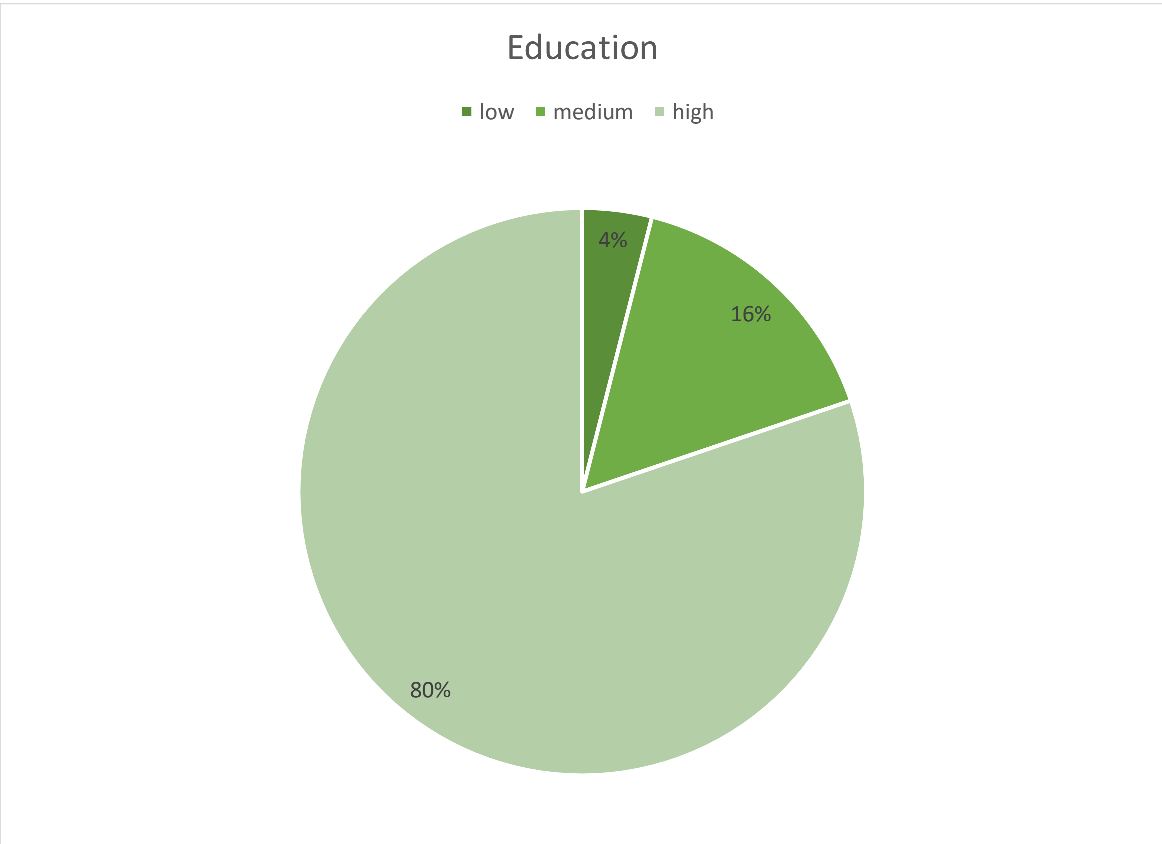
Income:


Income
<€20.000
€20.001-€30.000
€30.001 - €40.000
€40.001 - €50.000
>€50.000
I don't know/ don't want to tell
8%
28%
18%
10%
10%
26%

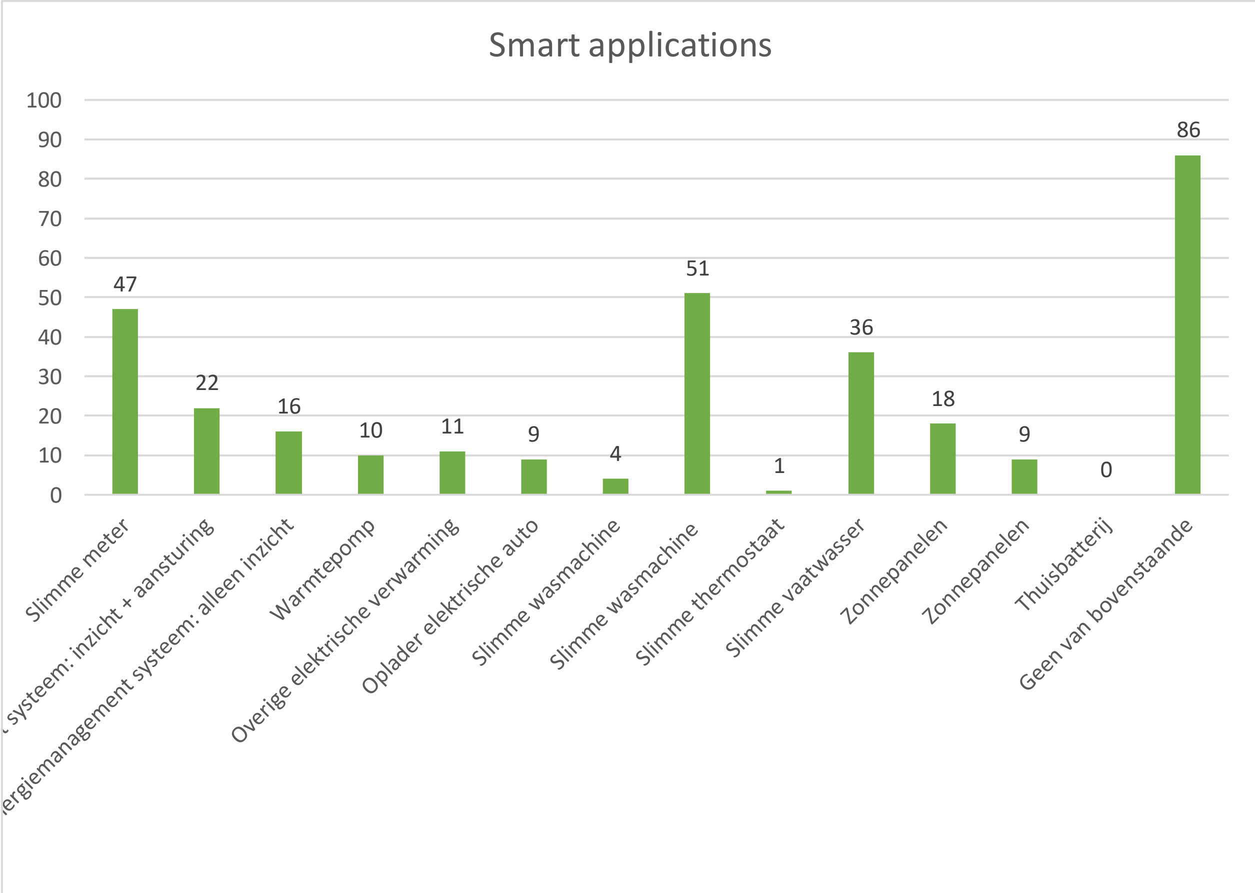
Contract party:



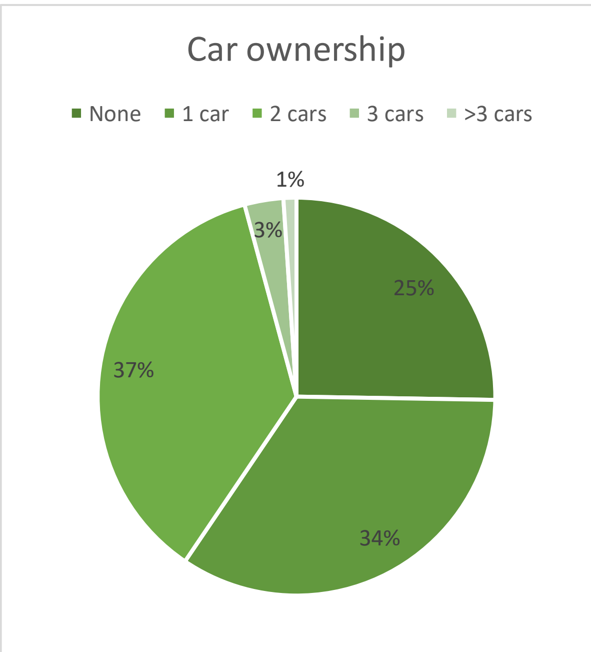
Education:

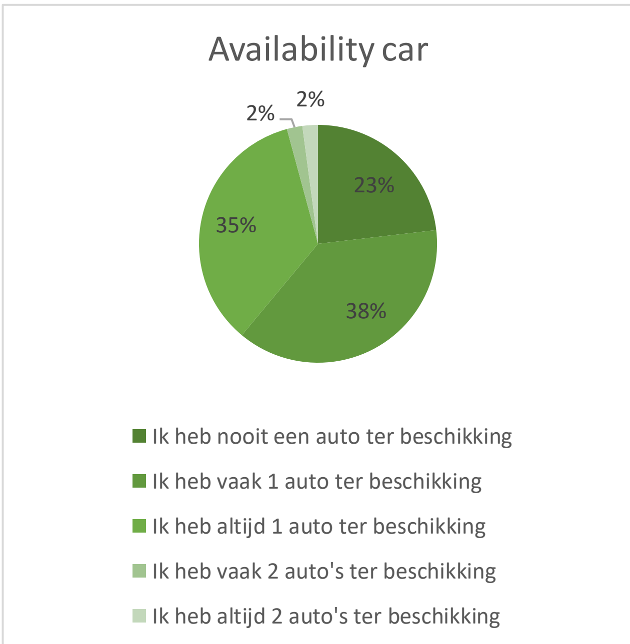


Smart applications:

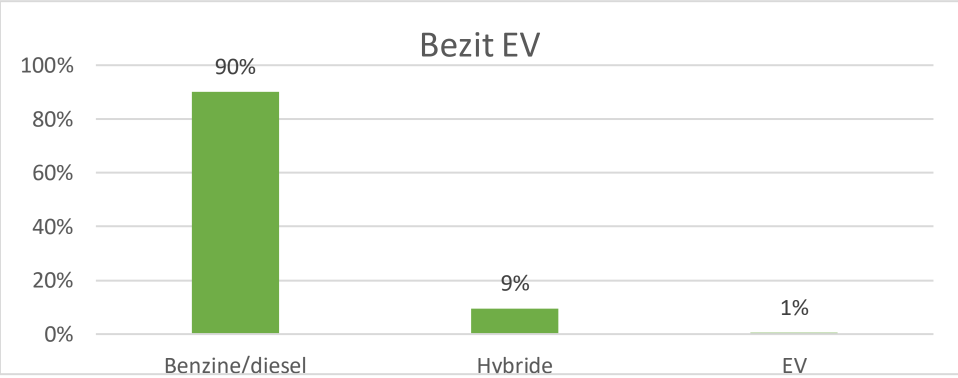


Car ownership:

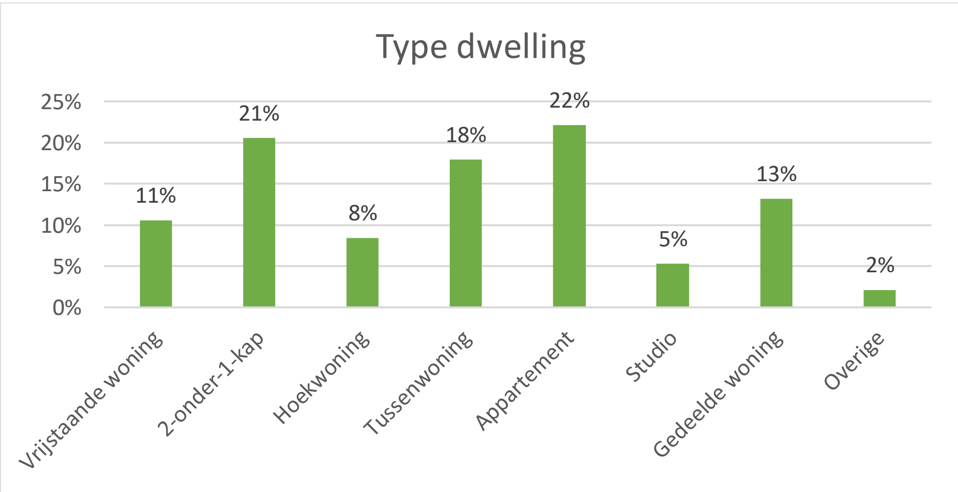




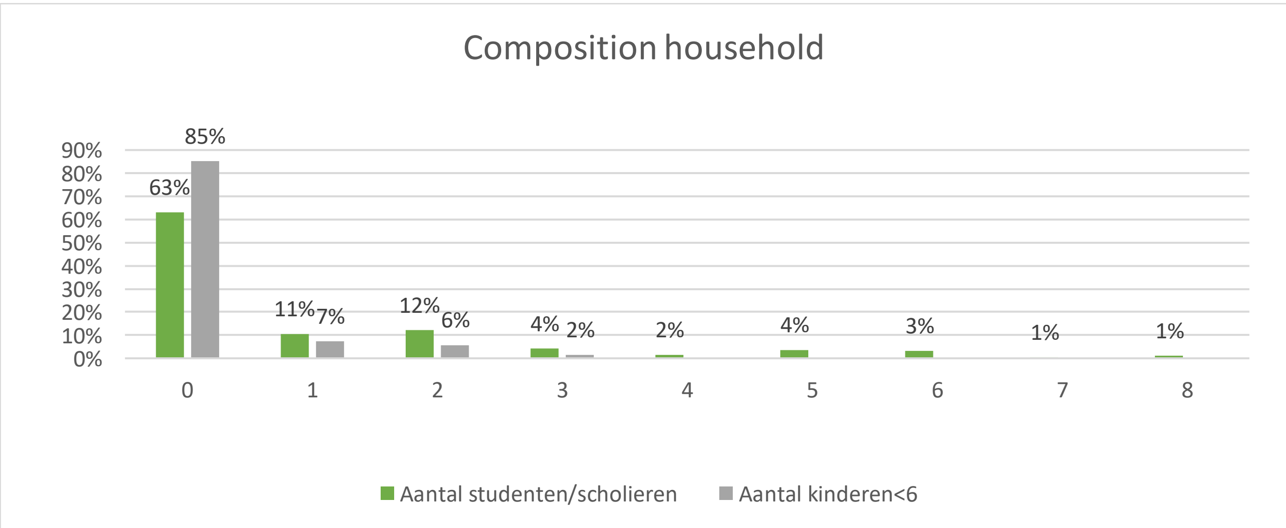
Ownership EV:



Type dwelling:

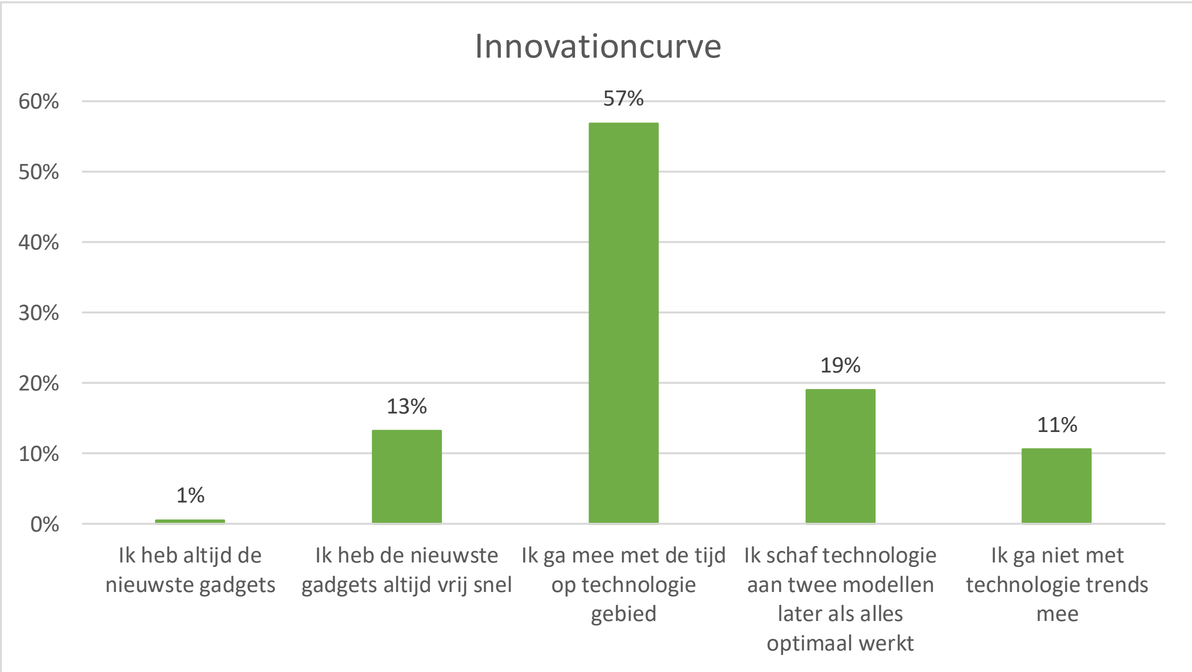


Composition household:

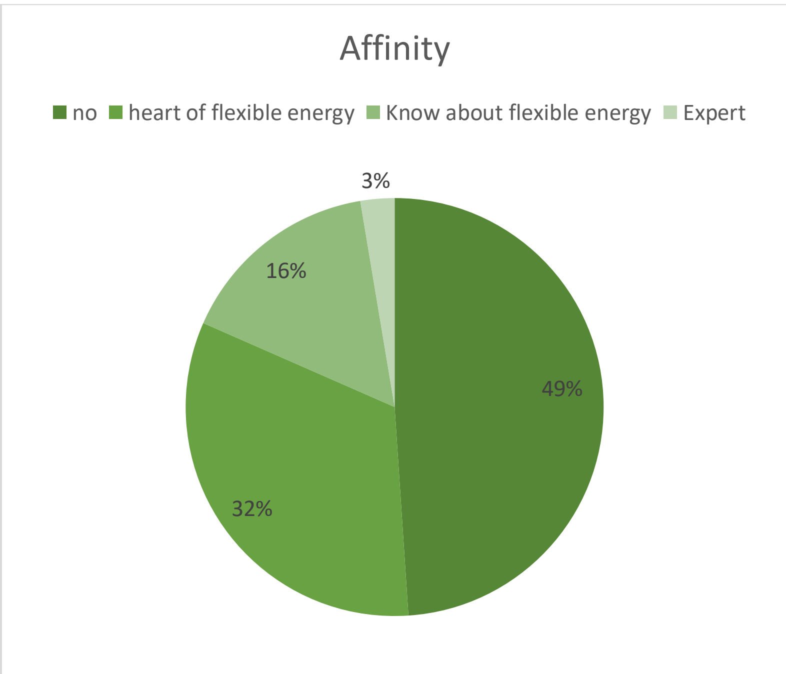


Geographical spread:

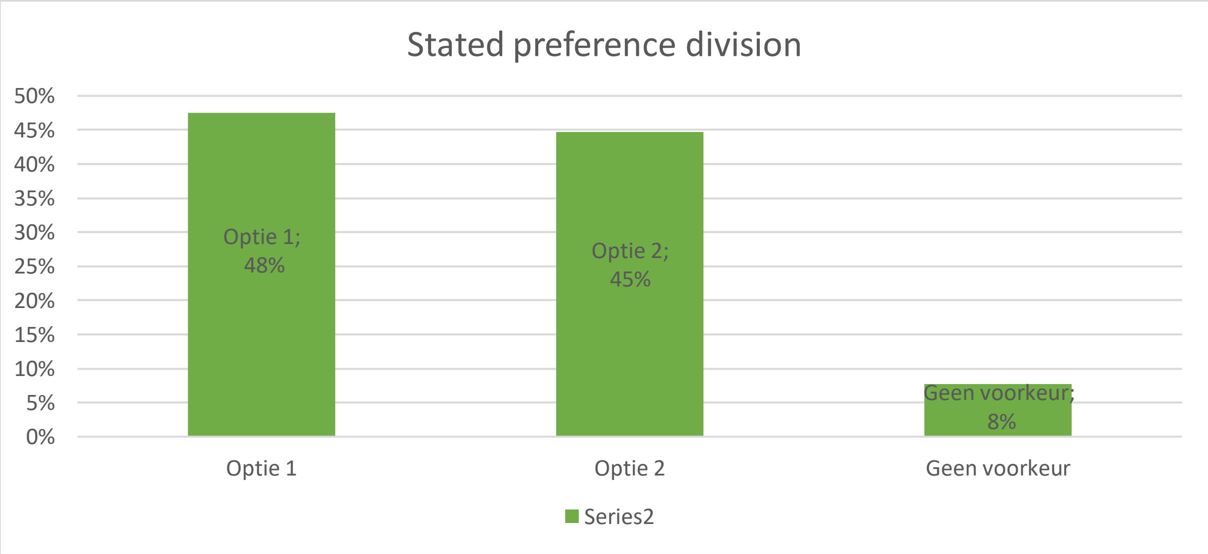
Innovationcurve:



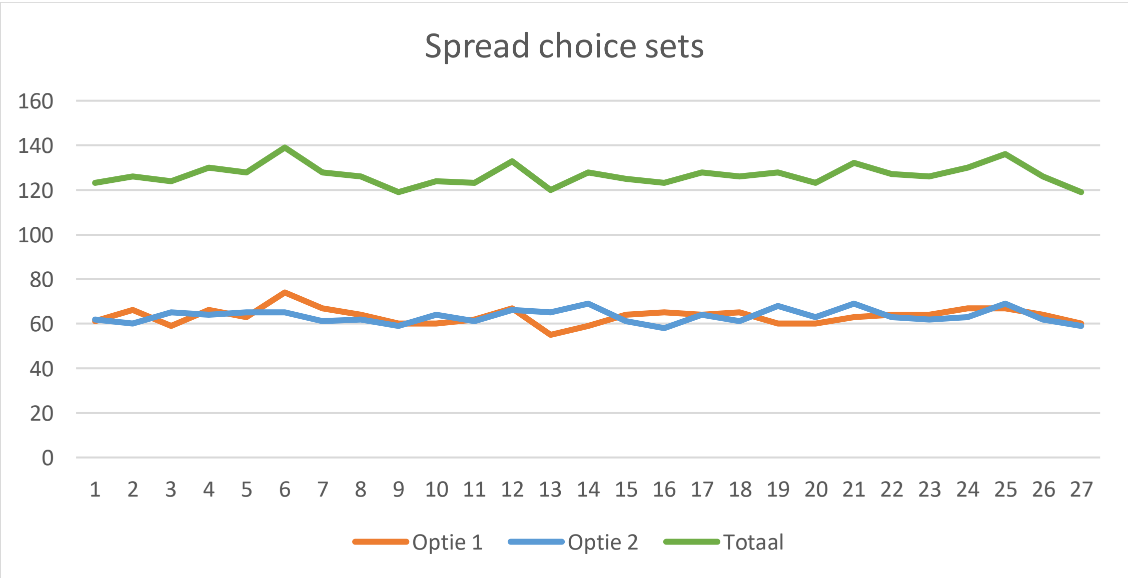
Affinity with flexible energy:



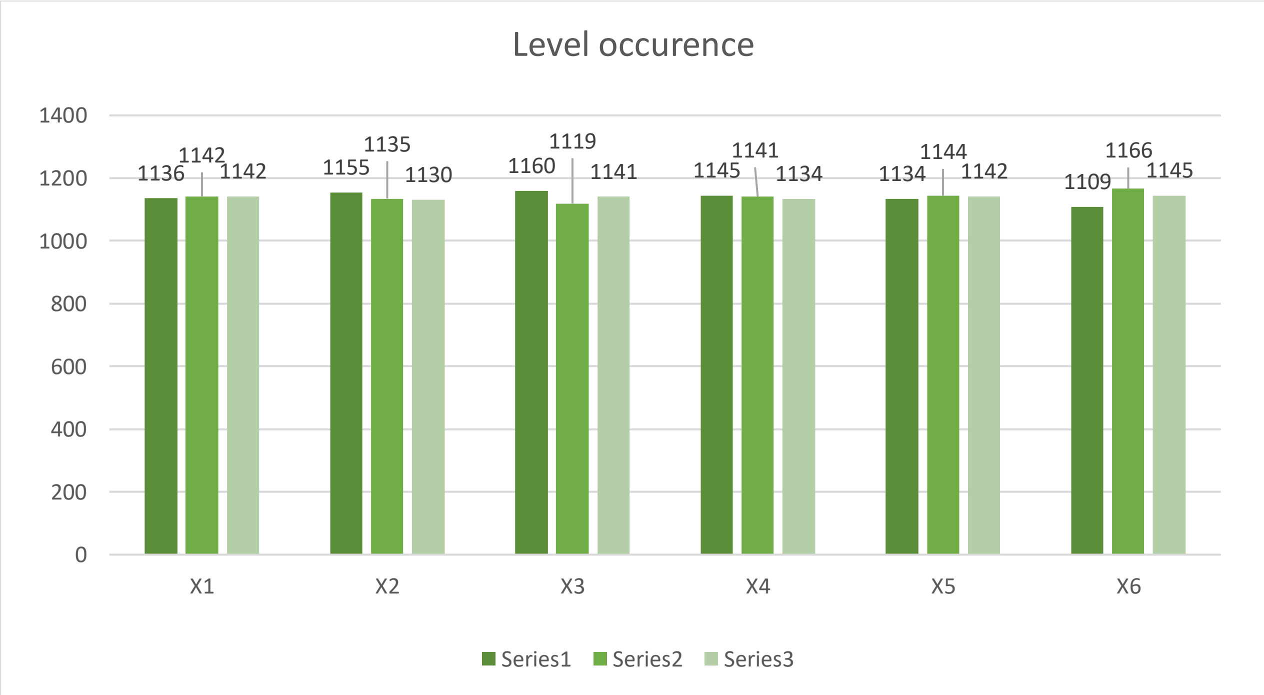
Stated preference:



Choice set spread



Quantity of level occurrence:



Appendix IV: Data analysis

Overview

Attribute	MNL	ML	LCM	
			Class1	Class2
Main attributes				
€50-100	0,01307	0,12523	.04123	-.06876
€100-150	0,23878***	0,53842***	.32674***	-.03370
EV doesn't charge 17:00-21:00	-0,10186*	-0,23296*	-.26291***	.29936
EV doesn't charge 5:00-21:00	-0,18347***	-0,28625**	-.20699***	-.23523
Variation with indicated temp. +-1,5˚C	0,07629	0,06266	.20903***	-.22139
Variation with indicated temp. +-2,5˚C	-0,13800**	-0,17348	-.25064***	.10581
No household app. 17:00-21:00	-0,04989	0,04577	-.11215*	.17360
No household app. 5:00-21:00	-0,42160***	-0,68596***	-.55811***	-.19740
Cost = €96,-/year	-0,48964***	-1,03034***	-.70671***	.01676
Cost = €48,-/year	-0,03795	0,13794	-.00078	-.17653
1 year contract	0,17936***	0,30786***	.11156	.40448***
3 year contract	-0,70306***	-1,22877***	-.73419***	-.90179***
Random St. dev.				
€50-100		.00284		
€100-150		.62208***		
EV doesn't charge 17:00-21:00		.53864***		
EV doesn't charge 5:00-21:00		.40206**		
Variation with indicated temp. +-1,5˚C		.11889		
Variation with indicated temp. +-2,5˚C		.78313***		
No household app. 17:00-21:00		.28984		
No household app. 5:00-21:00		.64457***		
Cost = €96,-/year		.76671***		
Cost = €48,-/year		.00013		
1 year contract		.33889*		
3 year contract		.78394***		
Members - -				
Male	-.06886	-.01780	-1.87500*	
Age 26-35	-.43214***	-.51818**	-2.28107*	
Age >35	.28577	.27460	-.61331	
3-4 person household	-.12495	-.16925		
>4 person household	-.16010	-.20474		
House	-.20764	-.32882	-.98683	
Rent excl. elect.	-.33382*	-.43546	137.614	
Bought house	.31798	.37056	-2.37332*	
Medium affinity	-.09074	.07709		
High affinity	.00187	-.23786		
Innovators / early adaptors	-.40386**	-.44221	131.489	
Late majority / laggards	.22735	.34335	-119.746	
Income <€30.000	-.04726	.03520	-2.56737**	
Income >€40.000	-.04551	-.13306	2.68147**	
Children <6	-1.17712***	-1.63346***	-.39799	
Students and pupils	.02070	-.02845	-.07628	
Energy bill <€100	-.25602	-.20584	-116.723	
Energy bill >€100	.37166**	.28754	.97419	
Desired discount <€30	.70380***	1.06536***	-110.377	
Desired discount >€30	-.22261	.01381	-116.630	
No car	-.22176	-.34957	-102.061	
1 car	-.06828	-.26468	110.400	
No car available	-.05983	-.16065		
1 car available	.19394	.25921		
Interrelated iterations				
€50-100 * Age 26-35	-.12178	-.10705		

€100-150	*	Age 26-35	-.14990*	-.24715*	
EV doesn't charge 17:00-21:00	*	Age 26-35	.06368	.13650	
EV doesn't charge 5:00-21:00	*	Age 26-35	.12908	.18792	
Variation with indicated temp. +-1,5˚C	*	Age 26-35	-.02164	.01444	
Variation with indicated temp. +-2,5˚C	*	Age 26-35	-.04746	-.15956	
No household app. 17:00-21:00	*	Age 26-35	.18986**	.29489**	
No household app. 5:00-21:00	*	Age 26-35	-.03750	-.02364	
Cost = €96,-/year	*	Age 26-35	-.11441	-.09872	
Cost = €48,-/year	*	Age 26-35	.11781	.20345	
1 year contract	*	Age 26-35	.15217*	.11634	
3 year contract	*	Age 26-35	-.22459**	-.20557	
€50-100	*	Age >35	.10151	.14886	
€100-150	*	Age >35	.07984	.09716	
EV doesn't charge 17:00-21:00	*	Age >35	.11576	.10890	
EV doesn't charge 5:00-21:00	*	Age >35	-.10262	-.12267	
Variation with indicated temp. +-1,5˚C	*	Age >35	-.11995	-.19179	
Variation with indicated temp. +-2,5˚C	*	Age >35	.20673**	.40251**	
No household app. 17:00-21:00	*	Age >35	-.20113**	-.25779*	
No household app. 5:00-21:00	*	Age >35	.00138	-.03984	
Cost = €96,-/year	*	Age >35	.04845	.04185	
Cost = €48,-/year	*	Age >35	-.07210	-.12327	
1 year contract	*	Age >35	-.01808	.08296	
3 year contract	*	Age >35	.12360	.09873	
€50-100	*	Rent excl. elect.	-.07597	-.14043	
€100-150	*	Rent excl. elect.	.04110	.02685	
EV doesn't charge 17:00-21:00	*	Rent excl. elect.	.15567*	.17480	
EV doesn't charge 5:00-21:00	*	Rent excl. elect.	.03997	.08869	
Variation with indicated temp. +-1,5˚C	*	Rent excl. elect.	.03601	.08008	
Variation with indicated temp. +-2,5˚C	*	Rent excl. elect.	.03271	.02319	
No household app. 17:00-21:00	*	Rent excl. elect.	-.14465*	-.21524	
No household app. 5:00-21:00	*	Rent excl. elect.	.07400	.13648	
Cost = €96,-/year	*	Rent excl. elect.	-.09075	-.20406	
Cost = €48,-/year	*	Rent excl. elect.	-.03418	.02764	
1 year contract	*	Rent excl. elect.	.02689	.04039	
3 year contract	*	Rent excl. elect.	-.04829	-.12535	
€50-100	*	Bought house	.12276	.25918*	
€100-150	*	Bought house	.00095	.02915	
EV doesn't charge 17:00-21:00	*	Bought house	-.18814*	-.19079	
EV doesn't charge 5:00-21:00	*	Bought house	-.07068	-.09002	
Variation with indicated temp. +-1,5˚C	*	Bought house	.02805	.01057	
Variation with indicated temp. +-2,5˚C	*	Bought house	-.03501	-.03577	
No household app. 17:00-21:00	*	Bought house	.17964*	.34583**	
No household app. 5:00-21:00	*	Bought house	-.15002	-.23127	
Cost = €96,-/year	*	Bought house	-.06484	-.02567	
Cost = €48,-/year	*	Bought house	.11500	.17142	
1 year contract	*	Bought house	.05762	.00421	
3 year contract	*	Bought house	-.05696	.02279	
€50-100	*	Children <6	-.08764	-.16742	
€100-150	*	Children <6	-.18383**	-.33978**	
EV doesn't charge 17:00-21:00	*	Children <6	.11594	.16679	
EV doesn't charge 5:00-21:00	*	Children <6	-.02332	-.02952	
Variation with indicated temp. +-1,5˚C	*	Children <6	-.01869	-.04611	
Variation with indicated temp. +-2,5˚C	*	Children <6	-.04486	-.18362	
No household app. 17:00-21:00	*	Children <6	-.04977	-.07586	
No household app. 5:00-21:00	*	Children <6	.03321	.11693	
Cost = €96,-/year	*	Children <6	.08977	.11608	
Cost = €48,-/year	*	Children <6	-.11408	-.15602	
1 year contract	*	Children <6	.02321	.09275	
3 year contract	*	Children <6	-.04121	-.06963	
€50-100	*	Desired discount <€30	-.10351	-.17561	
€100-150	*	Desired discount <€30	.15447*	.24848	
EV doesn't charge 17:00-21:00	*	Desired discount <€30	.01845	.07273	
EV doesn't charge 5:00-21:00	*	Desired discount <€30	.09874	.13849	
Variation with indicated temp. +-1,5˚C	*	Desired discount <€30	-.07955	-.18669	
Variation with indicated temp. +-2,5˚C	*	Desired discount <€30	-.05183	-.11743	
No household app. 17:00-21:00	*	Desired discount <€30	-.02500	-.11903	

No household app. 5:00-21:00	*	Desired discount <€30	.04571	.09712	
Cost = €96,-/year	*	Desired discount <€30	-.18348*	-.29459*	
Cost = €48,-/year	*	Desired discount <€30	.19761**	.30295**	
1 year contract	*	Desired discount <€30	.03278	.03649	
3 year contract	*	Desired discount <€30	.01177	-.06011	
€50-100	*	Desired discount >€30	.08411	.11668	
€100-150	*	Desired discount >€30	-.10239	-.16235	
EV doesn't charge 17:00-21:00	*	Desired discount >€30	.04961	.02852	
EV doesn't charge 5:00-21:00	*	Desired discount >€30	-.09856	-.11773	
Variation with indicated temp. +-1,5˚C	*	Desired discount >€30	.12708	.31102**	
Variation with indicated temp. +-2,5˚C	*	Desired discount >€30	.06382	.05529	
No household app. 17:00-21:00	*	Desired discount >€30	-.10768	-.03345	
No household app. 5:00-21:00	*	Desired discount >€30	.15095*	.18816	
Cost = €96,-/year	*	Desired discount >€30	-.01376	.02448	
Cost = €48,-/year	*	Desired discount >€30	-.06458	-.10013	
1 year contract	*	Desired discount >€30	.07963	.08820	
3 year contract	*	Desired discount >€30	-.17266*	-.22118	

Input

ML

Code 1st analysis:

```
RPLOGIT
;Lhs=ANTWOORD
;CHOICES=PA,PB,NONE
;Rhs=PA,X1A,X1B,X2A,X2B,X3A,X3B,X4A,X4B,X5A,X5B,X6A,X6B,
GEN,AGE1,AGE2,PERS1,PERS2,HOUSE,BUY1,BUY2,AFF1,AFF2,INNOV1,INNOV2,INC1,INC2
,CHILD,STUD,BILL1,BILL2,DISC1,DISC2,CAR1,CAR2,AVAIL1,AVAIL2,EV
;FCN=PA(N),X1A(N),X1B(N),X2A(N),X2B(N),X3A(N),X3B(N),X4A(N),X4B(N),X5A(N),X
5B(N),X6A(N),X6B(N)
;pds=pds
?;alg=bfgs
;halton
;pts=10000
$
```

Code 2nd analysis

```
RPLOGIT
;Lhs=ANTWOORD
;CHOICES=PA,PB,NONE
;Rhs=PA,X1A,X1B,X2A,X2B,X3A,X3B,X4A,X4B,X5A,X5B,X6A,X6B,
GEN,AGE1,AGE2,PERS1,PERS2,HOUSE,BUY1,BUY2,AFF1,AFF2,INNOV1,INNOV2,INC1,INC2
,CHILD,STUD,BILL1,BILL2,DISC1,DISC2,CAR1,CAR2,AVAIL1,AVAIL2,
X1AXAG,X1BXAG,X2AXAG,X2BXAG,X3AXAG,X3BXAG,X4AXAG,X4BXAG,X5AXAG,X5BXAG,X6AXA
G,X6BXAG,X60,X61,X62,X63,X64,X65,X66,X67,X68,X69,
X70,X71,X1AXBU,X1BXBU,X2AXBU,X2BXBU,X3AXBU,X3BXBU,X4AXBU,X4BXBU,X5AXBU,X5BX
BU,X6AXBU,X6BXBU,X84,X85,X86,X87,X88,X89,X90,X91,
X92,X93,X94,X95,X1AXCH,X1BXCH,X2AXCH,X2BXCH,X3AXCH,X3BXCH,X4AXCH,X4BXCH,X5A
XCH,X5BXCH,X6AXCH,X6BXCH,X1AXDI,X1BXDI,X2AXDI,X2BXDI,
X3AXDI,X3BXDI,X4AXDI,X4BXDI,X5AXDI,X5BXDI,X6AXDI,X6BXDI,X120,X121,X122,X123
,X124,X125,X126,X127,X128,X129,X130,X131
;FCN=PA(N),X1A(N),X1B(N),X2A(N),X2B(N),X3A(N),X3B(N),X4A(N),X4B(N),X5A(N),X
5B(N),X6A(N),X6B(N)
;pds=pds
?;alg=bfgs
```

```
;halton
;pts=1000
$
```

LC

```
LCLOGIT
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;Choices=PA,PB,none
;rhs=PA,X1A,X1B,X2A,X2B,X3A,X3B,X4A,X4B,X5A,X5B,X6A,X6B
;Lcm=GEN,AGE1,AGE2,HOUSE,BUY1,BUY2,INC1,INC2,CHILD,STUD,BILL1
;pts=2
;pds=9
$


LCLOGIT
;lhs=antwoord
;Choices=PA,PB,none
;rhs=PA,X1A,X1B,X2A,X2B,X3A,X3B,X4A,X4B,X5A,X5B,X6A,X6B
;Lcm=GEN,AGE1,AGE2,HOUSE,BUY1,BUY2,INC1,INC2,CHILD,STUD,BILL1
;pts=3
;pds=9
$


LCLOGIT
;lhs=antwoord
;Choices=PA,PB,none
;rhs=PA,X1A,X1B,X2A,X2B,X3A,X3B,X4A,X4B,X5A,X5B,X6A,X6B
;Lcm=GEN,AGE1,AGE2,HOUSE,BUY1,BUY2,INC1,INC2,CHILD,STUD,BILL1
;pts=4
;pds=9
$


LCLOGIT
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;Choices=PA,PB,none
;rhs=PA,X1A,X1B,X2A,X2B,X3A,X3B,X4A,X4B,X5A,X5B,X6A,X6B
;Lcm=GEN,AGE1,AGE2,HOUSE,BUY1,BUY2,INC1,INC2,CHILD,STUD,BILL1
;pts=5
;pds=9
$
```

Output

MNL

	MNL	MNL+
	coeff.	coeff.
Main attributes		
X1A	.01307	.04089
X1B	.23878***	.31247***
X2A	-.10186*	-.13231*
X2B	-.18347***	-.18748***
X3A	.07629	.05424
X3B	-.13800**	-.11334
X4A	-.04989	-.02775
X4B	-.42160***	-.45522***
X5A	-.48964***	-.59828***
X5B	-.03795	.02431
X6A	.17936***	.22600***
X6B	-.70306***	-.79200***
Socio-demographic values		
GEN|	-.08322	
AGE1|	-.64244**	
AGE2|	.40450	
PERS1|	-.30466	
PERS2|	-.13392	
HOUSE|	-.38978	
BUY1|	-.47873*	
BUY2|	.46029	
AFF1|	.11066	
AFF2|	-.07577	
INNOV1|	-.17456	
INNOV2|	.12024	
INC1|	-.12799	
INC2|	-.03160	
CHILD|	-1.35395***	
STUD|	.03164	
BILL1|	-.21136	
BILL2|	.16025	
DISC1|	.87136***	
DISC2|	.07907	
CAR1|	-.17193	
CAR2|	-.41115	
AVAIL1|	-.32794	
AVAIL2|	.31843	

Interrelated iterations		
AGE1*X4A		.21478**
AGE1*X6A		.16611*
AGE1*X6B		-.22977**
AGE2*X3B		.20630**
AGE2*X4A		-.22351**
BUY1*X4A		-.14377*
BUY2*X2A		-.19347*
BUY2*X4A		.17767*
CHILD*X1B		-.16935**
DISC1*X1B		.17146*
DISC1*X5A		-.19230*
DISC1*X5B		.19889**
DISC2*X6B		-.17044*
Sample size	1710	1710
LL0	-1557.9359	-1557.9359
LLß	-1316.28012	-1383.18512
R^2	.1551	.1122
R^2 adjusted	.1423	.0827

With socio-demographics

```
Start values obtained using MNL model
Dependent variable              Choice
Log likelihood function     -1316.28012
Estimation based on N =    1710, K =  38
Inf.Cr.AIC  =    2708.6 AIC/N =    1.584
Model estimated: Apr 19, 2017, 22:39:38
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only  -1557.9359  .1551 .1423
Response data are given as ind. choices
Number of obs.=  1710, skipped    0 obs
--------+--------------------------------------------------------------------
        |                  Standard            Prob.      95% Confidence
ANTWOORD|  Coefficient       Error       z    |z|>Z*         Interval
--------+--------------------------------------------------------------------
      PA|     .20045***      .05330     3.76  .0002       .09598    .30492
     X1A|     .01307         .05370      .24  .8077     -.09218    .11832
     X1B|     .23878***      .05412     4.41  .0000      .13269    .34486
     X2A|   -.10186*         .05396    -1.89  .0590     -.20762    .00389
     X2B|   -.18347***       .05409    -3.39  .0007     -.28948   -.07746
     X3A|    .07629          .05415     1.41  .1589     -.02984    .18241
     X3B|   -.13800**        .05393    -2.56  .0105     -.24371   -.03229
     X4A|   -.04989          .05349     -.93  .3510     -.15472    .05494
     X4B|   -.42160***       .05614    -7.51  .0000     -.53164   -.31157
     X5A|   -.48964***       .05532    -8.85  .0000     -.59806   -.38122
     X5B|   -.03795          .05454     -.70  .4866     -.14484    .06894
     X6A|    .17936***       .05396     3.32  .0009      .07360    .28511
     X6B|   -.70306***       .05700   -12.33  .0000     -.81478   -.59134
     GEN|   -.14907          .11813    -1.26  .2070     -.38061    .08247
    AGE1|   -.49394***       .15302    -3.23  .0012     -.79386   -.19403
    AGE2|    .37576*         .20082     1.87  .0613     -.01785    .76937
   PERS1|   -.29392*         .17107    -1.72  .0858     -.62921    .04136
```

PERS2	-.07914	.19462	-.41	.6843	-.46059	.30230
HOUSE	-.25457*	.14544	-1.75	.0801	-.53963	.03049
BUY1	-.30261*	.17712	-1.71	.0875	-.64975	.04454
BUY2	.29069	.21681	1.34	.1800	-.13425	.71564
AFF1	-.02313	.15216	-.15	.8792	-.32135	.27509
AFF2	.11298	.17746	.64	.5244	-.23484	.46079
INNOV1	-.10655	.18907	-.56	.5731	-.47712	.26402
INNOV2	-.01620	.18195	-.09	.9291	-.37281	.34041
INC1	-.16981	.18724	-.91	.3644	-.53680	.19717
INC2	.09766	.19592	.50	.6181	-.28633	.48166
CHILD	-1.01201***	.15077	-6.71	.0000	-1.30753	-.71650
STUD	.06432	.11766	.55	.5846	-.16629	.29494
BILL1	-.30876*	.16356	-1.89	.0591	-.62933	.01181
BILL2	.26730	.19010	1.41	.1597	-.10529	.63989
DISC1	.59789***	.15923	3.75	.0002	.28580	.90997
DISC2	-.17717	.16598	-1.07	.2858	-.50249	.14815
CAR1	-.12419	.23977	-.52	.6045	-.59413	.34575
CAR2	-.19180	.15936	-1.20	.2287	-.50413	.12053
AVAIL1	-.26435	.22793	-1.16	.2461	-.71109	.18238
AVAIL2	.33824**	.16449	2.06	.0398	.01584	.66064
EV	-.65367***	.13974	-4.68	.0000	-.92756	-.37977

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

Line search at iteration 60 does not improve fn. Exiting optimization.

With interrelated attributes

```
Start values obtained using MNL model
Dependent variable                 Choice
Log likelihood function     -1268.82010
Estimation based on N =   1710, K = 121
Inf.Cr.AIC  =   2779.6 AIC/N =    1.626
Model estimated: May 03, 2017, 18:48:41
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only  -1557.9359  .1856 .1524
Response data are given as ind. choices
Number of obs.=  1710, skipped    0 obs
```

ANTWOORD	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
PA	.26508***	.05459	4.86	.0000	.15809	.37208
X1A	.05745	.06927	.83	.4069	-.07832	.19322
X1B	.32077***	.06847	4.69	.0000	.18658	.45496
X2A	-.13325*	.06851	-1.94	.0518	-.26753	.00104
X2B	-.20821***	.06960	-2.99	.0028	-.34463	-.07178
X3A	.06615	.06855	.96	.3346	-.06821	.20050
X3B	-.11320	.06886	-1.64	.1002	-.24817	.02176
X4A	-.04725	.06708	-.70	.4812	-.17873	.08422
X4B	-.45309***	.07234	-6.26	.0000	-.59487	-.31131
X5A	-.60551***	.07178	-8.44	.0000	-.74620	-.46482
X5B	.03628	.07046	.51	.6066	-.10182	.17438
X6A	.22903***	.06968	3.29	.0010	.09247	.36559
X6B	-.79750***	.07411	-10.76	.0000	-.94276	-.65224
GEN	-.06886	.11227	-.61	.5396	-.28889	.15118
AGE1	-.43214***	.14949	-2.89	.0038	-.72513	-.13915
AGE2	.28577	.19433	1.47	.1414	-.09511	.66666
PERS1	-.12495	.16371	-.76	.4453	-.44583	.19592
PERS2	-.16010	.18698	-.86	.3919	-.52657	.20638
HOUSE	-.20764	.14002	-1.48	.1381	-.48207	.06679
BUY1	-.33382*	.17517	-1.91	.0567	-.67715	.00950
BUY2	.31798	.21675	1.47	.1424	-.10684	.74279
AFF1	-.09074	.14781	-.61	.5393	-.38045	.19897
AFF2	.00187	.17082	.01	.9912	-.33292	.33667
INNOV1	-.40386**	.17463	-2.31	.0207	-.74614	-.06159
INNOV2	.22735	.17172	1.32	.1855	-.10922	.56393

INC1	-.04726	.18015	-.26	.7931	-.40034	.30582
INC2	-.04551	.18722	-.24	.8080	-.41246	.32145
CHILD	-1.17712***	.14641	-8.04	.0000	-1.46408	-.89016
STUD	.02070	.11348	.18	.8553	-.20172	.24312
BILL1	-.25602	.15919	-1.61	.1078	-.56803	.05598
BILL2	.37166**	.18443	2.02	.0439	.01018	.73314
DISC1	.70380***	.15560	4.52	.0000	.39883	1.00877
DISC2	-.22261	.16554	-1.34	.1787	-.54707	.10184
CAR1	-.22176	.23087	-.96	.3368	-.67426	.23074
CAR2	-.06828	.15336	-.45	.6562	-.36887	.23231
AVAIL1	-.05983	.22060	-.27	.7862	-.49219	.37254
AVAIL2	.19394	.15832	1.22	.2206	-.11637	.50425
X1AXAG	-.12178	.08705	-1.40	.1618	-.29239	.04883
X1BXAG	-.14990*	.08844	-1.69	.0901	-.32324	.02344
X2AXAG	.06368	.08918	.71	.4752	-.11111	.23847
X2BXAG	.12908	.08951	1.44	.1493	-.04635	.30451
X3AXAG	-.02164	.08894	-.24	.8078	-.19595	.15268
X3BXAG	-.04746	.08787	-.54	.5891	-.21967	.12476
X4AXAG	.18986**	.08950	2.12	.0339	.01445	.36528
X4BXAG	-.03750	.09269	-.40	.6858	-.21916	.14417
X5AXAG	-.11441	.09287	-1.23	.2180	-.29644	.06762
X5BXAG	.11781	.09176	1.28	.1992	-.06203	.29764
X6AXAG	.15217*	.08776	1.73	.0829	-.01984	.32418
X6BXAG	-.22459**	.09587	-2.34	.0191	-.41249	-.03670
X60	.10151	.09324	1.09	.2763	-.08123	.28425
X61	.07984	.09238	.86	.3875	-.10123	.26091
X62	.11576	.09340	1.24	.2152	-.06729	.29881
X63	-.10262	.09576	-1.07	.2839	-.29031	.08507
X64	-.11995	.09260	-1.30	.1952	-.30144	.06155
X65	.20673**	.09151	2.26	.0239	.02738	.38608
X66	-.20113**	.09420	-2.14	.0327	-.38575	-.01651
X67	.00138	.09804	.01	.9888	-.19078	.19355
X68	.04845	.09676	.50	.6166	-.14120	.23810
X69	-.07210	.09547	-.76	.4501	-.25922	.11502
X70	-.01808	.09239	-.20	.8448	-.19917	.16300
X71	.12360	.09751	1.27	.2050	-.06752	.31471
X1AXBU	-.07597	.08587	-.88	.3763	-.24427	.09233
X1BXBU	.04110	.08686	.47	.6361	-.12915	.21134
X2AXBU	.15567*	.08722	1.78	.0743	-.01528	.32662
X2BXBU	.03997	.08999	.44	.6569	-.13640	.21635
X3AXBU	.03601	.08834	.41	.6836	-.13714	.20915
X3BXBU	.03271	.08783	.37	.7096	-.13943	.20484
X4AXBU	-.14465*	.08551	-1.69	.0907	-.31225	.02295
X4BXBU	.07400	.08944	.83	.4080	-.10130	.24929
X5AXBU	-.09075	.08998	-1.01	.3132	-.26711	.08561
X5BXBU	-.03418	.08792	-.39	.6974	-.20651	.13814
X6AXBU	.02689	.08665	.31	.7563	-.14295	.19673
X6BXBU	-.04829	.09217	-.52	.6003	-.22894	.13236
X84	.12276	.10434	1.18	.2394	-.08174	.32726
X85	.00095	.10080	.01	.9925	-.19661	.19851
X86	-.18814*	.10202	-1.84	.0652	-.38810	.01181
X87	-.07068	.10423	-.68	.4977	-.27497	.13360
X88	.02805	.10131	.28	.7819	-.17052	.22662
X89	-.03501	.10036	-.35	.7272	-.23171	.16169
X90	.17964*	.09805	1.83	.0669	-.01254	.37182
X91	-.15002	.10665	-1.41	.1595	-.35904	.05901
X92	-.06484	.10461	-.62	.5354	-.26988	.14020
X93	.11500	.10732	1.07	.2839	-.09534	.32535
X94	.05762	.10174	.57	.5711	-.14178	.25703
X95	-.05696	.10883	-.52	.6007	-.27027	.15635
X1AXCH	-.08764	.08332	-1.05	.2929	-.25094	.07566
X1BXCH	-.18383**	.08578	-2.14	.0321	-.35196	-.01571
X2AXCH	.11594	.08568	1.35	.1760	-.05199	.28387
X2BXCH	-.02332	.08344	-.28	.7799	-.18687	.14022
X3AXCH	-.01869	.08558	-.22	.8271	-.18642	.14903
X3BXCH	-.04486	.08638	-.52	.6035	-.21417	.12445
X4AXCH	-.04977	.08423	-.59	.5546	-.21486	.11531
X4BXCH	.03321	.08771	.38	.7049	-.13869	.20511
X5AXCH	.08977	.08649	1.04	.2993	-.07974	.25928
X5BXCH	-.11408	.08266	-1.38	.1676	-.27610	.04794
X6AXCH	.02321	.08495	.27	.7847	-.14329	.18971
X6BXCH	-.04121	.08888	-.46	.6429	-.21542	.13300
X1AXDI	-.10351	.09454	-1.09	.2736	-.28881	.08179
X1BXDI	.15447*	.09388	1.65	.0999	-.02953	.33847
X2AXDI	.01845	.09221	.20	.8414	-.16228	.19919
X2BXDI	.09874	.09492	1.04	.2982	-.08730	.28479
X3AXDI	-.07955	.09625	-.83	.4085	-.26821	.10910

X3BXDI	-.05183	.09483	-.55	.5847	-.23769	.13404
X4AXDI	-.02500	.09325	-.27	.7886	-.20777	.15776
X4BXDI	.04571	.10023	.46	.6484	-.15075	.24216
X5AXDI	-.18348*	.09815	-1.87	.0616	-.37586	.00890
X5BXDI	.19761**	.09370	2.11	.0349	.01396	.38126
X6AXDI	.03278	.09362	.35	.7262	-.15072	.21628
X6BXDI	.01177	.09834	.12	.9047	-.18096	.20451
X120	.08411	.08443	1.00	.3191	-.08136	.24958
X121	-.10239	.08462	-1.21	.2263	-.26824	.06346
X122	.04961	.08366	.59	.5532	-.11436	.21359
X123	-.09856	.08340	-1.18	.2373	-.26203	.06490
X124	.12708	.08480	1.50	.1340	-.03913	.29329
X125	.06382	.08384	.76	.4466	-.10051	.22815
X126	-.10768	.08639	-1.25	.2126	-.27700	.06164
X127	.15095*	.08877	1.70	.0891	-.02305	.32494
X128	-.01376	.08719	-.16	.8746	-.18464	.15712
X129	-.06458	.08500	-.76	.4474	-.23118	.10201
X130	.07963	.08369	.95	.3414	-.08440	.24367
X131	-.17266*	.08954	-1.93	.0538	-.34816	.00285

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

Maximum of 100 iterations. Exit iterations with status=1.

ML

With socio-demographics

```
Random Parameters Logit Model
Dependent variable              ANTWOORD
Log likelihood function      -1231.80359
Restricted log likelihood    -1878.62701
Chi squared [  51 d.f.]       1293.64684
Significance level                .00000
McFadden Pseudo R-squared       .3443065
Estimation based on N =    1710, K =  51
Inf.Cr.AIC  =    2565.6 AIC/N =    1.500
Model estimated: Apr 20, 2017, 09:40:26
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
No coefficients -1878.6270  .3443 .3344
Constants only  -1557.9359  .2093 .1974
At start values -1316.2801  .0642 .0500
Response data are given as ind. choices
Replications for simulated probs. =****
Used Halton sequences in simulations.
RPL model with panel has     190 groups
Variable number of obs./group =PDS
Number of obs.=  1710, skipped    0 obs
```

ANTWOORD	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
	Random parameters in utility functions					
PA	.21878**	.10532	2.08	.0378	.01236	.42519
X1A	.01004	.07973	.13	.8998	-.14623	.16630
X1B	.39920***	.09920	4.02	.0001	.20477	.59363
X2A	-.14782	.09096	-1.63	.1042	-.32610	.03046
X2B	-.31780***	.08802	-3.61	.0003	-.49032	-.14529
X3A	.10282	.08169	1.26	.2082	-.05729	.26294
X3B	-.20976**	.09675	-2.17	.0302	-.39938	-.02013
X4A	-.10164	.08478	-1.20	.2306	-.26781	.06452
X4B	-.62496***	.10070	-6.21	.0000	-.82234	-.42759
X5A	-.80564***	.10953	-7.36	.0000	-1.02031	-.59098
X5B	-.01706	.08101	-.21	.8332	-.17583	.14171
X6A	.28144***	.08240	3.42	.0006	.11994	.44294
X6B	-1.09781***	.11710	-9.37	.0000	-1.32733	-.86830
	Nonrandom parameters in utility functions					
GEN	-.08322	.18520	-.45	.6532	-.44619	.27976
AGE1	-.64244**	.25719	-2.50	.0125	-1.14651	-.13837
AGE2	.40450	.32446	1.25	.2125	-.23143	1.04043
PERS1	-.30466	.26936	-1.13	.2580	-.83259	.22327
PERS2	-.13392	.30118	-.44	.6566	-.72422	.45638
HOUSE	-.38978	.25299	-1.54	.1234	-.88563	.10606
BUY1	-.47873*	.27442	-1.74	.0811	-1.01657	.05912
BUY2	.46029	.34192	1.35	.1782	-.20985	1.13043
AFF1	.11066	.24509	.45	.6516	-.36972	.59103
AFF2	-.07577	.28691	-.26	.7917	-.63810	.48655
INNOV1	-.17456	.30167	-.58	.5628	-.76581	.41670
INNOV2	.12024	.28246	.43	.6703	-.43338	.67386
INC1	-.12799	.29520	-.43	.6646	-.70657	.45059
INC2	-.03160	.31155	-.10	.9192	-.64223	.57904
CHILD	-1.35395***	.24559	-5.51	.0000	-1.83529	-.87261
STUD	.03164	.19121	.17	.8686	-.34312	.40641
BILL1	-.21136	.26492	-.80	.4250	-.73059	.30788
BILL2	.16025	.30442	.53	.5986	-.43640	.75690
DISC1	.87136***	.25756	3.38	.0007	.36655	1.37617
DISC2	.07907	.28022	.28	.7778	-.47016	.62830
CAR1	-.17193	.38674	-.44	.6566	-.92992	.58607
CAR2	-.41115	.25439	-1.62	.1060	-.90973	.08744
AVAIL1	-.32794	.36366	-.90	.3672	-1.04069	.38482
AVAIL2	.31843	.25532	1.25	.2123	-.18198	.81885
EV	-.75395***	.23243	-3.24	.0012	-1.20951	-.29838
	Distns. of RPs. Std.Devs or limits of triangular					
NsPA	.87426***	.10555	8.28	.0000	.66738	1.08113
NsX1A	.00096	.17626	.01	.9957	-.34450	.34642
NsX1B	.68039***	.13300	5.12	.0000	.41971	.94106
NsX2A	.56408***	.14028	4.02	.0001	.28914	.83902
NsX2B	.41479***	.15648	2.65	.0080	.10809	.72150
NsX3A	.13610	.36581	.37	.7099	-.58087	.85307
NsX3B	.71597***	.12484	5.73	.0000	.47128	.96066
NsX4A	.32552	.19844	1.64	.1009	-.06340	.71445
NsX4B	.63336***	.13189	4.80	.0000	.37486	.89185
NsX5A	.77610***	.12873	6.03	.0000	.52379	1.02840
NsX5B	.04342	.21766	.20	.8419	-.38318	.47003
NsX6A	.24937	.24200	1.03	.3028	-.22493	.72367
NsX6B	.77492***	.12678	6.11	.0000	.52644	1.02340

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

With interrelated attributes

```
Random Parameters Logit Model
Dependent variable               ANTWOORD
Log likelihood function       -1186.66258
Restricted log likelihood     -1878.62701
Chi squared [ 134 d.f.]        1383.92887
Significance level                 .00000
McFadden Pseudo R-squared        .3683352
Estimation based on N =   1710, K = 134
Inf.Cr.AIC  =   2641.3 AIC/N =    1.545
Model estimated: May 03, 2017, 22:14:17
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
No coefficients -1878.6270  .3683 .3426
Constants only  -1557.9359  .2383 .2073
At start values -1268.8201  .0648 .0266
Response data are given as ind. choices
Replications for simulated probs. =1000
Used Halton sequences in simulations.
RPL model with panel has     190 groups
Variable number of obs./group =PDS
Number of obs.=  1710, skipped    0 obs
```

ANTWOORD	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
	Random parameters in utility functions					
PA	.31423***	.10883	2.89	.0039	.10092	.52754
X1A	.12970	.10245	1.27	.2055	-.07109	.33049
X1B	.53693***	.12157	4.42	.0000	.29865	.77520
X2A	-.17237	.11063	-1.56	.1192	-.38920	.04446
X2B	-.32137***	.11063	-2.91	.0037	-.53819	-.10455
X3A	.08475	.10221	.83	.4070	-.11557	.28508
X3B	-.18021	.12264	-1.47	.1417	-.42058	.06017
X4A	-.05985	.10436	-.57	.5663	-.26439	.14468
X4B	-.67426***	.12543	-5.38	.0000	-.92010	-.42841
X5A	-.91743***	.13428	-6.83	.0000	-1.18062	-.65425
X5B	.11050	.10375	1.07	.2869	-.09285	.31384
X6A	.33061***	.10683	3.09	.0020	.12122	.54000
X6B	-1.18828***	.14300	-8.31	.0000	-1.46856	-.90800
	Nonrandom parameters in utility functions					
GEN	-.01780	.18248	-.10	.9223	-.37546	.33986
AGE1	-.51818**	.25978	-1.99	.0461	-1.02734	-.00901
AGE2	.27460	.33115	.83	.4070	-.37445	.92365
PERS1	-.16925	.26783	-.63	.5274	-.69420	.35569
PERS2	-.20474	.30608	-.67	.5035	-.80465	.39516
HOUSE	-.32882	.25120	-1.31	.1905	-.82117	.16353
BUY1	-.43546	.27358	-1.59	.1115	-.97168	.10076
BUY2	.37056	.34691	1.07	.2854	-.30936	1.05048
AFF1	.07709	.24500	.31	.7530	-.40309	.55728
AFF2	-.23786	.29314	-.81	.4171	-.81241	.33669
INNOV1	-.44221	.29268	-1.51	.1308	-1.01585	.13144
INNOV2	.34335	.27845	1.23	.2175	-.20240	.88911
INC1	.03520	.29197	.12	.9040	-.53705	.60745
INC2	-.13306	.30568	-.44	.6633	-.73218	.46605
CHILD	-1.63346***	.24363	-6.70	.0000	-2.11096	-1.15596
STUD	-.02845	.19183	-.15	.8821	-.40444	.34754
BILL1	-.20584	.26737	-.77	.4414	-.72988	.31819
BILL2	.28754	.30670	.94	.3485	-.31359	.88866

DISC1|	1.06536***	.26130	4.08	.0000	.55322	1.57750
DISC2|	.01381	.28363	.05	.9612	-.54210	.56972
CAR1|	-.34957	.38889	-.90	.3687	-1.11179	.41264
CAR2|	-.26468	.25250	-1.05	.2945	-.75957	.23020
AVAIL1|	-.16065	.36596	-.44	.6607	-.87791	.55662
AVAIL2|	.25921	.25487	1.02	.3091	-.24032	.75874
X1AXAG|	-.10705	.12782	-.84	.4023	-.35756	.14347
X1BXAG|	-.24715*	.14888	-1.66	.0969	-.53895	.04464
X2AXAG|	.13650	.14154	.96	.3348	-.14091	.41392
X2BXAG|	.18792	.14050	1.34	.1811	-.08746	.46330
X3AXAG|	.01444	.13207	.11	.9130	-.24443	.27330
X3BXAG|	-.15956	.15940	-1.00	.3168	-.47197	.15285
X4AXAG|	.29489**	.13656	2.16	.0308	.02723	.56255
X4BXAG|	-.02364	.15472	-.15	.8786	-.32687	.27960
X5AXAG|	-.09872	.16069	-.61	.5390	-.41366	.21623
X5BXAG|	.20345	.13323	1.53	.1267	-.05767	.46457
X6AXAG|	.11634	.13247	.88	.3798	-.14330	.37598
X6BXAG|	-.20557	.16428	-1.25	.2108	-.52755	.11641
X60|	.14886	.13745	1.08	.2788	-.12054	.41825
X61|	.09716	.15763	.62	.5376	-.21178	.40610
X62|	.10890	.15055	.72	.4695	-.18618	.40397
X63|	-.12267	.15248	-.80	.4211	-.42153	.17618
X64|	-.19179	.13855	-1.38	.1663	-.46335	.07977
X65|	.40251**	.16993	2.37	.0179	.06945	.73557
X66|	-.25779*	.14556	-1.77	.0766	-.54309	.02751
X67|	-.03984	.16267	-.24	.8065	-.35868	.27899
X68|	.04185	.17235	.24	.8081	-.29596	.37966
X69|	-.12327	.13999	-.88	.3786	-.39765	.15111
X70|	.08296	.14303	.58	.5619	-.19738	.36331
X71|	.09873	.16876	.59	.5585	-.23203	.42950
X1AXBU|	-.14043	.12697	-1.11	.2687	-.38928	.10842
X1BXBU|	.02685	.14689	.18	.8550	-.26105	.31476
X2AXBU|	.17480	.14166	1.23	.2172	-.10285	.45245
X2BXBU|	.08869	.14050	.63	.5279	-.18669	.36407
X3AXBU|	.08008	.13250	.60	.5456	-.17960	.33977
X3BXBU|	.02319	.15471	.15	.8809	-.28004	.32641
X4AXBU|	-.21524	.13312	-1.62	.1059	-.47615	.04567
X4BXBU|	.13648	.15118	.90	.3667	-.15984	.43279
X5AXBU|	-.20406	.15961	-1.28	.2011	-.51688	.10876
X5BXBU|	.02764	.12950	.21	.8310	-.22619	.28146
X6AXBU|	.04039	.13234	.31	.7602	-.21898	.29977
X6BXBU|	-.12535	.16220	-.77	.4396	-.44326	.19255
X84|	.25918*	.15740	1.65	.0996	-.04932	.56768
X85|	.02915	.16948	.17	.8635	-.30303	.36133
X86|	-.19079	.16472	-1.16	.2468	-.51364	.13206
X87|	-.09002	.16330	-.55	.5815	-.41008	.23004
X88|	.01057	.15094	.07	.9442	-.28527	.30640
X89|	-.03577	.18078	-.20	.8432	-.39009	.31856
X90|	.34583**	.15466	2.24	.0253	.04270	.64897
X91|	-.23127	.17950	-1.29	.1976	-.58309	.12054
X92|	-.02567	.18386	-.14	.8890	-.38603	.33469
X93|	.17142	.15773	1.09	.2771	-.13773	.48057
X94|	.00421	.15609	.03	.9785	-.30172	.31014
X95|	.02279	.18880	.12	.9039	-.34726	.39284
X1AXCH|	-.16742	.12236	-1.37	.1712	-.40724	.07240
X1BXCH|	-.33978**	.14787	-2.30	.0216	-.62961	-.04995
X2AXCH|	.16679	.13809	1.21	.2271	-.10386	.43745
X2BXCH|	-.02952	.12903	-.23	.8190	-.28241	.22337
X3AXCH|	-.04611	.12810	-.36	.7189	-.29719	.20496
X3BXCH|	-.18362	.15453	-1.19	.2348	-.48650	.11926
X4AXCH|	-.07586	.12907	-.59	.5567	-.32883	.17710

X4BXCH	.11693	.14929	.78	.4335	-.17567	.40954
X5AXCH	.11608	.14977	.78	.4383	-.17747	.40963
X5BXCH	-.15602	.12129	-1.29	.1983	-.39373	.08170
X6AXCH	.09275	.12882	.72	.4715	-.15972	.34523
X6BXCH	-.06963	.15513	-.45	.6535	-.37368	.23442
X1AXDI	-.17561	.13965	-1.26	.2086	-.44932	.09810
X1BXDI	.24848	.15921	1.56	.1186	-.06357	.56052
X2AXDI	.07273	.15034	.48	.6285	-.22193	.36740
X2BXDI	.13849	.15062	.92	.3578	-.15672	.43370
X3AXDI	-.18669	.14411	-1.30	.1952	-.46913	.09576
X3BXDI	-.11743	.16720	-.70	.4825	-.44513	.21027
X4AXDI	-.11903	.14606	-.81	.4151	-.40530	.16724
X4BXDI	.09712	.16843	.58	.5642	-.23300	.42723
X5AXDI	-.29459*	.17650	-1.67	.0951	-.64053	.05136
X5BXDI	.30295**	.14151	2.14	.0323	.02560	.58030
X6AXDI	.03649	.14259	.26	.7980	-.24299	.31596
X6BXDI	-.06011	.17465	-.34	.7307	-.40242	.28221
X120	.11668	.12272	.95	.3417	-.12385	.35720
X121	-.16235	.14248	-1.14	.2545	-.44159	.11690
X122	.02852	.13299	.21	.8302	-.23213	.28918
X123	-.11773	.13051	-.90	.3670	-.37354	.13807
X124	.31102**	.12878	2.42	.0157	.05862	.56342
X125	.05529	.14839	.37	.7094	-.23554	.34613
X126	-.03345	.13085	-.26	.7982	-.28992	.22301
X127	.18816	.14765	1.27	.2025	-.10122	.47754
X128	.02448	.15407	.16	.8737	-.27750	.32646
X129	-.10013	.12487	-.80	.4226	-.34487	.14460
X130	.08820	.12699	.69	.4873	-.16070	.33710
X131	-.22118	.15355	-1.44	.1497	-.52213	.07976
	Distns. of RPs. Std.Devs or limits of triangular					
NsPA	.92111***	.11566	7.96	.0000	.69442	1.14779
NsX1A	.00284	.18289	.02	.9876	-.35561	.36130
NsX1B	.62208***	.13699	4.54	.0000	.35358	.89058
NsX2A	.53864***	.15301	3.52	.0004	.23875	.83853
NsX2B	.40206**	.17626	2.28	.0225	.05659	.74752
NsX3A	.11889	.26228	.45	.6503	-.39516	.63295
NsX3B	.78313***	.13200	5.93	.0000	.52442	1.04183
NsX4A	.28984	.19131	1.52	.1298	-.08513	.66481
NsX4B	.64457***	.14692	4.39	.0000	.35661	.93252
NsX5A	.76671***	.13675	5.61	.0000	.49869	1.03474
NsX5B	.00013	.19029	.00	.9994	-.37282	.37309
NsX6A	.33889*	.18417	1.84	.0657	-.02207	.69986
NsX6B	.78394***	.13018	6.02	.0000	.52880	1.03908

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

LC

2-class model

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----------------------------------------------------------------------------
--
Latent Class Logit Model
Dependent variable              ANTWOORD
Log likelihood function      -1378.49146
Restricted log likelihood    -1878.62701
Chi squared [  38 d.f.]       1000.27111
Significance level                .00000
McFadden Pseudo R-squared       .2662240
Estimation based on N =   1710, K =  38
Inf.Cr.AIC  =   2833.0 AIC/N =    1.657
Model estimated: May 04, 2017, 13:45:32
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
No coefficients -1878.6270  .2662 .2580
Constants only  -1557.9359  .1152 .1052
At start values -1443.1810  .0448 .0341
Response data are given as ind. choices
Number of latent classes =             2
Average Class Probabilities
     .766  .234
LCM model with panel has     190 groups
Fixed number of obsrvs./group=         9
BHHH estimator used for asymp. variance
Number of obs.=  1710, skipped    0 obs
--------+-------------------------------------------------------------------
--
        |                  Standard            Prob.      95% Confidence
ANTWOORD|  Coefficient       Error       z    |z|>Z*         Interval
--------+-------------------------------------------------------------------
--
        |Utility parameters in latent class -->> 1
    PA|1|     .91658***      .05791    15.83  .0000      .80307   1.03009
   X1A|1|     .04754         .07783      .61  .5413     -.10500    .20008
   X1B|1|     .33502***      .06377     5.25  .0000      .21003    .46000
   X2A|1|    -.23779***      .06624    -3.59  .0003     -.36762   -.10797
   X2B|1|    -.21752***      .05751    -3.78  .0002     -.33024   -.10480
   X3A|1|     .19764***      .06644     2.97  .0029      .06742    .32785
   X3B|1|    -.27445***      .06006    -4.57  .0000     -.39216   -.15673
   X4A|1|    -.09888         .06489    -1.52  .1275     -.22607    .02830
   X4B|1|    -.54620***      .06416    -8.51  .0000     -.67195   -.42045
   X5A|1|    -.71059***      .06365   -11.16  .0000     -.83535   -.58583
   X5B|1|    -.01875         .06818     -.28  .7833     -.15237    .11487
   X6A|1|     .08453         .06869     1.23  .2185     -.05010    .21915
   X6B|1|    -.68393***      .06009   -11.38  .0000     -.80171   -.56616
        |Utility parameters in latent class -->> 2
    PA|2|     .17594**       .06948     2.53  .0113      .03975    .31212
   X1A|2|    -.05412         .17661     -.31  .7593     -.40028    .29203
   X1B|2|    -.04332         .16283     -.27  .7902     -.36247    .27583
   X2A|2|     .19697         .19070     1.03  .3017     -.17681    .57074
   X2B|2|    -.18582         .22284     -.83  .4044     -.62257    .25094
   X3A|2|    -.16636         .16997     -.98  .3277     -.49948    .16677
   X3B|2|     .15433         .19501      .79  .4287     -.22789    .53654
   X4A|2|     .10724         .14722      .73  .4664     -.18132    .39579
   X4B|2|    -.26005**       .13230    -1.97  .0493     -.51935   -.00075
   X5A|2|     .01163         .12432      .09  .9254     -.23202    .25529
   X5B|2|    -.13632         .16456     -.83  .4074     -.45884    .18621
   X6A|2|     .44575***      .13354     3.34  .0008      .18401    .70749
   X6B|2|   -1.00670***      .13031    -7.73  .0000    -1.26210   -.75130
```

```
        |This is THETA(01) in class probability model.
Constant|    4.24986**      1.85474     2.29  .0219      .61463   7.88509
   _GEN|1|   -1.26688*        .66967    -1.89  .0585    -2.57940    .04564
  _AGE1|1|   -2.62378**      1.29174    -2.03  .0422    -5.15554   -.09203
  _AGE2|1|    -.36829        1.05399     -.35  .7268    -2.43406   1.69748
_HOUSE|1|   -1.25459        1.06213    -1.18  .2375    -3.33632    .82714
  _BUY1|1|    1.90908*       1.08813     1.75  .0794     -.22361   4.04177
  _BUY2|1|   -2.05002**      1.03446    -1.98  .0475    -4.07752   -.02253
  _INC1|1|   -2.38808*       1.25804    -1.90  .0577    -4.85379    .07763
  _INC2|1|    2.84529***     1.09601     2.60  .0094      .69716   4.99343
_CHILD|1|    -.71988          .61405    -1.17  .2411    -1.92340    .48364
  _STUD|1|     .02877          .57087      .05  .9598    -1.09011   1.14764
_BILL1|1|   -1.78758        1.31739    -1.36  .1748    -4.36962    .79446
        |This is THETA(02) in class probability model.
Constant|        0.0    .....(Fixed Parameter).....
   _GEN|2|        0.0    .....(Fixed Parameter).....
  _AGE1|2|        0.0    .....(Fixed Parameter).....
  _AGE2|2|        0.0    .....(Fixed Parameter).....
_HOUSE|2|        0.0    .....(Fixed Parameter).....
  _BUY1|2|        0.0    .....(Fixed Parameter).....
  _BUY2|2|        0.0    .....(Fixed Parameter).....
  _INC1|2|        0.0    .....(Fixed Parameter).....
  _INC2|2|        0.0    .....(Fixed Parameter).....
_CHILD|2|        0.0    .....(Fixed Parameter).....
  _STUD|2|        0.0    .....(Fixed Parameter).....
_BILL1|2|        0.0    .....(Fixed Parameter).....
--------+-------------------------------------------------------------------
--
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
Fixed parameter ... is constrained to equal the value or
had a nonpositive st.error because of an earlier problem.
---------------------------------------------------------------------------
--
```

3 class model

```
-----------------------------------------------------------------------------
Latent Class Logit Model
Dependent variable              ANTWOORD
Log likelihood function      -1326.61375
Restricted log likelihood    -1878.62701
Chi squared [  65 d.f.]       1104.02652
Significance level                .00000
McFadden Pseudo R-squared       .2938387
Estimation based on N =   1710, K =  65
Inf.Cr.AIC  =   2783.2 AIC/N =    1.628
Model estimated: May 04, 2017, 13:46:14
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
No coefficients -1878.6270  .2938 .2802
Constants only  -1557.9359  .1485 .1320
At start values -1443.2106  .0808 .0630
Response data are given as ind. choices
Number of latent classes =            3
Average Class Probabilities
     .081  .179  .740
LCM model with panel has     190 groups
Fixed number of obsrvs./group=        9
BHHH estimator used for asymp. variance
Number of obs.=  1710, skipped    0 obs
```

ANTWOORD	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
	Utility parameters in latent class -->> 1					
PA|1|	1.57275	1.57807	1.00	.3189	-1.52022	4.66571
X1A|1|	-.95644	717330.8	.00	1.0000	***********	***********
X1B|1|	4.45158	.1435D+07	.00	1.0000	***********	***********
X2A|1|	-.97536	717330.8	.00	1.0000	***********	***********
X2B|1|	-3.78841	717329.8	.00	1.0000	***********	***********
X3A|1|	-1.65802	717330.0	.00	1.0000	***********	***********
X3B|1|	-2.83243	717330.3	.00	1.0000	***********	***********
X4A|1|	2.54666	717330.5	.00	1.0000	***********	***********
X4B|1|	-5.60748	.1435D+07	.00	1.0000	***********	***********
X5A|1|	2.39071	717330.2	.00	1.0000	***********	***********
X5B|1|	1.55503	717330.2	.00	1.0000	***********	***********
X6A|1|	1.24286	717331.2	.00	1.0000	***********	***********
X6B|1|	2.80288	717330.2	.00	1.0000	***********	***********
	Utility parameters in latent class -->> 2					
PA|2|	.07264	.10787	.67	.5007	-.13878	.28406
X1A|2|	-.11331	.30726	-.37	.7123	-.71552	.48890
X1B|2|	.00245	.21836	.01	.9910	-.42552	.43042
X2A|2|	.30574	.28981	1.05	.2914	-.26229	.87376
X2B|2|	-.24146	.31871	-.76	.4487	-.86611	.38320
X3A|2|	-.10745	.20426	-.53	.5989	-.50780	.29290
X3B|2|	.05590	.26770	.21	.8346	-.46878	.58059
X4A|2|	.17758	.24515	.72	.4688	-.30290	.65807
X4B|2|	-.15633	.19188	-.81	.4152	-.53240	.21974
X5A|2|	-.01117	.16188	-.07	.9450	-.32846	.30611
X5B|2|	-.20659	.21595	-.96	.3387	-.62984	.21666
X6A|2|	.40603**	.18358	2.21	.0270	.04622	.76583
X6B|2|	-.80957***	.18432	-4.39	.0000	-1.17083	-.44832
	Utility parameters in latent class -->> 3					
PA|3|	.90202***	.05733	15.73	.0000	.78965	1.01438
X1A|3|	.02788	.08475	.33	.7421	-.13822	.19399
X1B|3|	.28359***	.06543	4.33	.0000	.15535	.41183
X2A|3|	-.31550***	.07411	-4.26	.0000	-.46075	-.17025
X2B|3|	-.10618*	.06416	-1.66	.0979	-.23193	.01957
X3A|3|	.18185**	.07405	2.46	.0141	.03671	.32698
X3B|3|	-.15442**	.06300	-2.45	.0142	-.27789	-.03095
X4A|3|	-.17619**	.07048	-2.50	.0124	-.31434	-.03805
X4B|3|	-.43723***	.07329	-5.97	.0000	-.58087	-.29359
X5A|3|	-.75562***	.07871	-9.60	.0000	-.90989	-.60135

```
   X5B|3|     .00379         .07437      .05  .9593     -.14197    .14955
   X6A|3|     .20507***      .07254     2.83  .0047      .06290    .34724
   X6B|3|    -.93969***      .07271   -12.92  .0000    -1.08221   -.79718
        |This is THETA(01) in class probability model.
Constant|   -15.0599      .1236D+08      .00 1.0000 ***********  ***********
   _GEN|1|     .44927        1.26082      .36  .7216    -2.02190   2.92043
  _AGE1|1|    -.89007        2.51000     -.35  .7229    -5.80958   4.02945
  _AGE2|1|    3.32913        5.02395      .66  .5076    -6.51763  13.17588
 _HOUSE|1|   -2.23444        2.69133     -.83  .4064    -7.50935   3.04047
  _BUY1|1|    7.31223       .1218D+08      .00 1.0000 ***********  ***********
  _BUY2|1|    5.85262       .1218D+08      .00 1.0000 ***********  ***********
  _INC1|1|   -11.5689       .1078D+08      .00 1.0000 ***********  ***********
  _INC2|1|    5.22054       .5392D+07      .00 1.0000 ***********  ***********
 _CHILD|1|    -.24160        1.23795     -.20  .8453    -2.66794   2.18475
  _STUD|1|    -.00078        1.14582      .00  .9995    -2.24654   2.24498
 _BILL1|1|   -2.25680        1.44144    -1.57  .1174    -5.08197    .56837
 _BILL2|1|     .76013        1.65224      .46  .6455    -2.47821   3.99847
        |This is THETA(02) in class probability model.
Constant|   -7.60878*        4.03743    -1.88  .0595   -15.52200    .30444
   _GEN|2|    2.79042*       1.52552     1.83  .0674     -.19955   5.78038
  _AGE1|2|    3.04675*       1.82460     1.67  .0950     -.52939   6.62289
  _AGE2|2|     .31437        1.14244      .28  .7832    -1.92477   2.55352
 _HOUSE|2|     .98798        1.16731      .85  .3973    -1.29991   3.27587
  _BUY1|2|   -3.15362        1.95932    -1.61  .1075    -6.99382    .68658
  _BUY2|2|    3.52251**      1.78689     1.97  .0487      .02027   7.02475
  _INC1|2|    2.55105*       1.36254     1.87  .0612     -.11948   5.22158
  _INC2|2|   -3.35300***     1.22160    -2.74  .0061    -5.74729   -.95871
 _CHILD|2|    -.05338         .80890     -.07  .9474    -1.63879   1.53202
  _STUD|2|     .11754         .82072      .14  .8861    -1.49105   1.72612
 _BILL1|2|    2.78053        2.37407     1.17  .2415    -1.87257   7.43362
 _BILL2|2|    -.28017        2.75011     -.10  .9189    -5.67029   5.10995
        |This is THETA(03) in class probability model.
Constant|       0.0     .....(Fixed Parameter).....
   _GEN|3|       0.0     .....(Fixed Parameter).....
  _AGE1|3|       0.0     .....(Fixed Parameter).....
  _AGE2|3|       0.0     .....(Fixed Parameter).....
 _HOUSE|3|       0.0     .....(Fixed Parameter).....
  _BUY1|3|       0.0     .....(Fixed Parameter).....
  _BUY2|3|       0.0     .....(Fixed Parameter).....
  _INC1|3|       0.0     .....(Fixed Parameter).....
  _INC2|3|       0.0     .....(Fixed Parameter).....
 _CHILD|3|       0.0     .....(Fixed Parameter).....
  _STUD|3|       0.0     .....(Fixed Parameter).....
 _BILL1|3|       0.0     .....(Fixed Parameter).....
 _BILL2|3|       0.0     .....(Fixed Parameter).....
--------+--------------------------------------------------------------------
Note: nnnnn.D-xx or D+xx => multiply by 10 to -xx or +xx.
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
Fixed parameter ... is constrained to equal the value or
had a nonpositive st.error because of an earlier problem.
-----------------------------------------------------------------------------
```

4 class model

```
Latent Class Logit Model
Dependent variable               ANTWOORD
Log likelihood function       -1283.81663
Restricted log likelihood     -1878.62701
Chi squared [  88 d.f.]        1189.62077
Significance level                 .00000
McFadden Pseudo R-squared        .3166197
Estimation based on N =   1710, K =  88
Inf.Cr.AIC  =   2743.6 AIC/N =    1.604
Model estimated: May 04, 2017, 13:44:51
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
No coefficients -1878.6270  .3166 .2986
Constants only  -1557.9359  .1760 .1542
At start values -1443.2306  .1105 .0870
Response data are given as ind. choices
Number of latent classes =            4
Average Class Probabilities
     .065  .129  .066  .740
LCM model with panel has     190 groups
Fixed number of obsrvs./group=        9
BHHH estimator used for asymp. variance
Number of obs.=  1710, skipped    0 obs
```

ANTWOORD	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
	Utility parameters in latent class -->> 1					
PA|1|	5.36226	41.53996	.13	.8973	-76.05457	86.77910
X1A|1|	-.91429	19.92299	-.05	.9634	-39.96264	38.13405
X1B|1|	.72668	37.43084	.02	.9845	-72.63642	74.08979
X2A|1|	3.43859	32.43883	.11	.9156	-60.14035	67.01753
X2B|1|	-5.05281	28.98503	-.17	.8616	-61.86243	51.75681
X3A|1|	3.79500	35.44902	.11	.9147	-65.68380	73.27380
X3B|1|	-8.59818	56.33978	-.15	.8787	-119.02212	101.82577
X4A|1|	-1.34317	37.21328	-.04	.9712	-74.27986	71.59352
X4B|1|	-4.79825	35.73265	-.13	.8932	-74.83297	65.23646
X5A|1|	-4.06241	33.34160	-.12	.9030	-69.41074	61.28592
X5B|1|	2.74081	18.62142	.15	.8830	-33.75651	39.23813
X6A|1|	-.58423	18.09234	-.03	.9742	-36.04457	34.87611
X6B|1|	2.54210	31.25761	.08	.9352	-58.72168	63.80588
	Utility parameters in latent class -->> 2					
PA|2|	.95820**	.46921	2.04	.0411	.03858	1.87783
X1A|2|	.14298	.76327	.19	.8514	-1.35301	1.63897
X1B|2|	-.73640	.67862	-1.09	.2779	-2.06648	.59368
X2A|2|	.10918	.50814	.21	.8299	-.88676	1.10513
X2B|2|	-.30239	.50351	-.60	.5481	-1.28925	.68447
X3A|2|	-.35887	.68612	-.52	.6009	-1.70364	.98591
X3B|2|	.27101	.58417	.46	.6427	-.87395	1.41597
X4A|2|	.20390	.65174	.31	.7544	-1.07348	1.48127
X4B|2|	.31380	.98726	.32	.7506	-1.62120	2.24880
X5A|2|	-.04456	.64099	-.07	.9446	-1.30087	1.21176
X5B|2|	-.25010	.67365	-.37	.7104	-1.57044	1.07023
X6A|2|	1.29932**	.54760	2.37	.0177	.22604	2.37260
X6B|2|	-3.06479***	.83181	-3.68	.0002	-4.69511	-1.43446
	Utility parameters in latent class -->> 3					
PA|3|	-.60854	1.43030	-.43	.6705	-3.41187	2.19480
X1A|3|	-.45269	8.71949	-.05	.9586	-17.54257	16.63719
X1B|3|	.53667	3.49909	.15	.8781	-6.32143	7.39477
X2A|3|	.12419	5.57395	.02	.9822	-10.80056	11.04894
X2B|3|	-.32678	3.62064	-.09	.9281	-7.42311	6.76955
X3A|3|	.13586	1.79196	.08	.9396	-3.37631	3.64803
X3B|3|	.36666	3.57971	.10	.9184	-6.64945	7.38277
X4A|3|	-.56197	2.80461	-.20	.8412	-6.05892	4.93497
X4B|3|	-.10233	3.79264	-.03	.9785	-7.53577	7.33112
X5A|3|	.23125	2.61303	.09	.9295	-4.89020	5.35270
X5B|3|	.26412	3.74958	.07	.9438	-7.08492	7.61316
X6A|3|	.13149	3.25255	.04	.9678	-6.24339	6.50636
X6B|3|	-.64778	4.70347	-.14	.8905	-9.86642	8.57086
	Utility parameters in latent class -->> 4					
PA|4|	.82715***	.06174	13.40	.0000	.70614	.94816
X1A|4|	.11158	.08839	1.26	.2068	-.06167	.28482
X1B|4|	.34364***	.06798	5.05	.0000	.21040	.47689
X2A|4|	-.24445***	.07853	-3.11	.0019	-.39835	-.09054
X2B|4|	-.16519**	.06828	-2.42	.0155	-.29902	-.03137

```
   X3A|4|     .05647          .07777       .73  .4678      -.09595    .20889
   X3B|4|    -.09498          .07514     -1.26  .2062      -.24224    .05229
   X4A|4|    -.07271          .07319      -.99  .3205      -.21615    .07073
   X4B|4|    -.54811***       .06780     -8.08  .0000      -.68099   -.41522
   X5A|4|    -.74974***       .06758    -11.09  .0000      -.88219   -.61729
   X5B|4|    -.02283          .07305      -.31  .7546      -.16601    .12035
   X6A|4|     .08821          .07561      1.17  .2434      -.05999    .23640
   X6B|4|    -.68056***       .07749     -8.78  .0000      -.83244   -.52867
        |This is THETA(01) in class probability model.
Constant|   -2.81883         4.44891      -.63  .5263    -11.53853   5.90086
   _GEN|1|   -.37364         1.15928      -.32  .7472     -2.64580   1.89852
  _AGE1|1|   -.82559         3.81941      -.22  .8289     -8.31149   6.66031
  _AGE2|1|   2.14855         6.07068       .35  .7234     -9.74976  14.04687
 _HOUSE|1|  -1.12818         3.94272      -.29  .7748     -8.85577   6.59942
  _BUY1|1|    .49980         3.10511       .16  .8721     -5.58610   6.58571
  _BUY2|1|   -.47786         4.34129      -.11  .9124     -8.98663   8.03091
  _INC1|1|  -1.70200         5.87562      -.29  .7721    -13.21800   9.81399
  _INC2|1|    .82215         3.14095       .26  .7935     -5.33400   6.97831
 _CHILD|1|    .52623         1.60138       .33  .7424     -2.61241   3.66487
  _STUD|1|    .27069         1.63371       .17  .8684     -2.93131   3.47270
 _BILL1|1|    .87587         3.15230       .28  .7811     -5.30251   7.05426
        |This is THETA(02) in class probability model.
Constant|   -2.71645*        1.41502     -1.92  .0549     -5.48983    .05694
   _GEN|2|   -.14485          .58143      -.25  .8033     -1.28443    .99473
  _AGE1|2|    .31713          .77200       .41  .6812     -1.19596   1.83021
  _AGE2|2|   -.21502          .93137      -.23  .8174     -2.04046   1.61043
 _HOUSE|2|   -.11903          .64836      -.18  .8543     -1.38978   1.15173
  _BUY1|2|    .06827         1.09217       .06  .9502     -2.07235   2.20889
  _BUY2|2|   1.76554         1.35047      1.31  .1911      -.88133   4.41241
  _INC1|2|    .23335          .91682       .25  .7991     -1.56359   2.03029
  _INC2|2|  -1.23768         1.08233     -1.14  .2528     -3.35901    .88365
 _CHILD|2|    .36518         1.03147       .35  .7233     -1.65646   2.38683
  _STUD|2|    .33829          .68574       .49  .6218     -1.00572   1.68231
 _BILL1|2|   1.25269          .98544      1.27  .2037      -.67873   3.18412
        |This is THETA(03) in class probability model.
Constant|   -8.55455        42788.78       .00  .9998 ***********  83855.91570
   _GEN|3|   6.15751        42788.93       .00  .9999 ***********  83870.91957
  _AGE1|3|   1.28956         2.80185       .46  .6453     -4.20197   6.78108
  _AGE2|3|   -.20779         4.35047      -.05  .9619     -8.73455   8.31896
 _HOUSE|3|   -.37369         3.40482      -.11  .9126     -7.04701   6.29963
  _BUY1|3|   -.74261         5.10469      -.15  .8843    -10.74762   9.26240
  _BUY2|3|    .96628         6.30154       .15  .8781    -11.38450  13.31707
  _INC1|3|    .88268         4.72352       .19  .8518     -8.37526  10.14061
  _INC2|3|  -1.73519         3.23893      -.54  .5921     -8.08337   4.61300
 _CHILD|3|   1.84837         3.66331       .50  .6139     -5.33159   9.02832
  _STUD|3|    .35558         1.75886       .20  .8398     -3.09173   3.80289
 _BILL1|3|   1.18020         3.36243       .35  .7256     -5.41004   7.77044
        |This is THETA(04) in class probability model.
Constant|        0.0     .....(Fixed Parameter).....
   _GEN|4|       0.0     .....(Fixed Parameter).....
  _AGE1|4|       0.0     .....(Fixed Parameter).....
  _AGE2|4|       0.0     .....(Fixed Parameter).....
 _HOUSE|4|       0.0     .....(Fixed Parameter).....
  _BUY1|4|       0.0     .....(Fixed Parameter).....
  _BUY2|4|       0.0     .....(Fixed Parameter).....
  _INC1|4|       0.0     .....(Fixed Parameter).....
  _INC2|4|       0.0     .....(Fixed Parameter).....
 _CHILD|4|       0.0     .....(Fixed Parameter).....
  _STUD|4|       0.0     .....(Fixed Parameter).....
 _BILL1|4|       0.0     .....(Fixed Parameter).....
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Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
Fixed parameter ... is constrained to equal the value or
had a nonpositive st.error because of an earlier problem.
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5 class model

```
Latent Class Logit Model
Dependent variable              ANTWOORD
Log likelihood function      -1250.38542
Restricted log likelihood    -1878.62701
Chi squared [ 113 d.f.]       1256.48319
Significance level                .00000
McFadden Pseudo R-squared       .3344153
Estimation based on N =   1710, K = 113
Inf.Cr.AIC  =   2726.8 AIC/N =    1.595
Model estimated: May 04, 2017, 13:46:41
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
No coefficients -1878.6270  .3344 .3117
Constants only  -1557.9359  .1974 .1700
At start values -1443.2443  .1336 .1040
Response data are given as ind. choices
Number of latent classes =             5
Average Class Probabilities
     .049  .126  .051  .085  .689
LCM model with panel has     190 groups
Fixed number of obsrvs./group=         9
BHHH estimator used for asymp. variance
Number of obs.=  1710, skipped    0 obs
--------+------------------------------------------------------------
--
        |                  Standard            Prob.      95% Confidence
ANTWOORD|  Coefficient       Error       z    |z|>Z*         Interval
--------+------------------------------------------------------------
--
        |Utility parameters in latent class -->> 1
   PA|1|    3.99425       80.39110      .05  .9604  -153.56942  161.55792
  X1A|1|    -.84194       49.12152     -.02  .9863   -97.11834  95.43446
  X1B|1|     .28167       80.05648      .00  .9972  -156.62614  157.18948
  X2A|1|    1.78196       54.03541      .03  .9737  -104.12550  107.68941
  X2B|1|   -2.98151       90.06509     -.03  .9736  -179.50585  173.54283
  X3A|1|    2.34653       31.13750      .08  .9399   -58.68186  63.37491
  X3B|1|   -6.94937       113.0322     -.06  .9510  -228.48834  214.58961
  X4A|1|    -.66146       72.67239     -.01  .9927  -143.09673  141.77381
  X4B|1|   -2.79775       52.13181     -.05  .9572  -104.97422  99.37871
  X5A|1|   -3.50883       81.36026     -.04  .9656  -162.97202  155.95435
  X5B|1|    1.61149       98.52385      .02  .9870  -191.49171  194.71470
  X6A|1|     .56146       51.34670      .01  .9913  -100.07623  101.19915
  X6B|1|     .79444       41.74449      .02  .9848   -81.02326  82.61214
        |Utility parameters in latent class -->> 2
   PA|2|     .94751         .72641     1.30  .1921     -.47623   2.37126
  X1A|2|     .13586         .72071      .19  .8505    -1.27671   1.54844
  X1B|2|    -.76112         .76318    -1.00  .3186    -2.25693    .73469
  X2A|2|     .00234         .66659      .00  .9972    -1.30414   1.30883
  X2B|2|    -.37475         .65123     -.58  .5650    -1.65114    .90164
  X3A|2|    -.45868         .83127     -.55  .5811    -2.08794   1.17058
  X3B|2|     .32671         .60234      .54  .5875     -.85386   1.50728
  X4A|2|     .21128         .91031      .23  .8165    -1.57289   1.99545
  X4B|2|     .29151        1.26743      .23  .8181    -2.19260   2.77562
  X5A|2|     .01016         .76518      .01  .9894    -1.48956   1.50988
  X5B|2|    -.37362         .82046     -.46  .6488    -1.98169   1.23445
  X6A|2|    1.39346**       .56842     2.45  .0142      .27938   2.50753
  X6B|2|   -3.28800***      .98952    -3.32  .0009    -5.22743  -1.34857
        |Utility parameters in latent class -->> 3
   PA|3|    -.90912       17.40882     -.05  .9584   -35.02979  33.21154
  X1A|3|    -.67583       29.91625     -.02  .9820   -59.31060  57.95893
```

X1B|3|	.53886	12.20008	.04	.9648	-23.37286	24.45058
X2A|3|	-.11139	12.07157	-.01	.9926	-23.77123	23.54844
X2B|3|	-.12149	39.34998	.00	.9975	-77.24603	77.00304
X3A|3|	.09975	32.75069	.00	.9976	-64.09041	64.28992
X3B|3|	.24835	50.09150	.00	.9960	-97.92919	98.42589
X4A|3|	-1.23900	42.95075	-.03	.9770	-85.42092	82.94292
X4B|3|	.26774	58.19749	.00	.9963	-113.79724	114.33272
X5A|3|	.02024	41.87163	.00	.9996	-82.04664	82.08713
X5B|3|	.31825	51.97685	.01	.9951	-101.55451	102.19100
X6A|3|	.35183	32.26083	.01	.9913	-62.87823	63.58189
X6B|3|	-.69041	51.81073	-.01	.9894	-102.23756	100.85675
|Utility parameters in latent class -->> 4						
PA|4|	1.24394	1.15127	1.08	.2799	-1.01250	3.50039
X1A|4|	.16929	2.55017	.07	.9471	-4.82895	5.16752
X1B|4|	1.68841	4.51195	.37	.7082	-7.15484	10.53166
X2A|4|	-.22215	1.50802	-.15	.8829	-3.17781	2.73352
X2B|4|	-1.55876	2.89564	-.54	.5904	-7.23412	4.11660
X3A|4|	-.30909	2.88779	-.11	.9148	-5.96905	5.35087
X3B|4|	-.56624	1.78656	-.32	.7513	-4.06783	2.93536
X4A|4|	1.09643	1.78461	.61	.5390	-2.40133	4.59420
X4B|4|	-2.73339	2.25563	-1.21	.2256	-7.15434	1.68756
X5A|4|	.45109	1.82604	.25	.8049	-3.12788	4.03007
X5B|4|	.31775	1.91048	.17	.8679	-3.42672	4.06222
X6A|4|	-.02189	3.28956	-.01	.9947	-6.46932	6.42554
X6B|4|	.29280	1.12033	.26	.7938	-1.90302	2.48861
|Utility parameters in latent class -->> 5						
PA|5|	.83073***	.06765	12.28	.0000	.69815	.96332
X1A|5|	.08817	.10932	.81	.4199	-.12608	.30242
X1B|5|	.34034***	.07923	4.30	.0000	.18506	.49562
X2A|5|	-.18676**	.09406	-1.99	.0471	-.37112	-.00240
X2B|5|	-.08306	.08075	-1.03	.3037	-.24133	.07521
X3A|5|	.06849	.09110	.75	.4522	-.11007	.24704
X3B|5|	-.07975	.08938	-.89	.3723	-.25493	.09544
X4A|5|	-.13525	.08623	-1.57	.1168	-.30426	.03377
X4B|5|	-.45521***	.08102	-5.62	.0000	-.61400	-.29641
X5A|5|	-.83151***	.08079	-10.29	.0000	-.98986	-.67316
X5B|5|	-.00594	.08779	-.07	.9461	-.17800	.16613
X6A|5|	.10318	.08897	1.16	.2462	-.07120	.27756
X6B|5|	-.77550***	.08993	-8.62	.0000	-.95175	-.59925
|This is THETA(01) in class probability model.						
Constant|	-3.25921	7.88479	-.41	.6793	-18.71310	12.19469
_GEN|1|	-.58087	2.39326	-.24	.8082	-5.27158	4.10984
_AGE1|1|	-1.38114	12.03203	-.11	.9086	-24.96348	22.20119
_AGE2|1|	2.80919	13.86570	.20	.8394	-24.36708	29.98546
_HOUSE|1|	-1.27388	6.90009	-.18	.8535	-14.79781	12.25005
_BUY1|1|	-.45892	5.53943	-.08	.9340	-11.31601	10.39817
_BUY2|1|	-.95096	9.90332	-.10	.9235	-20.36111	18.45919
_INC1|1|	-.98309	5.55520	-.18	.8595	-11.87108	9.90489
_INC2|1|	1.09882	8.74679	.13	.9000	-16.04457	18.24222
_CHILD|1|	.53797	2.92611	.18	.8541	-5.19711	6.27305
_STUD|1|	-.34164	2.61054	-.13	.8959	-5.45820	4.77493
_BILL1|1|	1.36288	5.91695	.23	.8178	-10.23413	12.95989
|This is THETA(02) in class probability model.						
Constant|	-3.21569	2.90597	-1.11	.2685	-8.91128	2.47990
_GEN|2|	-.13731	.71726	-.19	.8482	-1.54312	1.26850
_AGE1|2|	.42662	1.08339	.39	.6937	-1.69679	2.55003
_AGE2|2|	.08656	1.31299	.07	.9474	-2.48684	2.65997
_HOUSE|2|	-.21200	1.10898	-.19	.8484	-2.38556	1.96156
_BUY1|2|	.38544	2.25923	.17	.8645	-4.04257	4.81345
_BUY2|2|	2.20371	2.31542	.95	.3412	-2.33443	6.74184
_INC1|2|	.29443	1.06591	.28	.7824	-1.79472	2.38358

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  _INC2|2|   -1.43190        1.27808    -1.12  .2626    -3.93689   1.07308
 _CHILD|2|     .12091        1.34456      .09  .9283    -2.51439   2.75621
  _STUD|2|     .15232         .90232      .17  .8659    -1.61619   1.92082
 _BILL1|2|    1.14678        1.67700      .68  .4941    -2.14008   4.43365
        |This is THETA(03) in class probability model.
Constant|   -5.42753       76.11359     -.07  .9432  -154.60743  143.75236
   _GEN|3|    2.51994       74.84053      .03  .9731  -144.16481  149.20470
  _AGE1|3|    1.37539        5.29375      .26  .7950    -9.00017  11.75095
  _AGE2|3|    -.59599        7.92485     -.08  .9401   -16.12841  14.93643
 _HOUSE|3|    -.32398        5.25843     -.06  .9509   -10.63032   9.98236
  _BUY1|3|    -.44848        7.99008     -.06  .9552   -16.10876  15.21180
  _BUY2|3|     .91315        9.55919      .10  .9239   -17.82251  19.64880
  _INC1|3|     .48998        8.21376      .06  .9524   -15.60870  16.58865
  _INC2|3|   -1.74764        5.99523     -.29  .7707   -13.49808  10.00281
 _CHILD|3|    1.72825        6.83073      .25  .8003   -11.65973  15.11623
  _STUD|3|     .39420        2.80457      .14  .8882    -5.10265   5.89106
 _BILL1|3|    1.56474        5.87354      .27  .7899    -9.94719  13.07668
        |This is THETA(04) in class probability model.
Constant|   -5.28511       125.9694     -.04  .9665  -252.18050  241.61028
   _GEN|4|     .24967        1.23044      .20  .8392    -2.16195   2.66128
  _AGE1|4|    1.56857       125.5099      .01  .9900  -244.42632  247.56347
  _AGE2|4|    3.35568       125.2455      .03  .9786  -242.12108  248.83244
 _HOUSE|4|    -.09514        1.33370     -.07  .9431    -2.70915   2.51886
  _BUY1|4|    1.25479        5.36956      .23  .8152    -9.26935  11.77893
  _BUY2|4|    -.09891        5.70093     -.02  .9862   -11.27252  11.07470
  _INC1|4|   -1.80013        4.62786     -.39  .6973   -10.87058   7.27031
  _INC2|4|    -.06660        2.55129     -.03  .9792    -5.06705   4.93384
 _CHILD|4|    -.05681        3.86496     -.01  .9883    -7.63199   7.51836
  _STUD|4|    -.27949        1.19360     -.23  .8149    -2.61891   2.05992
 _BILL1|4|     .63935        1.56876      .41  .6836    -2.43537   3.71407
        |This is THETA(05) in class probability model.
Constant|        0.0    .....(Fixed Parameter).....
   _GEN|5|        0.0    .....(Fixed Parameter).....
  _AGE1|5|        0.0    .....(Fixed Parameter).....
  _AGE2|5|        0.0    .....(Fixed Parameter).....
 _HOUSE|5|        0.0    .....(Fixed Parameter).....
  _BUY1|5|        0.0    .....(Fixed Parameter).....
  _BUY2|5|        0.0    .....(Fixed Parameter).....
  _INC1|5|        0.0    .....(Fixed Parameter).....
  _INC2|5|        0.0    .....(Fixed Parameter).....
 _CHILD|5|        0.0    .....(Fixed Parameter).....
  _STUD|5|        0.0    .....(Fixed Parameter).....
 _BILL1|5|        0.0    .....(Fixed Parameter).....
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Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
Fixed parameter ... is constrained to equal the value or
had a nonpositive st.error because of an earlier problem.
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