BACHELOR THESIS

Energy-smart home users

How do household roles differ regarding the barriers towards accepting Energy-Smart Homes perceived by potential users?

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14-06-2015

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Abstract

Diminishing energy resources and the transfer to renewable energy require reductions and more flexibility in energy consumption, in particular in the residential sector where inhabitants' behavior significantly influences a household's energy usage. *Energy-Smart Homes* offer an answer to these issues by addressing a home's energy efficiency and the residents' energy related behavior. However, a sound understanding is lacking of what kind of users would live with and use them. This qualitative study researched user types *Energy-Smart Homes* in the Netherlands using a user-centered approach and a persona technique. With sixteen semi-structured individual interviews with potential users, the differences between household roles regarding users' adoption barriers were inquired. The results suggest two personas and one anti-persona. The two personas with different technology roles and no to moderate energy roles are interested in simple to advanced energy-smart technologies. The anti-persona has no technology and a strong energy role, which makes her skeptical about such technology.

Samenvatting

Afnemende energiebronnen en de overgang naar duurzame energie vereisen reducties en meer flexibiliteit in het energiegebruik, in het bijzonder in de residentiële sector, waar het gedrag van de bewoners het huishoudelijke energieverbruik aanzienlijk beïnvloedt. *Energie-Smart Homes* bieden een antwoord op deze kwesties door de energie-efficiëntie van een huis en het energie-gerelateerde gedrag van de bewoners aan te pakken. Hierbij ontbreekt echter nog een goed begrip van het soort gebruikers dat zulke huizen zou bewonen en gebruiken. Deze kwalitatieve studie onderzocht gebruikertypes voor *Energie-Smart Homes* in Nederland met een gebruiker-gecentreerde aanpak en een persona-techniek. Met zestien semi-gestructureerde individuele interviews met potentiële gebruikers werden de verschillen tussen huishoudrollen met betrekking tot hun adoptie-barrières onderzocht. De resultaten suggereren twee personas en een anti-persona. De twee personas met verschillende technologie-rollen en geen tot matige energie-rollen zijn geïnteresseerd in eenvoudige tot geavanceerde energie-intelligente technologieën. De anti-persona heeft geen technologie-rol en een sterke energie-rol, wat haar sceptisch over dergelijke technologie maakt.

Content

1 Introduction

The demand for electricity continues to increase with population growth, expansion of electricity grids, development of electronic technologies, and rising living standards (Li, 2014; Masoodian et al., 2014), while the shrinkage of traditional energy resources impedes energy supply. Furthermore, traditional power plants can only generate a constant energy supply aligned to high peak demands, which is wasteful during non-peak times. The aging Dutch electricity infrastructure requires new solutions for future energy supply (Verbong, Beemsterboer, & Sengers, 2013), which present the opportunity to integrate modern technologies, such as renewable energy. However, renewable resources like wind tend to fluctuate unpredictably and endanger the stability of the electricity grid (Verbong et al., 2013). A reliable access to energy would require energy usage to be more sustainable and flexible. This can be achieved by shifting the current system where energy generation always follows changes in demand to a system in which the users' demand has to follow the generation of energy supply (Verbong et al., 2013). Such change would require more monitoring of energy flow and communicating to locally balance energy supply and demand, in order to ensure grid stability (Verbong et al., 2013).

Households in developed countries contribute largely to a country's energy usage by using about 30% of a countries total energy (Masoodian et al., 2014) and determine the local energy demand, which makes them an important target for such efforts. The energy usage of a given household arises from the house's devices as well as from the inhabitants' activities to meet their everyday needs, for example for cooking, heating, comfort and entertainment (Geelen, Reinders, & Keyson, 2013; Masoodian et al., 2014). As Figure 1.1 shows, a building's designed energy consumption can be significantly altered by unaware and careless energy use or by conservation activities. Other studies similarly show that 12-40% of a household's energy consumption is influenced by inhabitants' behavior (Geelen et al., 2013).

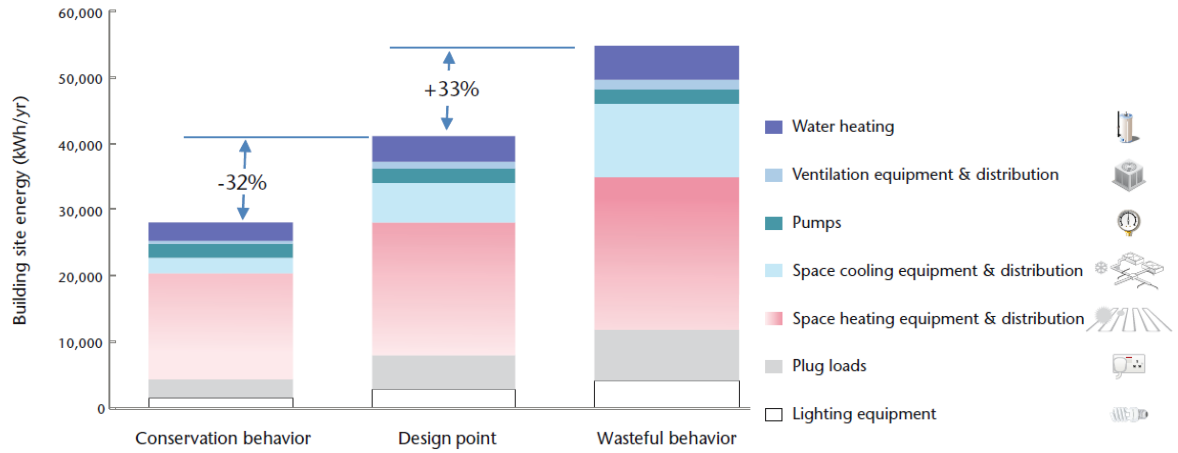


Figure 1.1. Impact of user behavior on residential site energy consumption. (WBCSD, 2009).

1.1 Energy-smart home technology

Modern home technologies offer a solution to the elaborated energy issues by addressing a home's energy efficiency and the residents' energy related behavior. The devices of a common home need to be controlled individually and manually, for example by pushing their buttons, which limits the possibilities to extensively manage energy (Balta-Ozkan, Davidson, Bicket, & Whitmarsh, 2013). When a home's technological components and their assembled information are linked to each other and to a management network, a home becomes smart and makes more options for household energy management available (Balta-Ozkan et al., 2013). Smart homes in general can serve various purposes such as enhanced security or assisted living for disabled people (Wilson, Hargreaves, & Hauxwell-Baldwin, 2014). Since this study focuses on smart home technology that regards the use of energy, the technological framework is accordingly defined as an 'energy-smart home'. The definition established for this study is composed based on several more fragmental definitions provided by Balta-Ozkan et al. (2013); Geelen et al. (2013); Paetz, Dütschke, and Fichtner (2012); and Wilson et al. (2014): An energy-smart home is a residence equipped with a selection of elements that serve the needs of the residents, assist the residents in reducing the household's energy demand, and enable the residents to participate in the management of the energy grid. However, although the home is referred to as smart it is not the building which should be perfectly smart, but the smart home should enable its inhabitants to live smarter.

1.1.1 Energy-smart home characteristics

The elements that form a smart home influence how the inhabitants experience their home. Depending on the composition an energy-smart home has different use properties, which can be described with three core characteristics that determine distinctive user experiences. These characteristics are the degree of automation, the extent to which technicalities are hidden from the user and who or what controls the smart home system. An automated system controls the home's devices to compensate for wasteful behavior of inhabitants, for example "automatically turning off the heating when windows are left open" (Masoodian et al., 2014, p. 519). Here, the system makes autonomous decisions on behalf of the user. A manual system on the other hand provides information about individual appliances and energy-saving potentials to the user, gives feedback about his consumption, and stimulates the user to change his behavior towards reducing his energy consumption (Masoodian et al., 2014). Such information shall support users to make more informed decisions (Wilson et al., 2014). In an automated home, complex technicalities are hidden so users do not need to understand the system (Rodden, Fischer, Pantidi, Bachour, & Moran, 2013). Also when the smart home's

functionalities are displayed indirectly via user interfaces that mimic the simple functionality of common homes to which the user is already used to, then the user needs less technical understanding. A smart home can be managed fully automatically, manually by its residents, or manually by a third party (a utility or a demand-side manager), and control can be given completely or only at given times (Paetz et al., 2012). This location of control influences how a user engages with his smart home and how dependent he is on the technology or a third party.

1.1.2 Energy-smart home components

The different smart home elements are, on the one hand, technologies such as sensors, smart devices, communication platforms and interfaces, or on the other hand, products and services such as remote monitoring and variable tariffs (Balta-Ozkan et al., 2013). Table 1.1 and 1.2 give an overview of recent findings from the literature about existing energy-smart home components and explain their function, respectively for the technologies and for the products or services. These tables also illustrate the user's involvement with each component as derived from the function of each component. This user role specifies the smart home-specific behavioral and cognitive efforts the user needs to make when interacting with a component. Table 1.1 and 1.2 show that more sophisticated technologies integrate more complex information, which allows for more extensive management of the home and offers more flexible options for its use. The tables show further that the user can be involved actively or passively. When the user interacts actively with a technology, he can react to this system (when he changes his behavior according to received information), the system can react to the user (when the home state is changed based on the user's input), or the system and the user can react to each other (when the user acts based on provided information, which results in new feedback from the system, to which the user reacts again). "User interactions with smart homes might therefore range from a one-off input of preferences for the domestic environment ('set and forget') to ongoing, repeated and adaptive decision-making and control" (Wilson et al., 2014).

Table 1.1

Energy-smart home technologies, their functions and the user's involvement

Technology	Function	User role
sensor network Ransing and Rajput	Sensors measure physiological parameters of the environment, like	The user is not actively involved.

(2015)	temperature, door openings or inhabitants' presence.	
smart meter Li (2014); Paetz et al. (2012); Rodden et al. (2013); Van Dam, Bakker, and Van Hal (2012)	A device records energy consumption and pricing, and automatically communicates this data between the user and the energy supplier(s).	The user monitors his energy consumption and adjusts his behavior based on the provided information and feedback. The user reacts to the system.
smart appliance Balta-Ozkan et al. (2013), Paetz et al. (2012)	An electrical household device operates automatically according to external signals about pricing, power supply or grid condition.	The user is not actively involved.
communication platform Bhide (2014), Li (2014), Ransing and Rajput (2015)	A wireless network enables autonomous information exchange between home devices and the internet (sometimes referred to as the Internet of Things).	The user is not actively involved.
automatic energy scheduling Carli and Dotoli (2014); Li (2014); Paetz et al. (2012); Pedrasa, Spooner, and MacGill (2010)	A system integrates data from smart meters to plan the optimal use of smart appliances in a predefined pattern according to variable tariffs (see below), while taking into account user preferences, such as a time when the washing machine should be ready or what task is more important.	When the system is completely pre-programmed, the user is not actively involved. Otherwise, the user monitors the overall energy state and operates an interface to input his preferences (his desired state of his home environment). Then the system reacts to the user.
autonomous software agent Corno and Razzak (2012); Kofler, Reinisch, and Kastner (2012); Lillis et al. (2015);	A system integrates technologies and information to manage the home appliances in an energy and cost saving pattern, while balancing their operations between system and user constraints and preferences. The system is partly	When the system is completely pre-programmed, the user is not actively involved. Otherwise, the user operates an interface to input his desired state of his home environment or to correct the

Mayer, Inhelder, Verborgh, Van de Walle, and Mattern (2014); Rodden et al. (2013); Sasidhar, Thomas, and Subeesh (2014); Shoji, Hirohashi, Fujimoto, and Hayashi (2014)	pre-programmed, capable of learning, and makes decision on behalf of the user or the energy provider. User interfaces follow the user's existing mental model of a home's way of working. The agent's service can range from passive personalized advice to active automatic appliance control.	system's way of operating. Then the system reacts to the user.

Table 1.2.

Energy-smart home products and services, their functions and the user's involvement

Product or service	Function	User role
remote monitoring and control Balta-Ozkan et al. (2013), Geelen et al. (2013), Masoodian et al. (2014), Van Dam et al. (2012)	An energy management system monitors and visualizes energy consumption data and manages home appliances energy and cost efficiently. Information is made visible through interactive displays.	The user operates an interface to gain insight into his energy consumption (usage and pricing) and to control his household devices based on the provided information. System and user react to each other.
variable energy tariffs Geelen et al. (2013), Paetz et al. (2012), Rodden et al. (2013), Verbong et al. (2013)	Energy prices are higher at peak demand times to reduce peak demand, which yields balance between energy demand and supply. By optimizing the use of generated energy, the whole grid works more efficiently.	The user adjusts his behavior based on the provided financial incentives. This adjustment means the shifting of energy demand towards non-peak periods. The user reacts to the system.

An example for a technology composition is a fully automated home. Here, the technology monitors, learns and predicts the users' preferences. Further, the technology has a programmed model about its environment which contains knowledge about the building, comfort parameters, household tasks, tariffs, weather conditions, the environmental impact of certain energy types, and how to manage electrical devices in an energy-and-cost-saving way

(Kofler et al., 2012). Users are seen as having erroneous wasteful behavior and "as having fixed and stable needs and preferences that homes, rather than the users themselves, can manage optimally" (Wilson et al., 2014, p. 6). Therefore an autonomous agent software makes decisions on behalf of its users to coordinate the home. The system can integrate users in two ways. On the one hand, user preferences can be pre-programmed into the system. On the other hand, users can model the desired state of their home environment graphically with a visual interface (Mayer et al., 2014).

1.2 Users

While the research field around smart homes in general is growing, it is dominated by technological approaches, which is why a good understanding of smart home users is lacking (Wilson et al., 2014). Past approaches towards influencing the energy related behavior of users typically treat them "as passive consumers rather than as co-providers" (Geelen et al., 2013, p. 152). However, as shown above energy users do not just use home technologies as intended by the designer, but fit them into their personal life and thereby influence energy consumption. This gap between design and actual use inhibits the spread of smart homes within the broader population (Wilson et al., 2014). A smart home has the potential to save up to 40% of its energy consumption (Srinivasan, 2015), but studies about how much energy is reduced through the use of smart home technology show much smaller and unstable results (Wilson et al., 2014). Further, research indicates that technological experts and the public mainly disagree about which barriers people have towards using smart homes (Balta-Ozkan et al., 2013). Such dissonance might yield technology that misses features users would expect to encounter before accepting the new technologies. Hence, "the introduction of energy efficient technology into the household may theoretically lead to changes in energy consumption, but when behavior in the household is not aligned, potential energy savings gains may not be realized. This does not imply that end-users should always have to adjust their behavior to technology. Technology should also fit end-user needs, wishes and abilities." (Geelen et al., 2013, p. 153). Since smart homes need to be adopted by users into the context of their daily lives, it is crucial to focus their development on the users' barriers towards this adoption. Such a user-centered design viewpoint aims at supporting the development of technology systems which are adapted to the users' needs by involving future users from the beginning in the whole design process (Wickens, Gordon, & Liu, 2004).

For the development of energy-smart home technology it is thus necessary to consider the kinds of barriers users perceive towards smart homes and saving energy. However, while the literature about users' barriers mainly focuses on common factors between users, other

studies explore differences in users' involvement with smart home technologies and energy. This research reports several roles users can have in their household, regarding how they use technology and energy. Such roles need to be considered as well for they could explain how different user types would accept energy-smart home technologies. These user types and their characteristics and differences in barriers can be described concretely and understandably by means of personas (Wickens et al., 2004). Personas are hypothetical persons that represent the users' typical characteristics, goals, environment, activities, capabilities and limits in concrete terms (Wickens et al., 2004). Therefore they are a useful means to represent the differences of users in their barriers for energy-smart homes and in their household roles.

1.2.1 Perceived barriers towards accepting smart homes

Users' interactions with smart home technologies shape their evaluations about accepting that technology (Wilson et al., 2014). The literature suggests a number of factors that users take into account for such evaluations, which are related to what they need from their home. A smart home technology would have to meet these needs before being accepted by potential users. Therefore, these factors can be regarded as users' barriers towards using smart home technologies. According to Green, Gyi, Kalawsky, and Atkins (2004), users' barriers are 1. costs for purchase and maintenance and potential savings; 2. trust in the reliability of the technology's functioning; 3. personal-data privacy and home security; 4. ease of use (simple and intuitive); 5. flexible working to fit individual living routines and daily demands; 6. added convenience; 7. independence to maintain valued activities; 8. future self-sustainability of the technology; and 9. amount of control interventions. These findings are confirmed by a number of more recent studies, for example Balta-Ozkan et al. (2013); Davidoff, Lee, Yiu, Zimmerman, and Dey (2006); Mennicken and Huang (2012); Paetz et al. (2012); Rodden et al. (2013); Van Dam et al. (2012); and Wilson et al. (2014). Some authors report additional barriers that are important to users. These are 10. trust in energy suppliers and technology producers (Balta-Ozkan et al., 2013) and 11. feeling 'home' (Eggen, Hollemans, & van de Sluis, 2003). A future smart home should meet users' needs, which means that a smart home should not present obstacles to users' requirements and additionally assist the users in their daily activities with its advanced technology (Eggen et al., 2003).

1.2.2 Perceived barriers towards saving energy

Along with barriers to accept technology, users have restraints for saving energy. Users might not save energy at home based on conscious considerations or unconsciously. Pierce, Schiano, and Paulos (2010) report that most of peoples' energy consumption happens unconsciously or

is based on irrational considerations, because most of energy-related actions are part of daily habits that people do not think much about, such as doing the laundry. Pierce et al. (2010) add that habits for everyday appliances do not develop based on rational decisions, but based on simple heuristics that yield solutions which work without much mental effort, such as sticking with the first washing machine setting that produces clean clothes. Further, deliberate energy-conserving behaviors can have paradoxical consequences the user might not be aware of. Bonino, Corno, and De Russis (2012) describe a rebound effect that develops "when a home inhabitant uses a new appliance much more than the older one, due to its higher efficiency" (p. 385), resulting in no savings or even an increased energy consumption. Users do not save energy consciously when they would like to know about conservation options (such as different temperature settings) but do not understand them due to impractical design, or when they prefer comfort and convenience over effortful energy reduction (Pierce et al., 2010). Additionally, Rodden et al. (2013) found that even when users are interested in using energy more efficiently and think that they should act more on that because it seems 'right', they still might fail to change their behaviors because fulfilling daily routines is more important.

1.2.3 Household roles

Users in households can be distinguished based on their affinity with technology, sustainability or cost saving. Van Dam et al. (2012) found that a smart home "device is often the 'pet' tool of one person in the family" (p. 93), which is usually male. Likewise, sustainable or cost-saving energy use in the household is often taken care of by one concerned adult who tries to stimulate others towards behavioral adjustments (Van Dam et al., 2012). Technology proponents can be, on the one hand, technophile and functional types who are "attracted to an ICT-enhanced lifestyle, and the potential for control and automation offered by the smart home" (Wilson et al., 2014, p. 5). Such 'home technology drivers' have a strong technical background (like a degree in a technical field), they are interested in equipping their home with automation technologies, gathering information about them and trying them out at home, they take responsibility for the technologies at home and they support others in using them (Mennicken & Huang, 2012). On the other hand, technology proponents can be incremental improvers who would like "modular, affordable and accessible smart home technologies" (p. 5) which he can build into a new or already existing home (Wilson et al., 2014). Such 'home technology responsibles' do not have a strong technical background and do not engage with the technologies directly (Mennicken & Huang, 2012). However, they also take responsibility for the technologies and are motivated to have technology installed, adjusted or repaired by professionals (Mennicken & Huang, 2012). Energy advocates could

be instrumental types who are rational, like to manage their domestic energy use, and make decisions based on information and potential savings in energy costs (Wilson et al., 2014). As opposed to these rational and functional user types, Wilson et al. (2014) describe a type of user who bases decisions on emotions, negotiations and pragmatics. Such users would value own ideals and interactions with other people above costs minimizing. This view stresses that people coexist in their home and therefore need to negotiate their preferences and responsibilities in the context of their everyday lives. According to these authors, emotional and rational components are reflected in the way houses are presented by technology developers and used by household members (divided into spaces for certain activities). This means that accumulations of objects and technologies would stimulate people to "give meaning and order to domestic space as part of the perpetual project of organising and constructing the home. This internal differentiation of the home matters for how, where, how often and by whom smart home technologies are likely to be used" (Wilson et al., 2014, p. 6).

In a home environment, technologies may not be used by a single person but by a group of housemates whose interactions make the technology use more complex. For example, Wilson et al. (2014) stress that families rather than individual users live in and use a home. Women, children en men use domestic spaces differently and need technology that is designed to respond to their different needs, which is why distinct gender roles and identities should be taken into account as well (Wilson et al., 2014). Further, a household can have "more active users—who set and enforce the rules for technology use at home—and more passive users who comply with (and at times resist) these rules" (Wilson et al., 2014, p. 7). Passive users use the technologies more broadly and do not actively engage in installation or maintenance (Mennicken & Huang, 2012). Passive users tend "to think about the technology in terms of how it supported their routines and tasks" (p. 157), and they tend to be skeptical towards home automation in general, because they see it as complex and doubt that it is necessary (Mennicken & Huang, 2012). Users without a technical background find smart home technology only 'smart' when it can do things they cannot and they need to rely on technophile people for understanding and operating new technology which can make them feel powerless (Mennicken & Huang, 2012). Users with a technical background on the other hand would often be motivated to add technology to their home, because they perceive "the installation and iterating to be hobby" (p. 156), which makes them enjoy the implementation process (Mennicken & Huang, 2012). "Parameterizing, adding new functions, and making it work are perceived as rewarding experiences that provide a sense of achievement" (Mennicken & Huang, 2012, p. 157). Passive users spend more time with the practical use of

the technologies and therefore tend to become the evaluators of the installed technology, based on their more practical values as explained above (Mennicken & Huang, 2012).

1.3 Research goal

The findings in the literature presented above describe a certain number of barriers people have to using energy-smart home technologies. However, not every person perceives the same obstacles towards using smart technology or saving energy. Understanding what these different user evaluations are based on could provide insights about how users would adopt energy-smart home technologies. As shown above, a few studies explore the roles people have in their homes related to technology and energy use. These roles offer explanations for the differences between users regarding their barriers to accept energy-smart home technology. This study shall contribute to the understanding of this relationship between users' roles and barriers. For this purpose the research question is formulated as follows: *How do household roles differ regarding the barriers towards accepting Energy-Smart Homes perceived by potential users?* In order to answer this question, this study explores the household roles Dutch adults have regarding technology and energy use, in how far and why these respondents would adopt energy-smart home technology (to identify possible barriers and their importance), and how these roles and barriers are associated with each other. Based on interview data, personas are created with the Personas* Technique from Castro, Acua, and Juristo (2008), which should allow statements about users' preferences and evaluation manners regarding energy-smart homes. Based on the personas it should be possible to give advice on the appropriate energy-smart home technologies for a particular user group, and how the technology needs to be designed in order to be favored by a certain user group.

Based on the reviewed literature three expectations about the study's findings for the research question can be formulated. Supported by the elaborations of Mennicken and Huang (2012), Van Dam et al. (2012) and Wilson et al. (2014) it is expected that, firstly, users have distinctive household roles and that, secondly, associated with these household roles users perceive different barriers towards accepting energy-smart homes. Since a person's acceptance of smart homes should be related to these barriers which should be associated with the household roles, thirdly, users' household roles and their perceived barriers should indicate to which extent they are willing to adopt energy-smart homes.

2 Method

2.1 Respondents

In order to enquire the research question, qualitative interviews were conducted in March and April 2015 involving a group of 16 participants living in Enschede or nearby. 14 participants were Dutch and 2 were German. Half of the respondents were male and half were female. On average, they were 27 years old. The educational backgrounds ranged from social educations such as Nursing to educations with a heavy technological focus such as Electrical Engineering. On average, 6 people lived in one household and the respondents had been living for four years in their home. The types of housing were flat (9 respondents), rented house (5 respondents) and own house (2 respondents). 8 respondents lived in a student house, 2 lived with friends, and 6 lived with a partner.

The participants were selected based on availability sampling in Enschede at the University of Twente and at the Saxion University of Applied Sciences. An important inclusion criterion was to pay one's own rent, which was chosen to ensure that the respondents already had dealt with their energy consumption in some form. For the participation in this study mainly students and additionally a few recent graduates and employed people were recruited. The reason to select mainly students was that they usually do not have fully equipped homes yet and that the smart technologies will probably be available when the students start to purchase such household equipment, which makes them a suitable future target group for smart homes (Paetz et al., 2012). Students' everyday habits for household management are still developing which makes them more flexible in choosing smart home components (Paetz et al., 2012). Additionally a few recently graduated and working participants were included in order to enhance the heterogeneity of the sample. This enhanced diversity is desirable because this study aims at identifying varying types of users. Furthermore, the sampling should yield a respondent group with a wide range of household compositions and technical backgrounds, which is why it included different educational fields with a varying technological focus as well as different household sizes and types.

2.2 Materials

The necessary data to investigate the research hypotheses stated above was collected with a semi-structured interview (Appendix E). It consisted of a number of main subjects, each of which had one or more open questions and short lists with topics to be talked (Baarda, De Goede, & Teunissen, 2009). To support this semi-structured character of the interview, these topic lists provided only the content for the probing questions, while giving the interviewer

the freedom to adjust the formulation and order of the questions to the interview progress (Baarda et al., 2009). The questions were formed based on the research goal and the elaborated theoretical overview.

This first half of the interview yielded information about the participant's present household situation. The questions 1-4 about current technology use were based on section 1.2.1 about perceived barriers towards accepting smart homes. Question 5 about current energy use was based on section 1.2.2 about barriers towards saving energy. The questions 6-10 about current household roles were based on section 1.2.3 about household roles. These questions about familiar situations should guide the respondent to project him- or herself into the interview subject by building on previous experiences and existing knowledge (Baarda et al., 2009). This familiarization was facilitated by the order of the questions. Each of the three topics about technology, energy and household roles was introduced with a neutral and easy descriptive question and was then extended with more detailed, abstract or personal questions (Baarda et al., 2009). It was further chosen to inquire the household roles after talking about technology and energy to stimulate the respondent to take these two topics into account when thinking about his or her household role, because this connection is important for this study.

After these questions, the energy-smart home concept as elaborated in section 1.1 about energy-smart home technology was introduced with a brief presentation which outlined its typical components. This part aimed at establishing a common understanding about the concept between the interviewer and the interviewee. Since the introduced technological concept is complex and barely prevalent among the participants it presents a quite abstract topic which might be difficult for the respondents to talk about. For these reasons, a visualization of the energy-smart home technology was developed to support the verbal explanation of the concept and the subsequent conversation. This visual tool consisted of a number of paper cards with sketches of typical energy-smart home elements (Appendix F and G). The included elements were derived from Table 1.1 and 1.2 in section 1.1.2 about energy-smart home components. The drawings of these elements were adapted from Rodden et al. (2013). Paper cards were chosen because they can be made quickly and cheap. Sketches were used because their lack of precise details focuses the attention on the core aspects while enabling the interviewee to relate the content to his life through filling in gaps with his own associations and experiences (Rodden et al., 2013).

The second half of the interview projected the interview topics of the first half on the explained energy-smart home concept. Based on the respondent's present situation as established in the first half and on the explanation of the energy-smart home concept, the

questions 11-18 should provide information about the respondent's opinion about an energy-smart home and how the respondent would imagine the use of an energy-smart home. While the first half of the interview was about the respondent's current living situation, the second half of the interview inquired imagined or future situations (Baarda et al., 2009). The conversation about this topic was introduced with more broad and easy questions and then extended with more topic-specific, abstract or personal questions (Baarda et al., 2009). After several subtopics were discussed which gave the respondent the opportunity to form an elaborate opinion about the use of energy-smart home technology, this topic was concluded with a broad question about this opinion (Baarda et al., 2009).

2.3 Procedure

The respondents were found via personal contacts of the researchers and approached personally. Persons selected for participation were then contacted via email about details regarding the interview and practical appointments for their participation (Appendix A and B). The respondents did not receive any incentive beyond gaining personal insights about the study's topic and the opportunity to contribute to this work. The data was collected by conducting a semi-structured interview with each participant, which was audio-recorded with a recording device from Sony and with a smart phone. The whole interview procedure consisted of five phases – an introduction, the first half of the interview, an explanation of the energy-smart home concept, the second half of the interview, and a conclusion. During the introduction each participant was welcomed, informed about the interview procedure and duration, and asked to read and sign an informed consent form (Appendix C). Further, each participant was asked to complete a questionnaire about demographic information and background information for the interview topics (Appendix D). Then the interview (Appendix E) was conducted. Each interview topic was introduced with an open question and continued with a topic list, which provided the content for the probing questions. In order to facilitate the comprehension of the interview questions by the interviewee, synonyms or additional explanation for words that where possibly difficult to understand where included in the interview schema.

The first half of the interview (questions number 1-10) inquired the respondent's daily use of technology and energy at home, and the respondent's household role. Then, in-between the interview, the energy-smart home concept was introduced to the interviewee with a brief presentation which outlined the typical components of an energy-smart home, supported by paper cards visualizing these components. A larger paper depicting a house, including several

rooms with each a typical household device in it, was used as main board (Appendix F), representing the participant's home. The separate rooms represented typical home areas were energy is regularly used. Smaller cards each showing a particular smart home component (Appendix F) were placed on or next to the main board by the interviewer while he or she explained the energy-smart home concept. Each participant received the same information in order to create the same knowledge base and associations for the following questions. The second half of the interview (questions number 11-18) explored the respondent's opinion about an energy-smart home and how they would imagine the use of an energy-smart home. The explanations about comfort and control as well as the questions 19-22 were used for a different study but are presented in Appendix E for completeness. During the conclusion part, there was room for comments and questions about the study, and each participant was thanked for his or her participation.

In order to test this procedure and the interview questions, a pilot interview was conducted to practice the procedure and to detect potential shortcomings. Based on the outcome of this pilot interview, minor changes were made in how the interview questions are formulated. These changes should facilitate the understanding of the interview questions by the interviewee. The actual 16 interviews were conducted by two researchers; each of them conducted half of the interviews. Each interview was conducted individually and personally, held in Dutch (the common language of each participant and interviewer), and audio-recorded. Further, the interviews were conducted at the participant's home to provide the context of the interview topics and to have a quiet and private place, except of two interviews where the respondents requested it to be held at their work places. The interviews lasted on average 42 minutes.

2.4 Data analysis

To analyze the data yielded from the interviews Activity 1 – 5 from the Personas* Technique from Castro et al. (2008) were applied. Since the remaining activities from this technique are beyond the scope of this study, they were not carried out. 'Activity 1.1: Identify possible personas' consisted of formulating expectations for the personas, based on the findings about users from the literature presented in section 1.2 and based on the research hypotheses presented in section 1.3. These expectations are about variables on which users differ and serve as persona hypotheses, as presented in Table 2.1. 'Activity 1.2: Hold ethnographic interviews' consisted of conducting the interviews and transcribing them by using Microsoft Office Word 2007. 'Activity 2.1: List Behavioural Variables' consisted of coding the

transcribed interviews according to Baarda et al. (2009) and by using ATLAS.ti 7.5.6. Based on the themes found in the interviews, a coding schema (Appendix G) was constructed which was used to label the quotes. The coding yielded a number of variables on which users differ. According to Castro et al. (2008), the identified distinguishing variables each should have a range of manifestations along a dimension with two opposing extremes. 'Activity 2.2: Synthesize Interview Responses' consisted of comparing the distinguishing variables with the personas hypotheses in Table 2.1 to validate these hypotheses.

Table 2.1.

Persona hypotheses

Hypothesis 1:	There are different personas representing different household roles.
Hypothesis 2:	Personas differ in how they handle modern technologies.
Hypothesis 3:	Personas differ in their use of energy.
Hypothesis 4:	Personas differ in their barriers towards energy-smart homes.
Hypothesis 5:	Differences in the barriers to adopt energy-smart homes are related to differences in household roles.

During 'Activity 3.1: Identify the Ranges of Behavioural Variables', the variables were sorted into a schema that displays these ranges and a number of salient items for each range. During 'Activity 3.2: Map Interview Subjects', based on the interview responses each of the respondents was placed on the ranges for each of the distinguishing variables in order to yield a representation, or mapping, of how the respondents are grouped with respect to these variables. This was done with IBM SPSS Statistics Version 20 by, firstly, assigning a score to each item and then assigning each score to the corresponding respondents, based on the interview coding (Appendix H). Secondly, this placing of each respondent in the ranges yielded a mapping of the respondents with regard to the distinguishing variables (Appendix I). During 'Activity 4: Identify Significant Behaviour Patterns', based on the mapping of the respondents a graphic (Appendix J) and a table (Appendix K) were assembled showing the percentage of respondents sharing each of the distinguishing variable range values. The groups of respondents with the highest percentages formed the significant patterns which are the sources of the personas.

'Activity 5: Synthesize Characteristics and Relevant Goals' consisted of synthesizing the data for each identified persona (significant pattern), thereby specifying the behavioral characteristics and relevant goals (distinguishing variables) identified during the coding of the

interviews, and describing each persona's personality. This step yielded the personas grounding document.

3 Results

3.1 Distinguishing variables

This section shows the results from 'Activity 2.1: List Behavioural Variables' and 'Activity 2.2: Synthesize Interview Responses'. From the coding of the interviews eight separate variables emerged on which users differ. According to Castro et al. (2008), theses distinguishing variables each should have a range of manifestations along a dimension with two extremes. Based on his or her answers each respondent can be assigned to one position on such a range. Of the indentified variables, 'Modern technology use', 'Knowledge about energy use' and 'Energy saving' meet this requirement. For three other variables, 'Modern technology opinion', 'Household role technology' and 'Household role energy', the ranges' extremes are not exactly opposed, but rather represent noticeable differences in the respondents' answers. For the other two concepts, the variables 'Home feeling' and 'Energy-smart home barriers', no ranges with opposing extremes emerged but a number of distinctive topics. These topics do not represent a single dimension but rather distinctive aspects within each concept. Each respondent talked about one or more topics during the interview and can therefore be assigned to several topics for each variable. The identified variables, ranges and topics are displayed in Table 3.1. For variable 5 and 8 all topics are displayed. For the other variables only the extremes of the ranges are shown because they sufficiently illustrate the respective range.

Table 3.1.

Distinguishing variables and their ranges or topics

Variable	**Range/topics**
1. Modern technology use	Few devices infrequently – many devices frequently
2. Modern technology opinion	More negative than positive – only positive
3. Knowledge about energy use	Trivial – detailed
4. Energy saving	No activities – comprehensive activities
5. Home feeling	Rest | companionship | own space | own way
6. Household role technology	Not involved – collective role

7. Household role energy	Not involved – collective role
8. Energy-smart home barriers	Energy awareness | technology self-regulation | personal saving | privacy, security | environmental saving| keeping control | unnecessary

3.2 Variable ranges and persona patterns

This section shows the results from 'Activity 3.1: Identify the Ranges of Behavioural Variables', 'Activity 3.2: Map Interview Subjects' and 'Activity 4: Identify Significant Behaviour Patterns'. Each variable from Table 3.1 is defined and explained with translated quotes from the interviews. The original Dutch quotes with their corresponding translation are displayed in Appendix M. Each variable is displayed in a figure that shows its range and a number of salient items for each range. For variable 5 and 8, respectively, the salient topics are shown instead. Based on the respondents' mapping (Appendix I) the salient persona patterns were identified. These personas' positions regarding the ranges and topics are also displayed in the figure for each variable hereunder. Furthermore, based on the respondents' mapping a graphic (Appendix J) and a table (Appendix K) are assembled which shows the percentage of respondents within each persona that share each variable. The differences on the variables between the personas are mainly based on their use of modern technology, their knowledge about their own energy use and their household roles regarding energy and technology. The core difference between the personas lies in their affinity with technologies in general and in how willing there are to save energy.

Variable 1: Modern technology use

Respondents vary in how often they use modern technology. Modern technology was defined as technology that is recently developed. It was further left to the respondents judgment which of his or her devices to consider as modern. Persona Lotte uses modern technology the least and persona Bas the most, while persona Jan's use is centered between the other two. Persona Lotte uses *few modern devices infrequently*, which means that she does not use them regularly such as daily or weekly. Respondents like persona Jan have *one or two modern devices*, like a new smart phone, tablet or laptop, which they use often and regularly. Persona Bas uses *more than two devices* often and regularly.

"Yeah for example my smartphone is an iPhone four. Thus pretty old. And also all the equipment of the kitchen is not very fancy or new." (Persona Lotte, respondent 16)

"Phone and laptop are new, they are developed most recently I think. Yeah ... no, more ... I don't have any gadgets in my oven or something. No, that's all old-fashioned." (Persona Jan, respondent 7)

"Computer, smartphone, I'm just thinking if there are other things in my room or something. Yes, speakers, recording gear, microphones, amplifiers." (Persona Bas, respondent 8)

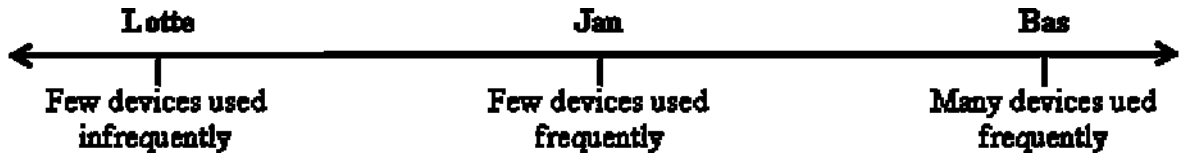


Figure 3.1. Range of 'Modern technology use' with persona grouping.

Variable 2: Modern technology opinion

The respondents tend to judge modern technology in general positively, but a number of them also have strong objections against it. Persona Bas is more enthusiastic than the other two personas. He states *only positive* aspects about modern technology, in particular that it is very interesting and adds some value to his life. Persona Lotte and Jan state about *as many positive as negative aspects*. They think that modern technology is convenient, but also tends to have considerable disadvantages.

["What makes it interesting?"] "Partly that it's new, but also that technical, that it can make your life easier. That you can do so much with it, and that it can have many different purposes." (Persona Bas, respondent 8)

"It makes it easier, it's nice, it's convenient that for example with a mobile phone you can always reach someone and if you also have navigation, it's just practical, but I do think that sometimes new technologies – it's a pity that often the newest things often are so ridiculously expensive that they are not accessible to everyone, that's too bad. I do it not necessarily need to have it, but I find it a shame that you often need a particular brand to connect everything." (Persona Lotte, respondent 3)

"Especially with entertainment technologies I notice that I get the feeling of, gosh, should we not sometimes use it less and more just sitting less behind screens and more just, yeah, being engaged with each other and being busy with, not only in the home but in general. However, new technologies like improved connections or using your lights longer because you have

LED lights instead of ... I think stuff like that is positive, it just makes things easier and better." (Persona Jan, respondent 2)

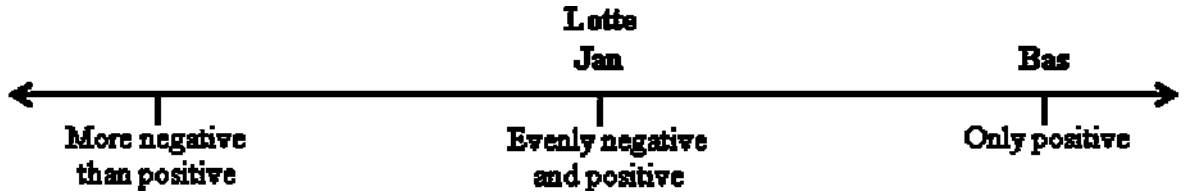


Figure 3.2. Range of 'Modern technology opinion' with persona grouping.

Variable 3: Knowledge about energy use

The respondents differed strongly in how much they know about their energy use at home. Persona Jan has the least knowledge. He knows *trivial* to *rough* facts about his energy consumption, which means that he mainly can tell that he uses electricity, water or gas, but that he also can roughly estimate how much energy he or she consumes. Persona Lotte has *detailed* knowledge, which means that she knows for example details about energy providers or how much her individual devices consume. Persona Bas is difficult to be clearly placed on one position on this knowledge range, because half of the respondents that make up his persona have trivial knowledge while the other half has detailed knowledge about the own energy consumption. The respondents of persona Bas with detailed knowledge use modern technologies more extensively and have a more electro-technical educational background than the persona's respondents with trivial knowledge. Since persona Bas further has the characteristics of studying Electrical Engineering and using many modern devices frequently, he is assigned to the detailed knowledge position. These findings imply that if a user like persona Bas has less affinity with modern technologies, he might also have less knowledge about his energy use at home.

"I think our monthly costs... anyway something like 80 euro per month." (Persona Jan, respondent 5)

"We do not have a washing machine here, so that helps. We live with two people here, of course there is not so much space, so in the weekend we go home, so that makes a difference because that would use much energy. The microwave uses a lot of energy I think, but that's not turned on continuously, yeah it's plugged in the socket but when it is not running it's of course just very little power that runs through it for the alarm or the clock... The refrigerator and freezer use quite some power, we also have gas stoves here, but we have two additional

small radiators which use a lot of power, but we use them just as little as possible, to heat a bit of course." (Persona Lotte, respondent 3)

"The biggest things are probably that I often have my computer turned on during the day because I need to study. And it uses a lot of energy because I don't have a laptop, so that's a lot more energy to normal. And I always shower quite long, that takes a lot of energy. I think those are the two biggest things. And then smaller things, like my music is sometimes on and the like." (Persona Bas, respondent 4)

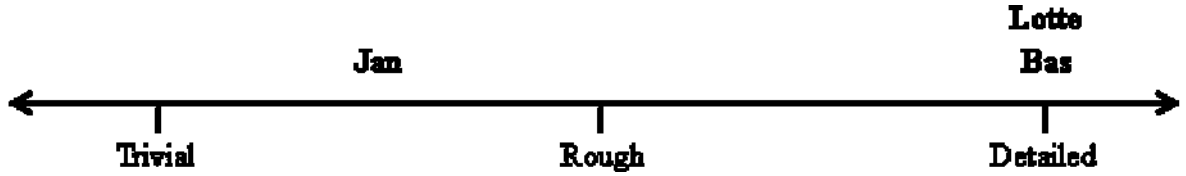


Figure 3.3. Range of 'Knowledge about energy use' with persona grouping.

Variable 4: Energy saving

This variable indicates to which extent respondents execute deliberately activities to save energy. Persona Jan and Bas conduct somewhat less energy savings than persona Lotte. Persona Jan and Bas *frequently perform small actions* to save energy, like always turning off devices that are not in use or closing doors from heated rooms in the winter. Persona Lotte also performs such frequent small actions, but she also would conduct *comprehensive activities* to save energy, such as purchasing more efficient devices, selecting a better energy provider, or even renovating her house to make it more energy conserving.

"I'm kind of one of those people who always says, who always really likes the idea to be energy efficient and save money, but when it comes to the crunch I still shower much too long. Well that's how I am. So I always try to, for example, to switch off the light behind me and to turn off my computer when I leave and the like. But at the same time I have an aquarium that is heating 24/7 and I shower longer than average because I love showering. So, I do try to save, but not when my own, if I need to adjust a lot, then not." (Persona Jan, respondent 10)

"I try to make sure that I always switch off the lamps when I leave my room and to turn off the heating when I don't need it. But otherwise I don't care much. It's not that I do not watch TV, because I think it takes energy. If I want to cook well, I just make a nice stew, even though I know that then the gas will burn half the day." (Persona Bas, respondent 6)

"We have just bought a new dryer because it was so old and it is, that equipment, of course we pay attention to energy consumption, that it's A+++, so that less, B was engaged a lot to make sure that it uses less power." (Persona Lotte, respondent 11)

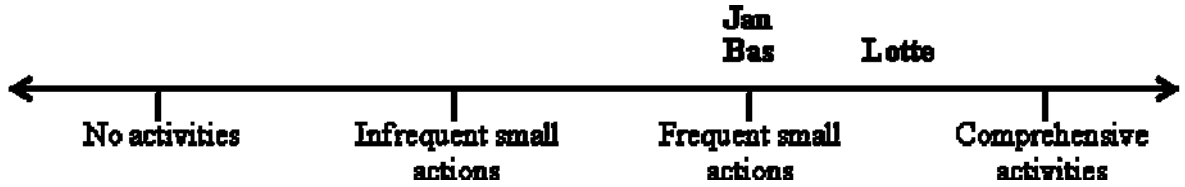


Figure 3.4. Range of 'Energy saving' with persona grouping.

Variable 5: Home feeling

When asked about what being home means to them, the respondents repeatedly talked about five topics. Firstly, an *own place* for oneself might be important which is arranged and equipped like the person wants. Secondly, going one's *own way*, being able to do what you want and being yourself was stated by the interviewees. Thirdly, respondents told that they need *rest*, want to unwind, and not having to do something. Fourthly, participants might need *companionship* in the form of being with important people and having a cozy home. Persona Jan stands out because he solely regards rest as important while being home. Persona Bas appears to be more individualistic than the other two personas, because he does not demand companionship at home. Persona Lotte has some overlap with each of the other two personas, because she regards both companionship and going her own way at home as important.

"For me, at home I'm resting to leaving afterwards for doing fun things, and perhaps also to prepare some things, so to work a bit at home, but that's, basically everything is about resting. So yeah, a place where I can relax, perhaps." (Persona Jan, respondent 15)

"For me it's maybe more a question of definition: This is my home, fine. Then I come home after a hard working day, I throw my bag in the corner, I hang my coat on, I make a cup of coffee, and then I'm home. So I think it's important to me that things are here which I want to use in my spare time. And that's my TV, my laptop, my bed to sleep in, my knife for cooking." (Persona Bas, respondent 6)

"Just going my own way here, people to talk to, or not if I don't want to. That's what I like." (Persona Lotte, respondent 1)

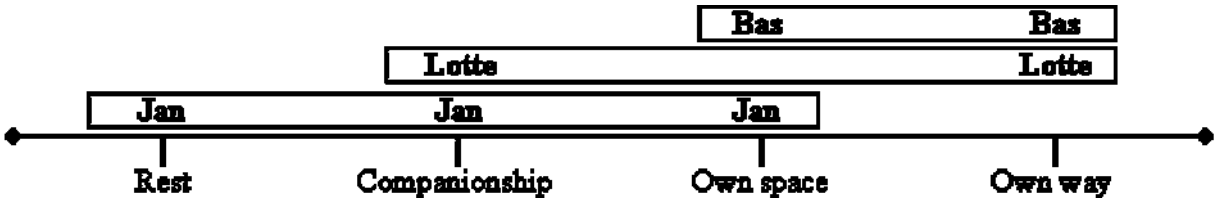


Figure 3.5. Topics of 'Home feeling' with persona grouping.

Variable 6: Household role technology

Respondents can have different roles in their household regarding how they take care of the technology at home. Taking care of technological devices includes for example to install, maintain or repair the devices. Persona Lotte is *not involved* at all in such activities, which predisposes her to be an anti-persona. Persona Jan is involved indirectly with technological tasks at home by *directing others* who are handier with a given issue to solve the technology problem. Persona Bas has a *collective technology role*, which means that he directly takes care of technological issues at home, usually together with other household members.

"S. and J. are doing electrical engineering and things like that. They are all pro technical… computer, lights and lamps, those things, they understand that. Then it's like, hey, I need help, and then they help." (Persona Lotte, respondent 16)

"We have two technical people who are good with technology and with computers and things like that, so they actually arrange everything. If something is broken then we go to them and then we say, ohh it is broken, and then they fix it. And if something from my things is broken, I first try it myself and if that does not succeed then I go to those people and they usually know what to do." (Persona Jan, respondent 10)

"Since I do have an affinity with that, I think I'm one of the people who make sure that technically everything is okay." ["And what do you do for example? With these technical things?"] "I make sure that people in the living room can nicely watch TV or listen to music and that everything works well and sounds good. And if something is broken, the toasters or whatever, then we just fix it. I think soon I'm going to pimp the coffeemaker, that it gets a timer so we know when the coffee was made." (Persona Bas, respondent 8)

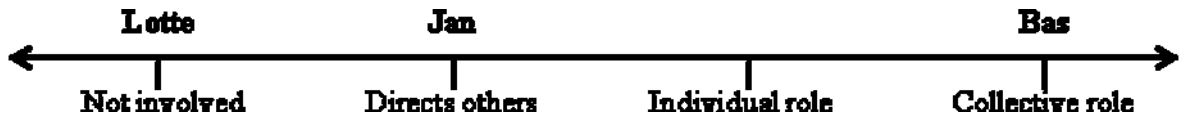


Figure 3.6. Range of 'Household role technology' with persona grouping.

Variable 7: Household role energy

Next to their household role regarding technology, the respondents have different roles regarding how they are involved in saving energy in their household. Persona Bas is *not involved* in deliberate energy saving, as opposed to persona Jan and Lotte who both engage in such activities in their home. Persona Lotte conducts such activities more *collectively*, that is together with other housemates, than persona Jan who takes care of energy savings in the household more *on his own*.

"I think that some people do it and others do not, and ultimately not really much energy is saved, as there are always so many things turned on. In such a house like this ... it will always be done a little bit, but in the end it really will not matter, in my opinion." (Persona Bas, respondent 8)

"The treasurer does have the list of the numbers. Then, R. has introduced the bulbs. Personally, I often do, when I see that somewhere the light is on then I turn off the light. Such things. So it's a bit like all of us." (Persona Lotte, respondent 1)

"I sometimes try to make people aware of it, like, is the light in the living room still on, just turn that off when you go away, is the light in the bathroom still on, turn it off when you are leaving. But further it's not really considered." (Persona Jan, respondent 10)

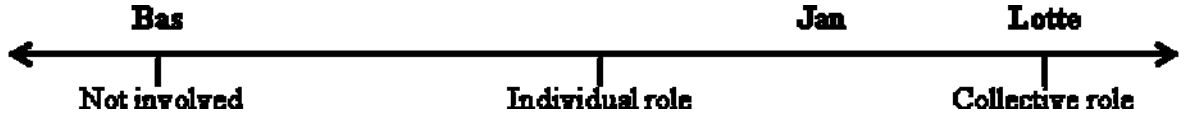


Figure 3.7. Range of 'Household role energy' with persona grouping.

Variable 8: Energy-smart home barriers

There are seven different barriers respondents might perceive for using energy-smart home technology. On three barriers the personas do not differ as they all regard them as important. Firstly, all personas are concerned about *energy awareness*, which means that they would want the smart technology to give them insight into their own energy consumption and they also would want to act on this information. Regarding such awareness, they might however not constantly be consciously concerned with their current energy consumption by being confronted with information about it too much. Secondly, the personas would prefer the smart technology to *regulate itself* without user involvement. They do not want to think much about the technology or invest much effort in it. They further would not want to be engaged with

their devices or their home by receiving information while doing something else or being somewhere else. Thirdly, the personas would want to be assured that they eventually can *save energy or costs* for themselves before they would purchase energy-smart home technology.

Besides these similarities, the three personas differ in their concerns about privacy/security, staying in control, saving for the environment and the technologies' usefulness. Persona Jan is the only one concerned about *privacy and security*, which includes possible misuse of personal information by energy suppliers or unwanted access to the home or personal information by others through the smart technology. He would rather not purchase technologies that endanger his privacy or security, like the smart meter sending information about him to the energy suppliers. Persona Jan is further notably interested in *keeping control* and *contributing to environmental savings*. He would prefer to occasionally act himself instead of letting the smart technology carry out various tasks, in order to do himself what he regards necessary at the moment or what fits best into his own routine. Additionally, he regards saving energy for the environment or the society as important and would want his energy-smart home technology to contribute to that. Like persona Jan, also persona Bas is concerned about saving for his environment. He is further concerned about the *usefulness* of specific smart technologies. He thinks that they might be unnecessary, which means that they might add nothing useful or valuable to his daily activities or that they might offer nothing better than existing devices or manual activities. If he does not see a useful value in a smart technology, he might not purchase it. Persona Lotte seems to be more critical about energy-smart home technology than the other two personas, as she is concerned with staying in control over household activities and with whether smart technologies might be unnecessary, which predisposes her to be an anti-persona.

"Yeah I don't like data collection and that people can see your data. For me it's better when it remains a bit anonymous and confidential. I do not want that too much data about myself is collected." (Persona Jan, respondent 13)

"I think it's very good to save energy, and that's for two reasons. On one hand that saves money of course, but I'm not very keen on that, I'd even would spend some money on it if it eventually could save energy. That's the whole story behind the smart grids, that ultimately energy is saved when the peaks and valleys are averaging in energy consumption. So that I would favor very much." (Persona Bas, respondent 6)

"I think that the devices that use quite much power, such as the refrigerator and freezer, and they are of course turned on all day, but you cannot just turn it off because then you'd spoil the food. So that are things where I think you cannot do anything with it. But I'm like, before the holidays I'm like, yeah, when you're not here for some time then you might as well, then it's convenient if you just empty your fridge and pull out the plug, done. Thus, therefore I find it a bit difficult indeed because then, how much would it actually yield." (Persona Lotte, respondent 3)

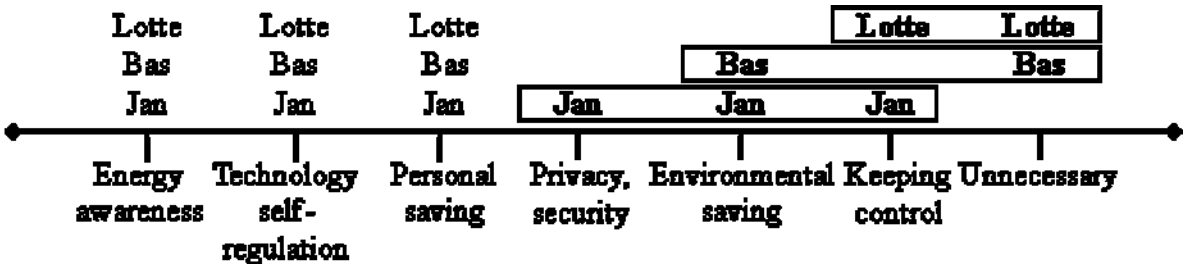


Figure 3.8. Topics of 'Energy-smart home barriers' with persona grouping.

3.3 Personas' synthesis

This section shows the results from 'Activity 5: Synthesize Characteristics and Relevant Goals', which is a detailed description of each identified persona including a persona's personality, behavioral characteristics and relevant goals (distinguishing variables). Appendix L additionally provides a brief overview of the respondents' characteristics for each persona.

Two personas, Jan and Bas, are suitable for an energy-smart home. Jan has some skills for using smart technologies and invests some effort to save energy in which he incorporates the smart technologies. Bas applies his broad technological expertise a lot to smart technologies and only saves energy when the technology can do that for him. The third persona, Lotte, is barely suitable for an energy-smart home, as she does not prefer modern technologies and already broadly saves energy herself.

The first persona, Jan, is based on 8 respondents. Their age ranges from 22 to 52 years (M = 28; Mdn = 24; SD = 10). Four of them are female and four are male.

Jan

"I like to save energy with my smart home, but only if that does not disturb my everyday life."

Jan is 28 years old and has studied Industrial Design. Since about four years he lives with his girlfriend in a flat in Enschede. Since it is important for him to have a cozy home, he carefully furnished it and arranged his and his partner's things at home to make it a comfortable place for both of them. After a working day he likes coming home to be with her and to take rest from the day. His usual homely activities are spending some time with his girlfriend, feeding the fish in his aquarium and watching them drifting around for a while, and watching series on his laptop. When Jan leaves a room the lights are automatically turned off behind him by the smart sensors he purchased lately, because he likes to be economical with energy and thinks it is nonsense to leave unused things on. He still enjoys this feature a lot because in the past he always needed to do that himself. He also tries to motivate his girlfriend to be more aware of her energy use by sometimes reminding her to turn the heating down when leaving, but with little success. However, they both have undertaken some efforts to make their home more energy-saving. For example, they bought some led lighting and they upgraded their central-heating boiler with smart technology to make its water heating efficiently adjusted to their daily use pattern. Jan finds it important to improve his household's energy usage, because he wants to save money for himself and to save energy for the environment. He lacked insight into his energy consumption because his only source of information used to be his monthly energy bill. Therefore, Jan acquired a smart meter so that he can check the real-time consumption of his devices at home. When it was new he used it often to get a picture of their energy usage. Especially after the purchase of the boiler, he frequently consulted the smart meter to see how much energy the new boiler uses compared to the old one. Thereby he realized that his long showers consume quite much water. However, energy is not so important to him that he would give up such comfort and change this habit. Now that he has a good impression of their energy use Jan uses his smart meter less. At the end of the day he quickly consults it meter to see whether all lights, devices and the heating are turned off. Sometimes he also checks his smart meter to see whether his energy use is still within the usual range. Then he takes a nice long shower and goes to bed.

If some device at home needs to be installed or makes trouble, he preferably asks a friend who is handier with technology than him to fix the problem. When no such person is available he would as well try to solve the problem on his own, but he prefers to not invest too much effort in such tasks, hence he rather directs other people to do them for him. He also prefers the technology to regulate itself and to be hardly involved with its functioning. Likewise, what he likes about his new water heating system is that he is not bothered anymore with thinking about the warm water and adapting his showering moments. However, he does not want his whole home to be automated because he likes to stay in control about his way of living and to not adjust his daily routine to the energy-efficient decisions of smart software, like when to do his laundry. He wants his smart technology to fit into his lifestyle, which includes relaxing while watching series and little luxuries like his aquarium. Further, Jan only has a few personal modern technologies which he regularly uses, which are his smart phone and his new laptop. Devices like these two or his energy saving lamps he finds very convenient, but in general he is skeptical about new technological developments. What bothers him is that he and his girlfriend tend to spend much time with their laptops instead of with each other. Another big concern of Jan is that the energy suppliers might misuse information about him and his energy use to gain more profit, which is why his smart meter is set to not transfer information about him outside his home. On the other hand, Jan is glad that he purchased his smart devices as he can enjoy their benefits every day. This makes him thinking about acquiring more upgrades like their smart water heating system.

Figure 3.9. Photograph depicting industrial designer. [Primary source].

The anti-persona, Lotte, is based on 4 respondents. Their age ranges from 20 to 52 years (M = 29; Mdn = 22; SD = 15) and they are all female.

Lotte

"I already save so much energy; I am not sure what smart technologies could add."

Lotte is a 22-year-old Communication Science student. She shares a flat in Enschede with six students, where she lives since about four years. After a day at the university she likes coming

home and having time for herself and just doing what she wants, but also being with her many housemates and talking about their day. Lotte's home is cozily arranged with mainly older or second-hand furniture and devices. Modern technology plays only a little role in her life. She acknowledges that modern developments can make life more convenient, but at the same time modern devices appear to be complicated and expensive. For that reason Lotte rather sticks to familiar and reliable gadgets, like her 5-year-old iPhone. Since she has not much technological affinity Lotte is not involved in repairing or installing devices in the household. If she encounters a problem with one of her own devices she would simply ask one of her housemates for help. Lotte heard about new smart technologies, but she would not like to buy them because to her their installation and maintenance seems to require too much effort.

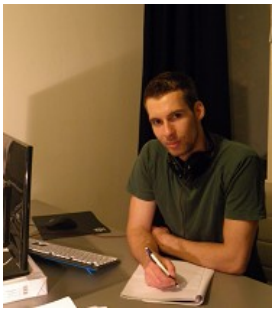
As opposed to this, Lotte does care a lot about energy at home and is aware of how the different devices in her household consume energy, like the microwave which always has a little clock display turned on in the standby mode or their old fridge which does not function energy-inefficiently. Therefore, because the refrigerator broke down today she goes to the shop together with a housemate to find a new one. She convinces her flatmate to buy a device with an A+++ label because it will work more efficiently and save them energy in the long run. Lotte is also interested in how much energy their individual devices consume but she used to have no means to find that out. That is why she is glad that her housemates installed a smart meter that now gives her such information. It further helps her to better compare the energy results of different kinds of devices and also of their saving efforts. Therefore, during the next week Lotte will keep track of the new refrigerator's energy consumption to see how much will change compared to when they had the old one. She gladly incorporates such information into her own saving actions. Lotte also knows how to save quite some energy with simple actions. In the winter for example, when the living room constantly needs to be heated, she keeps the door to the hallway closed and in the evening also the curtains, in order to save warmth. Sometimes she turns the heating off before going to bed, but usually another housemate does that because he goes to bed later than Lotte. Both of them and also a few others are further economical with their water consumption and share for example laundries, and they habitually make sure to turn off the light and other devices when leaving a room. Lotte is glad that they save so much energy together, because each new energy bill is somewhat smaller than the previous one. As she does often, today Lotte looks up the results of their saving efforts in the smart meter's consumption records, which additionally encourages her. She further likes about the smart meter that it functions easily without her involvement. Other smart technologies than that do not seem interesting to Lotte, because she

is not sure what use such technologies could add to her homely life since she is already happy with her home and because they already save energy so embracingly themselves.

Figure 3.10. Photograph depicting Communication Science student. [Primary source].

The third persona, Bas, is based on 4 respondents. Their age ranges from 20 to 24 (M = 23; Mdn = 24; SD = 2) and they are all male.

Bas



"My self-adjusted smart technologies ease my life and some even save energy."

Bas is 23 years old and studies Electrical Engineering. He shares a flat in Enschede with eight students, where he lives since about two years. When he comes home he hangs his coat at the coat rack, puts his bag with study material away and makes a cup of coffee. His room is simply arranged with mainly his bed, television, laptop and music gear, because these things and their related activities are enough for him to have a comfortable home. He finds technology very interesting, especially new developments, because he is fascinated by their functioning and the diverse possibilities they offer to improve the daily live. Therefore he has many modern devices which he uses often during his free time at home, like his computer, his smart phone or his music recording devices. Some of his housemates share these interests, so together they take care of the technological equipment of their household. When they spend time together at home they sometimes install useful features for their flat, like a good sound system in the living room or a program for their smart coffee machine that will make a cup of coffee when someone is on his way home. Also if some device needs to be repaired, Bas often helps out. A drawback of these many and advanced devices is that they require much energy. Bas knows quite well how much energy the devices in his home consume since he can read that information off with self-installed smart meters, but he does not care enough to change his daily consumption behavior. He needs his devices during the whole day for his study and his hobbies, and he also sometimes enjoys a long shower or just lets the music turned on all day. Bas often turns off his lamps and heating when he does not need them, but when he feels like doing something like watching a movie he would not cancel it because he knows it costs

much energy at that moment. That is also why he would not adjust his routine to variable energy tariffs. Additionally, in his big student household Bas does not deliberately contribute to energy savings, because he believes that with many individual life styles efficient energy use is not possible and his efforts would not matter much. For this reason he also believes that his big messy student house would not benefit very much from smart technology, but he still upgrades his own room with smart technology because these gadgets fascinate him a lot. When he will later live in his own house he would like to use smart technology even more, also to save energy because he would then consider that useful. However, Bas knows quite well how his energy usage could become more efficient, he wants to save money for himself and, above all, he finds saving for the environment valuable. He is even willing to invest some money to contribute to wider energy savings. Therefore, he has undertaken a few particular efforts which will save some energy in the long term without his further involvement. He added smart technology to his heating which is linked to his mobile phone's GPS and his alarm clock timer, in order to automatically and energy-efficiently preheat his room until he arrives home or until he needs to get up in the morning.

Figure 3.11. Photograph depicting Electrical Engineering student. [Primary source].

4 Discussion and conclusion

4.1 Differences in energy-smart home barriers between household roles

This study should contribute to the understanding of the relationship between users' household roles and their barriers to accept smart home technology. For this purpose, this study explored the household roles Dutch adults have regarding technology and energy use, in how far and why these respondents would adopt energy-smart home technology (to identify possible barriers and their importance), and how these roles and barriers are associated with each other. This should answer the study's research question: *How do household roles differ regarding the barriers towards accepting Energy-Smart Homes perceived by potential users?* In order to obtain information about users' roles and barriers, based on sixteen interviews with potential users personas were created with the Personas* Technique from Castro et al. (2008), which should allow statements about users' preferences and evaluation manners regarding energy-smart homes.

This study identified two kinds of household roles users can have, which are on the one hand taking care of the technology at home and on the other hand being engaged in saving energy in one's household. For each kind of role, users differ in whether they are

involved individually, collectively, not at all, or, regarding only technology, by merely directing others. Besides these roles seven barriers for using energy-smart homes emerged, which concern 1. energy awareness, 2. technology self-regulation, 3. personal saving, 4. privacy and security, 5. environmental saving, 6. keeping control, and 7. unnecessary features. Users differ in which barriers they regard as important. Hence, different household roles can be associated with different barriers. This study identified three types of users (personas) which have varying technology and energy roles and varying corresponding energy-smart home barriers, as presented in Table 4.1. Related to their roles and barriers, these three user types vary in the extent to which they generally would adopt energy-smart technology. A user with a strong technical orientation who has a collective technology role, like persona Bas, would be interested in advanced self-regulating technology that offers useful and cost-saving benefits while also saving energy. A user with some interest in technology and energy who directs other for technological issues and has an individual to collective energy role, like persona Jan, would be interested in simple self-regulating technology that saves energy and costs while also keeping his privacy and security and allowing him to keep control about his daily activities. A user with a strong focus on energy who has a collective energy role and is not involved with technology, like persona Lotte, would be less interested in energy-smart technology because he doubts whether that would offer a useful addition to the saving activities he already conducts on his own.

Table 4.1

Identified user types with roles and barriers

	Role		
Persona	**Technology**	**Energy**	**Energy-smart home barriers**
Bas	Collectively	Not involved	Energy awareness, technology self-regulation, personal saving, environmental saving, unnecessary
Jan	Directs others	Partly individually and collectively	Energy awareness, technology self-regulation, personal saving, privacy and security, environmental saving, keeping control
Lotte	Not involved	Collectively	Energy awareness, technology self-regulation, personal saving, keeping control, unnecessary

4.2 Reflection on the literature

The household roles concerning technology and energy found by this study correspond with user types presented in the existing literature, but also add some nuances to them. Regarding technologies, Mennicken and Huang (2012) and Wilson et al. (2014) describe on the one hand a technophile home technology driver and on the other hand a home technology responsible and improver, which are comparable with the technology roles of the personas Bas and Jan. Furthermore, Mennicken and Huang (2012) elaborate a passive user type without a technical background who corresponds to the technology role of persona Lotte. Regarding energy, Wilson et al. (2014) describe an energy saving advocate who is similar to the energy roles of the personas Jan and Lotte. This study thus confirms the overall concept of technology and energy roles emerging from existing research. However, the roles elaborated by the existing literature miss a distinction that this study identified as an important component of each household role. As shown in Table 4.1, a household role can be fulfilled individually, such as by persona Jan, or collectively in cooperation with other housemates, such as by the personas Bas and Lotte. Many existing studies about home users present stand-alone user types (Mennicken & Huang, 2012; Van Dam et al., 2012; Wilson et al., 2014), whereas this study suggests that this view is incomplete and needs to be complemented by a more socially oriented perspective. This issue is also addressed by Davidoff et al. (2006) who explain that families in a home are collective entities with complex and organic relationships, as opposed to the prevalent singular and static concept of a user. According to the same authors this discrepancy limits the application of systems that are developed for a single user but used collectively by a group of users. This argumentation suggests that there is a need for more detailed research about the social component of users' household roles. Another suggestion this study offers is that, while the reviewed literature reports about either the technological or the energy affinity of home users, the association between a user's technology and energy roles appears to relate to a user's interest in energy-smart home technologies. As displayed in Table 4.1., both persona Jan and anti-persona Lotte fulfill an energy saving role, which seems to make them potential energy-smart home users since this technology could aid them in their saving efforts. However, only the technological oriented persona Jan who fulfills a technology role is a potential user, while anti-persona Lotte has no technological affinity and would barely use the smart technology. These results stress that next to 'positive' user types, which the existing literature mainly focuses on, also users for whom energy-smart home technology is not suitable can be identified, like anti-persona Lotte. These findings suggest that the development of energy-smart homes needs to take into account such complex interaction of

user characteristics and to distinguish potential user types from 'anti-user types' in order to appropriately address potential users.

Five of the energy-smart home barriers found by this study correspond with barriers reported in the literature, while two identified barriers are not yet explicitly described in the reviewed literature. A number of authors, for example Green et al. (2004), state technology-barriers concerning the amount of users' control interventions, costs and potential savings, data privacy and home security, and the users' independence to maintain valued activities. These are comparable with the identified barriers of technology self-regulation, personal saving, privacy and security, and keeping control. Regarding barriers to save energy, Rodden et al. (2013) report that some users are interested in using energy more efficiently and Pierce et al. (2010) additionally found that some users would like to better understand their energy saving possibilities, which is similar to the identified barrier of gaining awareness about one's energy consumption. This study thus confirms a number of barriers that were already identified by several existing studies. Furthermore, this study suggests two new barriers for avoiding unnecessary technology features and contributing to environmental savings, which seem to be relevant because, as Table 4.1 shows, they distinguish the three identified user types. While existing research mainly focuses on how smart technologies would be applied by residents, this study additionally distinguishes circumstances in which smart technology would not be used. It shows for example that anti-persona Lotte regards most smart technologies as unnecessary and therefore does not used them. On the contrary, persona Bas is very interested in smart technologies but thinks that they are less useful for his big student house, which is why he would use them extensively only when he lives in his own place. Besides that, this study extends previous research about either smart technology use or energy consumption by suggesting insights about the combined use of smart technology and energy. For example, a user type like persona Bas who is not involved in energy saving in his household would be interested in smart technology that autonomously contributes to overall environmental savings. These findings suggest that the association between smart technology and energy use needs to be explored in more detail, and that the development of energy-smart homes needs to take into account 'not-user types' and less suitable use circumstances as well in order to better address potential users.

4.3 Strengths and restrictions

The present study offers new insights into how residents' use of technology and energy can be associated with each other and in how far that makes them willing to adopt energy-smart

technology. For both users' household roles and smart home barriers this study provides one of the first approaches to combine the domains of energy and technology. Thereby the results of this study extend the existing literature by differentiating a social component in users' household roles, by suggesting new barriers which distinguish user types of energy-smart homes, and by adding an anti-user for energy-smart home technology. Besides that, this study further elaborates a tool which can support research about users of energy-smart home technology. The paper card-aided explanation of the energy-smart concept developed for the interviews allowed it to explain the unfamiliar energy-smart home concept easily and quickly. Since thereby the participants were not exposed directly to a smart home and responded based on their imagination and self-report, the answers might reflect their potential use of the smart technology less realistically. However, this explanation with paper cards provides a simple yet effective way of introducing the concept, which makes it much easier to conduct studies with potential users than it would be with using for example complete prototype houses.

Some remarks should be made about the methodology. Since this study used a small availability sampling, it might not adequately represent the targeted user group. Therefore, the results can possibly not be generalized to the Dutch population and further research is needed to confirm the presented results. Besides that, the interviews were not fully structured and conducted by two different interviewers, which could make the respondents' answers less well comparable. In order to enhance the reliability of the procedure and hence this comparability, one common interview schema was created, the realization of the procedure was discussed between both interviewers, and both interviewers conducted a pilot interview which they evaluated together. Further, for this study no inter-rater reliability was determined. Therefore the interview data is possibly interpreted too subjectively (Baarda et al., 2009). The intersubjectivity could have been examined and improved by having a second researcher label the interview transcripts with the created coding scheme, comparing in how far the two labeling systems are conform with each other and possibly adjusting the coding scheme (Baarda et al., 2009). Adding this step would ensure that the results adequately represent the respondents' answers. Finally, the persona technique of Castro et al. (2008) could not be neatly applied to create the distinguishing variables, as for five of the eight variables no dimension with two opposite extremes could be defined, but rather ranges with noticeable different extremes or a number of distinctive topics emerged. This technique appeared however to be suitable for both the development of personas as well as for the creation of an anti-persona.

4.4 Recommendations

There is little research yet on users for energy-smart homes and currently little is known about which kinds of users there are. This study suggests that there are interested potential users as well as not-interested people, which can be distinguished based on their domestic technology and energy roles. Since the development of energy-smart homes needs to focus on potential users in order to appropriately address them, future research should be directed at identifying and confining these possible user types. One way to do this, like this study suggests, would be to inquire the household roles an inhabitant can fulfill and how they are related to each other. This study further points out that an important component of these household roles is the part that social relationships play in them. Since there are little results yet about this aspect, future research should focus in particular on such social factors. Other characteristics of the potential users which the future development of energy-smart homes needs to take into account are their barriers towards accepting the technology, since they seem to determine how users would apply the smart technologies. Alongside the number of barriers which are repeatedly confirmed in the literature, this study suggests two barriers about unnecessary features and environmental savings, which future research should inquire further in order to clarify them.

4.5 Conclusion

The present study identified a number of household roles and adoption barriers regarding energy-smart technologies that can distinguish user types for energy-smart homes and contributed new insights to existing research about these concepts by inquiring the association between the residential use of both technology and energy. This approach elicited nuances in the users' household roles related to their social relationships at home as well as two additional barriers regarding the technologies' usefulness for a given household and environmental contributions. Furthermore, this study not only presents two user types particular for energy-smart homes alongside with suggestions for technologies appropriate for them, but also confines a novel anti-user type. This provides new insights into what kind of users should or should not be addressed by the future development of energy-smart homes, and what kind of technologies would attract these user types.

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Appendix A: First email to respondent

Beste NAAM,

Leuk dat je mee wilt doen aan ons onderzoek! Zoals besproken zullen we binnenkort samen een interview houden over Smart Home technologieën en hun gebruik. Dit interview maakt deel uit van Johannes en mijn Bachelorondersoek aan de Universiteit Twente. Het zal ongeveer 45 minuten duren. Nu wil ik graag een afspraak met je maken om het interview af te nemen. Ik stel voor om op DATUM tussen TIJD en TIJD bij jou thuis af te spreken. Welk tijdstip komt je goed uit? Mocht je dan niet kunnen, op welk moment zou je liever willen afspreken?

Voor het interview hebben we een plekje nodig waar we ongestoord kunnen praten en waar we aan een tafel kunnen zitten. Verder hoef je niets voor te bereiden. Je gegevens zullen vertrouwlijk worden behandeld en later anoniem in het onderzoeksverslag worden weergegeven.

Mocht je vóór je eigen interview iemand spreken die al aan dit interview heeft deelgenomen, bespreek dan alsjeblieft geen details van het onderzoek met diegene. We willen namelijk graag dat je onbeïnvloed naar je eigen interview komt. Voor en na het interview zul je genoeg gelegenheid hebben om vragen te stellen aan de interviewer.

Mocht je nu alvast vragen hebben hoor ik het graag.

Groetjes,
Lisa

Appendix B: Information brochure

Informatiebrochure

In deze brief wil ik je informeren over het onderzoek waarvoor je je hebt aangemeld.

Het doel van dit onderzoek is te weten te komen wat mensen van een *Smart Home* verwachten, hoe ze over *Smart Home* technologieën denken en waarop ze deze beoordelingen baseren zijn. Het onderzoek bestaat uit een persoonlijk interview dat ongeveer 45 minuten zal duren. Je zal door een onderzoeker geïnterviewd worden die je verschillende vragen zal stellen. In dit interview gaat het alleen om je eigen mening. Je hoeft dus geen bepaalde voorkennis te hebben en er zijn geen goede of foute antwoorden.
Het interview wordt opgenomen met audio-opname apparatuur. De verzamelde data wordt vertrouwelijk behandeld, volledig geanonimiseerd verwerkt en niet door derden worden ingezien. Het interview is geheel vrijwillig en je mag op elk moment van het interview stoppen zonder dat dit verdere consequenties voor jou heeft. Na het interview heb je het recht je medewerking bij het onderzoek op elk moment in te trekken. Je data zullen in dit geval worden vernietigd en zullen niet in het onderzoek worden verwerkt.
Na afloop van het volledige onderzoek kun je, indien je dat wenst, middels een debriefing over de verkregen resultaten op de hoogte worden gesteld.

Met vriendelijke groet,

Lisa Scheifler (l.scheifler@student.utwente.nl),
Johannes Terwort (j.terwort@student.utwente.nl)

Appendix C: Informed consent

Informed consent

Ik verklaar hierbij dat ik duidelijk ben geinformeerd over de aard en methode van het onderzoek. Mijn vragen zijn naar tevredenheid beantwoord. Ik stem geheel vrijwillig in met de deelname aan dit onderzoek over de meningen van potentiele *Smart Home* gebruikers over *Smart Home* technologieën. Ik behoud daarbij het recht deze instemming weer in te trekken zonder dat ik daarvoor een reden hoef op te geven en ik besef dat ik op elk moment mag stoppen met het onderzoek. Indien mijn onderzoeksresultaten gebruikt zullen worden in wetenschappelijke publicaties, dan wel op een andere manier openbaar zullen worden gemaakt, zal dit volledig geanonimiseerd gebeuren. Mijn persoonlijke gegevens zullen niet door derden worden ingezien zonder mijn uitdrukkelijke toestemming.

....

Naam proefpersoon Handtekening

Voor verdere informatie over het onderzoek kun je contact opnemen met Lisa Scheifler (telefoon: 06-26241294; e-mail: l.scheifler@student.utwente.nl) of Johannes Terwort (telefoon: +49176-75051793; e-mail: j.terwort@student.utwente.nl). Voor eventuele klachten over dit onderzoek kun je contact opnemen met de secretaris van de Commissie Ethiek van de faculteit Gedragswetenschappen van Universiteit Twente, mevr. J. Rademaker (telefoon: 053-4894591; e-mail:j.rademaker@utwente.nl, Postbus 217, 7500 AE Enschede).

Ik heb toelichting gegeven over het onderzoek en ben bereid nog opkomende vragen over het onderzoek naar vermogen te beantwoorden.

....

Naam onderzoeker Handtekening

Appendix D: Questionnaire demographics and home info

Datum: _____

Onderzoeker: _____ Respondentnummer:____

Demografische gegevens

1. Nationaliteit:
2. Woonplaats:
3. Leeftijd:
4. Geslacht: man / vrouw
5. Opleiding/professie en specialisatie:

Thuis-informatie

6. Aantal mensen in je huishouden:
7. Status: bij familie / met vrienden / op me zelf / studentenhuis / anders, namelijk…
8. Type: eigen huis / gehuurd huis / flat / anders, namelijk…
9. Aantal jaren van verblijf:

Appendix E: Interview schema

Respondentnummer: __

Begin

- bedankt voor je deelname
- dit interview is voor mijn bacheloronderzoek binnen Psychologiestudie op UT
- doel: achterhalen wat potentiele gebruikers van smart homes vinden en waarom
- interview bestaat uit aantal onderwerpen over die ik je vragen ga stellen
- wat je zegt en je persoonlijke gegevens worden vertrouwelijk behandeld
- alle antwoorden zijn goed. je kunt gewoon vertellen wat je denkt
- tussendoor vragen
- audio-opname, om informatie later te kunnen analyseren. geef je toestemming?
- heb je nu nog vragen?
- (opname-apparatuur aanzetten)

tijd:

Omgang met technologie

1. We beginnen met je thuis. Stel je even voor welke ruimtes je in je hele huis hebt. Wat voor technische apparatuur heb je hier? *'technische apparatuur' = heeft stroom nodig*
2. Hoe gebruik je je persoonlijke apparatuur?
    - waarvoor
    - wat gebruike je het vaakst
    - wat gebruik je minder vaak
3. Wat voor moderne apparatuur heb je thuis? Met modern bedoel ik recentelijk ontwikkeld, maximaal een paar oud.
    - Wat is het modernste wat je hebt?
4. Wat vind je van nieuwe technologieën in het algemeen?
    - wat vind je belangrijk voor gebruik
    - Hoe komt dat?

tijd:

Omgang met energie

5. Kun je wat vertellen over je energieverbruik thuis? kernwoorden:
    - activiteiten die energy verbruiken
    - apparatuur die energy verbruikt
    - hoeveel *bijv. veel/weinig, meer/minder dan*
    - kosten *bijv. hoog/laag, meer/minder dan*
    - besparen – doe je dat, weet je hoe (kennis), hoe doe je dat (acties)
    - Wat vind je belangrijk bij het gebruik van energie?
    - Waarom? Hoe komt dat?

tijd:

Rol in het huishouden

6. Je hebt het net al ingevuld, maar kun je voor mij kort samenvatten hoe je woonsituatie is?
    - soort woning? *bijvoorbeeld huis of flat*
    - met hoe veel mensen?
    - wat voor relatie? *bijvoorbeeld familie, vrienden, of woongroep*
7. Stel je nu alsjeblieft voor, wat je "thuisgevoel" is. *(wat betekent thuis zijn).* Wat is daar belangrijk voor je? kernwoorden:
    - Kun je dat uitleggen? Hoe komt dat?
8. Hoe delen jullie thuis technische taken en klussen op? *Je zei net... Kun je dat nog verder uitleggen? Wil je nog iets toevoegen?*
    - wie installeert apparatuur
    - wie onderhoudt/repareert apparatuur
    - Hoe komt dat?
9. Wie let thuis op het energieverbruik? *Je zei net... Kun je dat nog verder uitleggen? Wil je nog iets toevoegen?*
    - Hoe komt dat?
10. Denk even terug aan wat we net hebben besproken over hoe jullie thuis samen leven. Wat is jouw rol daarin? *'rol' = bijdrage aan gezamenlijk wonen, takenpakket*
    - mbt. technologieën
    - mbt. energiegebruik
    - Hoe ben je in die 'positie' gekomen?
    - Is die verdeling prettig voor jou?
    - Wat vind je belangrijk bij je 'rol'?
    - voorbeeld (feiten/acties + beleving)
    - Hoe komt dat?

tijd:

Het energie-smart home

- onderzoek gaat over smart homes
- Ik ga nu uitleggen wat dat is en wat het te maken heeft met energie.
- vragen mag tussendoor
- Ik ga nu plaatjes neerleggen. Als we hier straks over praten, kun je ze graag ook aanwijzen en verschuiven.
- huis-plaatje neerleggen, gedraaid naar de respondent: Stel je voor dat dit je woning of huisje is. jij, activiteiten
- energieleveranciers: Dit verbruikt energy. energieleverancier, kosten
- smart meter: Hoe kun je nagaan hoeveel je verbruikt? smart m., display, gebruik aanpassen
- variabele energietarieven: twee weg communicatie door smart meter, prijzen aanpassen
- smart apparaat: Moet je dat nou alles zelf bijhouden? apparaten kunnen zelfstandig werken op basis van informatie over energievoorraad en -prijzen
- (het) communicatieplatform: Hoe "weet" de apparatuur dat? wireless datatransfer tussen...

- remote toezicht en controle: Prijzen zijn hoog als veel mensen tegelijkertijd energie gebruiken, en dus laag als verder niemand dat doet. Moet je dan steeds 4:00 ’s nachts je was doen omdat dan de energieprijzen laag zijn? je apparaten besturen en verbruik bijhouden, via cloud en display
- automatisch energierooster: geoptimaliseerd energieverbruik volgens automatisch vastgelegde planning; Het systeem integreert daarbij de informatie van je smart meter (verbruik en prijzen) en jouw voorkeuren.
- autonome software agent: een stap verder. Een software agent houdt informatie bij over energie, kosten, apparaturen en je voorkeuren. Het systeem kan gewoontes leren en voorspellingen doen. De agent neemt beslissingen voor jou en/of voor de energieleverancier en beheert zelfstandig je apparatuur. Jij kunt voorkeuren aangeven via een display en eventueel toestemming geven of wijgeren voor wat de agent doet. De agent kan meer passief zijn individueel advies geven. Of hij kan je apparaten volledig automatisch controleren.

11. Heb je hier nog vragen over?
12. Wat vind je van deze technologieën? Wijs ajb. de kaartjes aan.
13. Wat bevalt je aan deze smart home technologieën? *Je zei net... Wil je daar nog iets aan toevoegen of zijn er nog andere dingen die je niet bevallen?*
    - Hoe komt dat?
14. Wat bevalt je niet aan een smart home? *Je zei net... Wil je daar nog iets aan toevoegen of zijn er nog andere dingen die je niet bevallen?*
    - Hoe komt dat?
15. Wat zouden smart home technologieën kunnen toevoegen aan jullie gehele huishouden?
    - voorbeeld (feiten/acties + beleving)
    - Waarom denk je dat dat zo is?
16. We hebben net je omgang met energie thuis besproken. Je zei dat je ... (5. parafraseren). Denk je dat dit zou veranderen door smart home technologie?
    - Zo ja, hoe? Zo niet, waarom niet?
17. Denk even terug aan wat we over je “thuisgevoel” hebben besproken. Je zei dat je ... (7. parafraseren). Wat voor effect zou een smart home hierop hebben?
    - Zou je je meer thuis voelen?
    - Zo ja, hoe komt dat? Zo niet, waarom niet?
    - Wat voor invloed zou dat hebben op je gebruik van smart home technologieën?
    - voorbeeld (feiten/acties + beleving)
18. Stel je voor je zou de mogelijkheid hebben om smart home technologieën aan te kunnen schaffen. Zou je ze thuis willen hebben?
    - Welke wel of niet? Wijs ajb. de kaartjes aan.
    - Waarom wel of niet?
    - Zo ja, waarvoor zou je ze gebruiken?
    - Wat vind je aantrekkelijk aan die technologieën? *voordelen*
    - Wat zou je tegenhouden om die technologieën te gebruiken? *nadelen*
    - voorbeeld (feiten/acties + beleving)

tijd:

Comfort (kort voorlezen)

Iedereen heeft een eigen idee van wat hij comfortabel acht en welk level van comfort hij wenselijk vindt. Smart Home technologie kan een grote invloed hebben op het gevoel van comfort in een huis. Als je niet zeker weet wat jij als comfortabel acht in je huis, denk dan even na over wat je wensen voor een comfortabel huis zijn. Denk eraan welke rol Smart Home technologie in je huis voor je comfort zou kunnen spelen.

Controle

Er zijn twee verschillende manieren hoe Smart Home techniek kan worden gecontroleerd: Het intelligente computer systeem in het huis kan geprogrammeerd worden om op een bepaalde manier de techniek automatisch aan en uit te zetten en te besturen. Of de gebruiker kan de techniek in het huis handmatig controleren via een schakel, App op het Smart Phone of op andere manieren.

19. In hoeverre denk je dat een Smart Home invloed heeft op het comfort in je huishouden? *(Mogelijk verband met thuisgevoel)*
20. Als alles mogelijk zou zijn, wat wil je dat een Smart Home kan, zodat het bijdraagt aan jouw comfort?
    - Wil je bepaalde dingen graag geautomatiseerd hebben?
    - Wil je bepaalde dingen niet geautomatiseerd hebben?
    - In welke mate wil je dit (niet) geautomatiseerd hebben?
    - Zo ja, waarom?
    - Wat draagt dit volgens jou bij aan je comfort?
21. Een Smart Home zou comfort kunnen bieden, maar het kan echter ook dat een Smart Home discomfort kan bieden. Wanneer denk jij dat een Smart Home geen comfort kan bieden?
    - Waarom?
    - In hoeverre / In welke mate zou je dit accepteren?
    - Wat zijn je redenen om dit te accepteren?
22. Denk terug aan het Energy-Smart-Home.

In hoe verre ben je bereid comfort in te leveren om energie te besparen? (Als dit al bij vraag 21 werd beantwoord, dan alleen doorvragen op de punten beneden.)

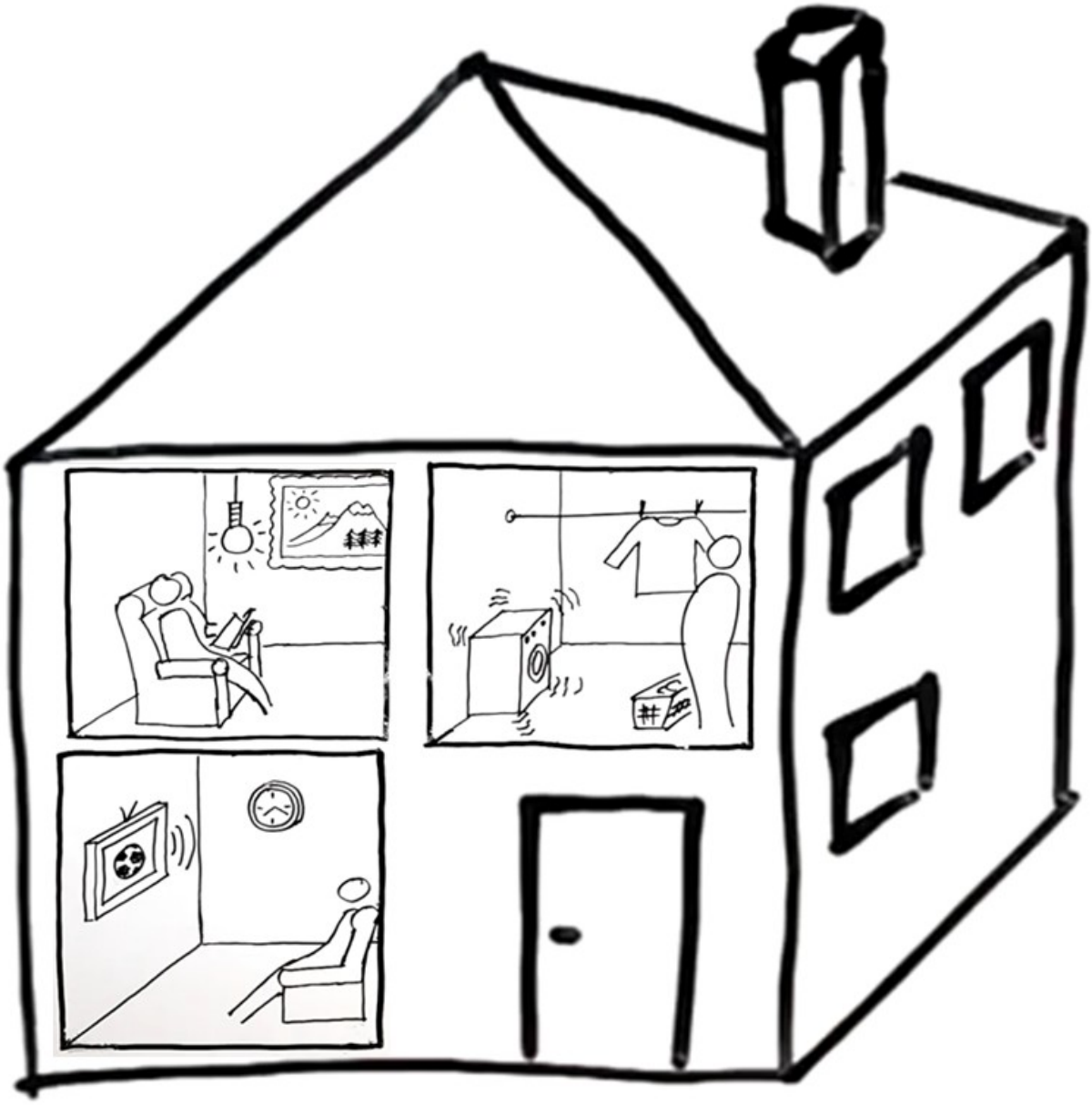
- Welk soort comfort zou je opgeven?
- Waarom?
- Zou je een voorbeeld kunnen geven?

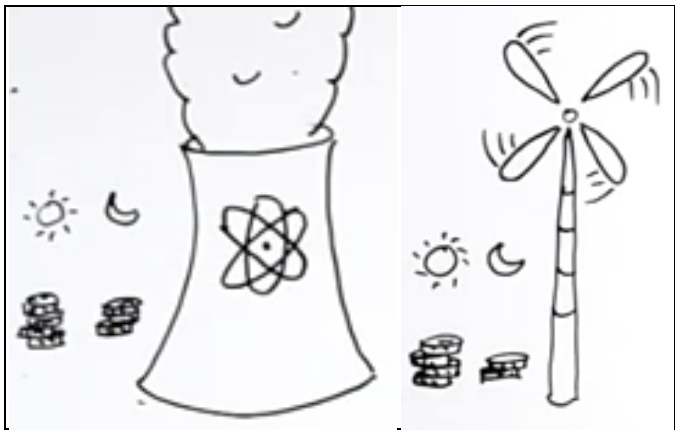
tijd:

Afsluiting

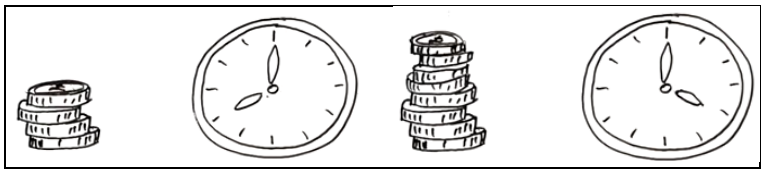
- (opname-apparatuur uitzetten)
- we zijn nu klaar met het onderzoek
- bedankt voor je tijd
- heb je nog vragen of opmerkingen?

Appendix F: Paper cards

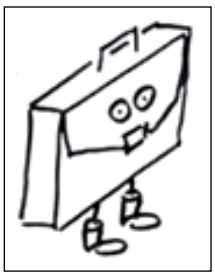




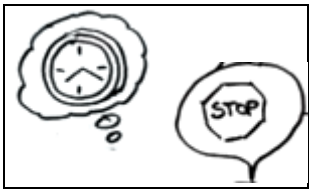
1. energieleveranciers



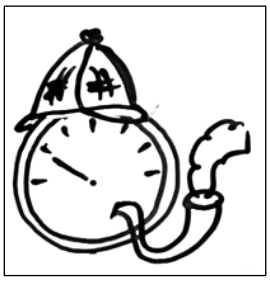
3. variabele energietarieven



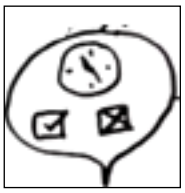
8. autonome software agent



9. individueel/automatisch



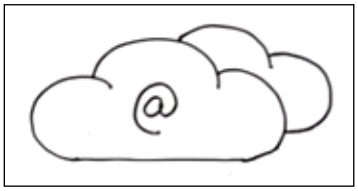
2. smart meter



4. smart apparaat

7. automatisch energierooster

6. remote toezicht en controle



5. (het) communicatieplatform

Appendix G: Coding schema

Codes	Topics
1. Modern technology use	
1.1 Few devices used infrequently	*niet regelmatig, niet dagelijks in gebruik*
1.2 Few devices used frequently	*een of twee apparaten regelmatig in gebruik*
1.3 Many devices used frequently	*meer dan twee apparaten regelmatig in gebruik*
2. Modern technology opinion	
2.1 More negative than positive	*kan leuk zijn, maar voegt vaak niks toe, heeft geen nut, niet nodig*
2.2 Evenly negative and positive	*handig, maar heeft ook nadelen*
2.3 Only positive	*voegt veel toe, heel interessant*
3. Knowledge about energy use	
3.1 Trivial	*ik gebruik electriciteit/stroom, water, gas*
3.2 Rough	*kan grofweg inschatten hoe veel hij/zij verbruikt*
3.3 Detailed	*kennis over bijv. kWh, kosten, verbruik van aparte apparaten, hoe isolering schilt, energie-aanbieders*
4. Energy saving	
4.1 No activities	*wordt niet gedaan, wordt niet op gelet*
4.2 Infrequent small actions	*soms doe ik wel dit en dit*
4.3 Frequent small actions	*altijd uit-/dichtdoen wat niet gebruikt wordt*
4.4 Comprehensive activities	*zuinige apparaten aanschaffen, huis verbouwen om energie te besparen, aanbieder kiezen*
5. Home feeling	
5.1 Own space	*plek voor mezelf, ingericht zoals ik wil*
5.2 Own way	*kunnen doen wat ik wil, mezelf zijn*
5.3 Rest	*rust hebben, tot rust komen, niets hoeven*
5.4 Companionship	*belangrijke mensen om me heen, gezelligheid*
6. Household role technology	
6.1 Not involved	*ik bemoei me daar niet mee*
6.2 Directs others	*regelt dat anderen het doen die er beter mee zijn*
6.3 Individual role	*ik zorg dat het in orde komt*
6.4 Collective role	*we zorgen samen dat het in orde komt*
7. Household role energy	
7.1 Not involved	*besparen is niet belangrijk/heeft geen nut/kost te veel moeite en wordt niet gedaan*
7.2 Individual role	*ik let op dat ik bespaar/dat er bespaart wordt*
7.3 Collective role	*we zorgen samen dat er bespaard wordt*

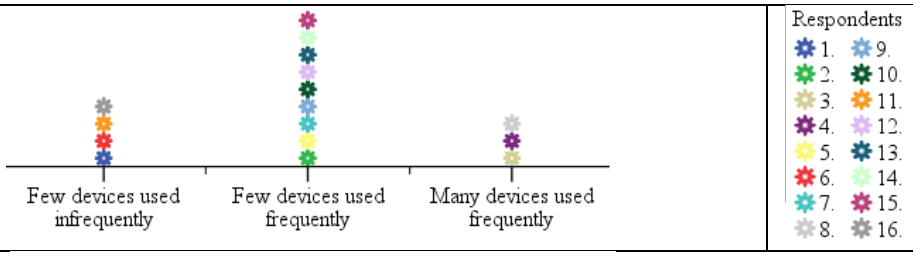
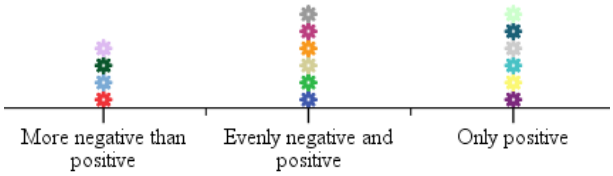
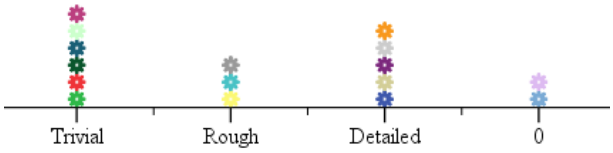
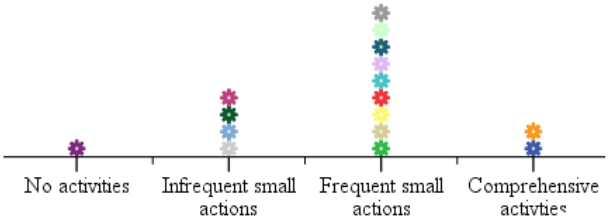
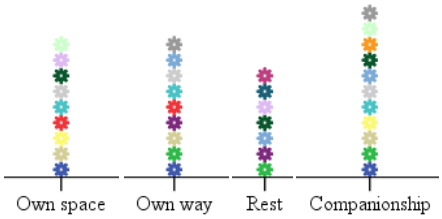
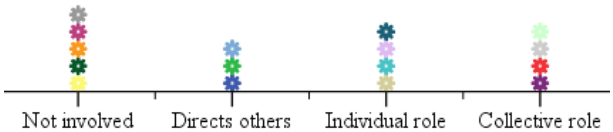
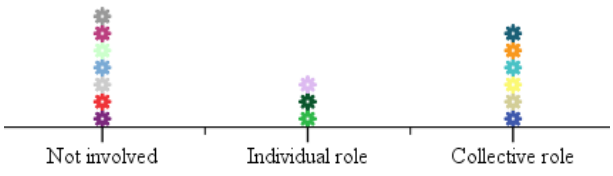
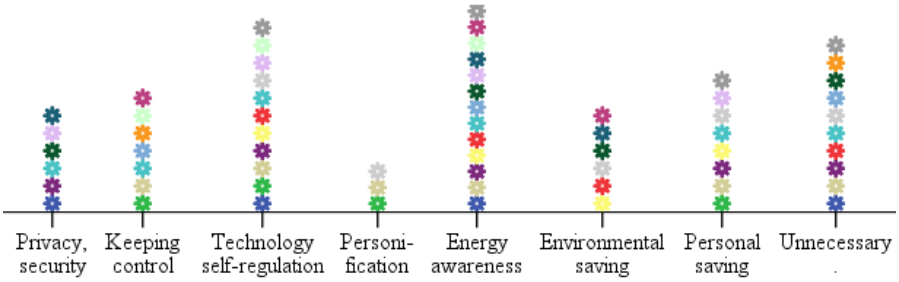
8. Energy-smart home barriers

8.1 Privacy, security	*informatie over jezelf naar anderen, toegang tot je huis door anderen, misbruik hiervan*
8.2 Keeping control	*zelf controle behouden over wat er gebeurt, liever zelf ipv technologie laten doen, zelf doen wat op dat moment nodig is of wat in eigen routine past*
8.3 Technology self-regulation	*technologie werkt zelfstandig, niet over na willen denken, geen moeite insteken, niet met huis bezig willen zijn terwijl men iets anders aan het doen is*
8.4 Personification	*alsof je huis (de technologie) voor je zorgt, huis moet gezellig blijven*
8.5 Energy awareness	*inzicht in eigen verbruik krijgen, bewust bezig zijn met verbruik, op basis daarvan kunnen handelen, niet altijd thuis van energie bewust willen zijn*
8.6 Environmental saving	*goed voor het milieu, voor het milieu of de maatschappij besparen*
8.7 Personal saving	*energie of kosten besparen, voor mezelf besparen*
8.8 Unnecessary	*technologie voegt niets toe aan/heeft geen nut voor dagelijkse bezigheden, overbodig, biedt niets beters tov bestaande apparaten/activiteiten*

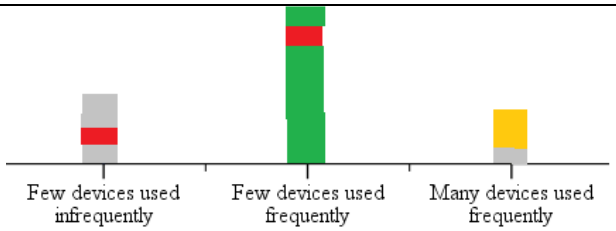
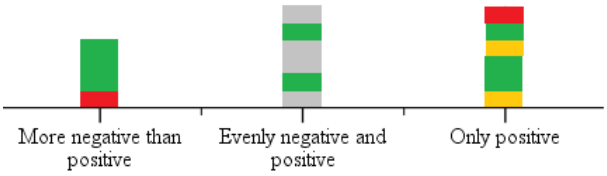
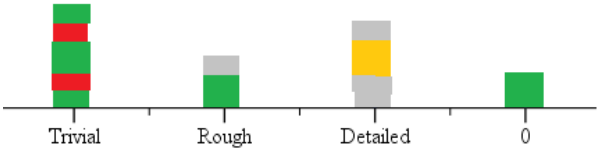
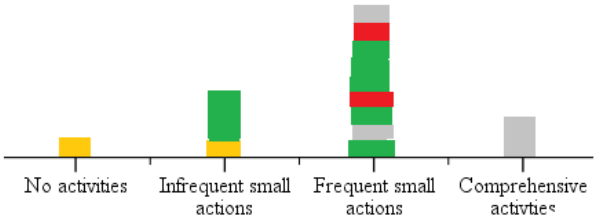
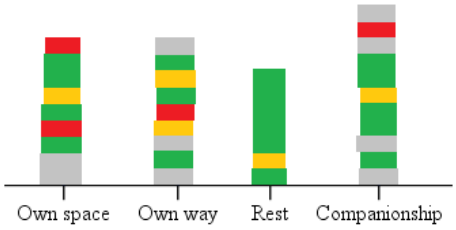
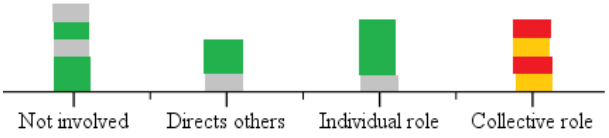
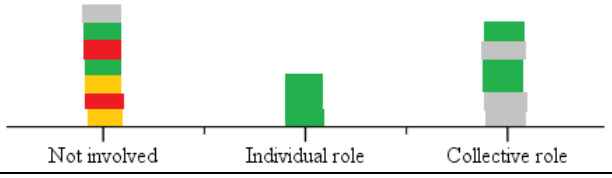
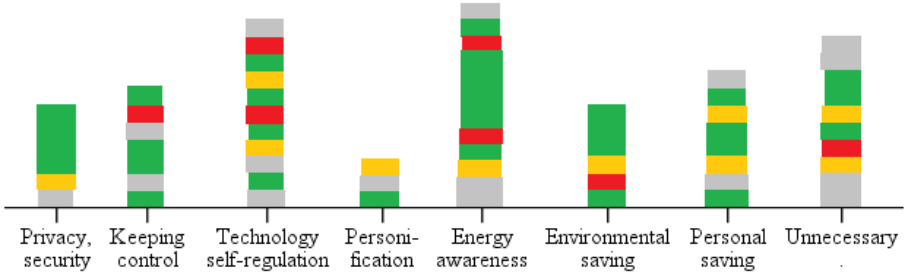
Appendix H: Percentages of respondents sharing variables

Variable	Range	Percentage
Modern technology use	Few devices used infrequently	25,0
	Few devices used frequently	56,3
	Many devices used frequently	18,8
Modern technology opinion	More negative than positive	25,0
	Evenly negative and positive	37,5
	Only positive	37,5
Knowledge about energy use	Trivial	37,5
	Rough	18,8
	Detailed	31,3
	Respondents without information	12,5
Energy saving	No activities	6,3
	Infrequent small actions	25,0
	Frequent small actions	56,3
	Comprehensive activities	12,3
Home feeling: Own space	Yes	56,3
	No	43,8
Home feeling: Own way	Yes	56,3
	No	43,8
Home feeling: Rest	Yes	43,8
	No	56,3
Home feeling: Companionship	Yes	68,8
	No	31,3
Household role technology	Not involved	31,3
	Directs others	18,8
	Individual role	25,0
	Collective role	25,0
Household role energy	Not involved	43,8
	Individual role	18,8
	Collective role	37,5
Energy-smart home barrier: Privacy, security	Yes	37,5
	No	62,5
Energy-smart home barrier: Keeping control	Yes	43,8
	No	56,3
Energy-smart home barrier: Technology self-regulation	Yes	68,8
	No	31,3
Energy-smart home barrier: Personification	Yes	18,8
	No	81,3
Energy-smart home barrier: Energy awareness	Yes	81,3
	No	18,8
Energy-smart home barrier: Environmental saving	Yes	37,5
	No	62,5
Energy-smart home barrier: Personal saving	Yes	50,0
	No	50,0
Energy-smart home barrier: Unnecessary	Yes	62,5
	No	37,5

Appendix I: Mapping of the respondents on the distinguishing variables

Variable	Mapping of the respondents
1. Modern technology use	
2. Modern technology opinion	
3. Knowledge about energy use	
4. Energy saving	
5. Home feeling	
6. Household role technology	
7. Household role energy	
8. Energy-smart home barriers	

Appendix J: Differences between and within personas (graphic)

Variable	Range with persona patterns
1. Modern technology use	
2. Modern technology opinion	
3. Knowledge about energy use	
4. Energy saving	
5. Home feeling	
6. Household role technology	
7. Household role energy	
8. Energy-smart home barriers	

Note. 'green' = persona Jan; 'grey' = persona Lotte; 'yellow' and 'red' = persona Bas

Appendix K: Differences between and within personas (frequencies)

Variable	Range	Jan	Lotte	Bas
Modern technology use	Few devices used infrequently	0	.75	.25
	Few devices used frequently	1	.25	.25
	Many devices used frequently	0	0	.50
Modern technology opinion	More negative than positive	.375	0	.25
	Evenly negative and positive	.25	1	0
	Only positive	.375	0	.75
Knowledge about energy use	Trivial	.50	0	.5
	Rough	.25	.25	0
	Detailed	0	.75	.5
	Respondents without information	.25	0	0
Energy saving	No activities	0	0	.25
	Infrequent small actions	.375	0	.25
	Frequent small actions	.625	.5	.5
	Comprehensive activities	0	.5	0
Home feeling: Own space	Yes	.5	.5	.75
	No	.5	.5	.25
Home feeling: Own way	Yes	.375	.75	.75
	No	.625	.25	.25
Home feeling: Rest	Yes	.75	0	.25
	No	.25	1	.75
Home feeling: Companionship	Yes	.625	1	.5
	No	.375	0	.5
Household role technology	Not involved	.375	.50	0
	Directs others	.25	.25	0
	Individual role	.375	.25	0
	Collective role	0	0	1
Household role energy	Not involved	.25	.25	1
	Individual role	.375	0	0
	Collective role	.375	.75	0
Energy-smart home barrier: Privacy, security	Yes	.5	.25	.25
	No	.5	.75	.75
Energy-smart home barrier: Keeping control	Yes	.5	.5	.25
	No	.5	.5	.75
Energy-smart home barrier: Technology self-regulation	Yes	.5	.75	1
	No	.5	.25	0
Energy-smart home barrier: Personification	Yes	.125	.25	.25
	No	.875	.75	.75
Energy-smart home barrier: Energy awareness	Yes	.875	.75	.75
	No	.125	.25	.25
Energy-smart home barrier: Environmental saving	Yes	.5	0	.5
	No	.5	1	.5
Energy-smart home barrier: Personal saving	Yes	.5	.5	.5
	No	.5	.5	.5
Energy-smart home barrier: Unnecessary	Yes	.375	1	.75
	No	.625	0	.25

Appendix L: Overview respondents per persona

Persona 1 – Jan

- based on 8 respondents (number 2, 5, 7, 9, 10, 12, 13, and 15)
- age ranges from 22 to 52 years (M = 28)
- 4 female, 4 male
- number of people in household ranges from two to fourteen (M = 6)
- 3 live in a student house, 1 lives with friends, 4 live with a partner
- 4 live in a flat, 3 live in a rented house, 1 lives in an own house
- years of residence range from one month to ten years (M = 4.5 years)
- educational backgrounds: Industrial Design, Physics, Civil Engineering, Human-Media Interaction, Biomedical Engineering, Chemistry, Psychology, Applied Physics
- home feeling: rest, companionship, own space
- few modern devices used frequently
- evenly negative and positive opinion about modern technology
- household role technology: directs others
- trivial to rough knowledge about own energy use
- frequent small actions for energy saving
- household role energy: individual role to collective role
- energy-smart home barriers: (energy awareness, technology self-regulation, personal saving), privacy/security, environmental saving, keeping control

Persona 2 – Lotte

- based on 4 respondents (number 1, 3, 11, and 16)
- age ranges from 20 to 52 years (M = 29)
- all female
- number of people in household ranges from two to fourteen (M = 6)
- 2 live in a student house, 1 lives with friends, 1 lives with a partner
- 2 live in a flat, 1 lives in a rented house, 1 lives in an own house
- years of residence range from five months to ten years (M = 4.4 years)
- educational backgrounds: Psychology, Technical Medicine, Nursing, Communication Science
- home feeling: companionship, own way
- few modern devices used infrequently
- evenly negative and positive opinion about modern technology
- household role technology: not involved
- detailed knowledge about own energy use
- frequent small actions to comprehensive activities for energy saving
- household role energy: collective role
- energy-smart home barriers: (energy awareness, technology self-regulation, personal saving), keeping control, unnecessary

Persona 3 – Bas

- based on 4 respondents (number 4, 6, 8 and 14)
- age ranges from 20 to 24 (M = 23)
- all male
- number of people in household ranges from two to fourteen (M = 8)
- 3 live in a student house, 1 lives with a partner
- 3 live in a flat, 1 lives in a rented house
- years of residence range from one month to six years (M = 2.5 years)
- educational backgrounds: two times Electrical Engineering, Management of Product Development, Art and Technology
- home feeling: own space, own way
- many modern devices used frequently
- only positive opinion about modern technology
- household role technology: collective role
- detailed knowledge about own energy use
- frequent small actions for energy saving
- household role energy: not involved
- energy-smart home barriers: (energy awareness, technology self-regulation, personal saving), environmental saving, unnecessary

Appendix M: Quote translations

Vari-able	Original Dutch quote	Translated English quote
1	"Ja bijvoorbeeld mijn smartphone is een iphone vier. Dus redelijk oud. En ook alle apparaturen van de keukenaparaturen zijn niet erg fancy of nieuw."	"Yeah for example my smartphone is an iPhone four. Thus pretty old. And also all the equipment of the kitchen is not very fancy or new."
	"Telefoon en laptop zijn nieuw, die zijn het recentelijkst ontwikkeld denk ik. Ja... nee, meer... ik heb geen snufjes in mijn oven zitten ofzo. Nee dat is allemaal ouderwets."	"Phone and laptop are new, they are developed most recently I think. Yeah ... no, more ... I don't have any gadgets in my oven or something. No, that's all old-fashioned."
	"Computer, smartphone, ik zit even te denken of er nog andere dingen zijn op mijn kamer ofzo. Ja, speakers, opnamespullen, microfoons, versterkers."	"Computer, smartphone, I'm just thinking if there are other things in my room or something. Yes, speakers, recording gear, microphones, amplifiers."
2	["Wat maakt het interessant?"] "Deels dat het nieuw is, maar ook dat technische, dat het je leven eenvoudiger kan maken. Dat je er zoveel mee kan en dat het heel veel verschillende doeleinden kan hebben."	["What makes it interesting?"] "Partly that it's new, but also that technical, that it can make your life easier. That you can do so much with it, and that it can have many different purposes."
	"Het maakt het makkelijker, het is fijn, het is handig dat je bijvoorbeeld met een mobiele telefoon altijd iemand kan bereiken en als je dan ook navigatie hebt, het is gewoon practisch, maar ik vind wel dat soms nieuwe technologieën – wat ik jammer vind dat vaak de nieuwste dingen vaak zo belachelijk duur zijn dat ze niet voor iedereen toegankelijk zijn, dus dat vind ik wel jammer. Ik hoef het ook niet per se te hebben, maar ik vind het wel jammer dat je dan vaak een bepaald merk nodig hebt om alles aan elkaar te koppelen. Dan denk ik: dat zou makkelijker allemaal samen kunnen werken ofzo."	"It makes it easier, it's nice, it's convenient that for example with a mobile phone you can always reach someone and if you also have navigation, it's just practical, but I do think that sometimes new technologies – it's a pity that often the newest things often are so ridiculously expensive that they are not accessible to everyone, that's too bad. I do it not necessarily need to have it, but I find it a shame that you often need a particular brand to connect everything. Then I often think, it should be possible that that is easier or something."
	"Vooral bij entertainment technologien merk ik, dat ik het gevoel krijg van, goh, moeten we niet af en toe eens wat maar daavan terug gaan en meer gewoon wat minder achter schermpjes zitten en wat meer gewoon, ja, bezig zijn met elkaar en bezig zijn met, niet alleen hier in het huis maar over het algemeen. Maar, nieuwe technologien als in betere verbindingen of dingen waardoor je langer met lampen kan rondhangen omdat je led-lampen hebt in plaats van... dat soort dingen vind ik wel positief, dat het gewoon dingen gemakkelijker en beter kan maken."	"Especially with entertainment technologies I notice that I get the feeling of, gosh, should we not sometimes use it less and more just sitting less behind screens and more just, yeah, being engaged with each other and being busy with, not only in the home but in general. However, new technologies like improved connections or using your lights longer because you have LED lights instead of ... I think stuff like that is positive, it just makes things easier and better."
3	"Volgens mij gingen we nu maandbedrag... sowieso iets van 80 euro per maand ofzo."	"I think our monthly costs... anyway something like 80 euro per month."
	"We hebben hier geen wasmachine, dus dat scheelt. We wonen met z'n tweeën, natuurlijk is daar niet zo veel ruimte voor, dus en we gaan in het weekend naar huis toe dus dat scheelt want dat gebruikt natuurlijk normaal veel energie.	"We do not have a washing machine here, so that helps. We live with two people here, of course there is not so much space, so in the weekend we go home, so that makes a difference because that would use

	Magnetron kost wel veel energie denk ik, maar die heb je niet continu aanstaan, ja hij zit wel aan het stopcontact maar als het niet draait is het natuurlijk een heel klein stroompje dat er doorheen loopt voor de wekker of voor de klok zegmaar... De koelkast en de vriezer kan ook wel wat energie verbruiken, verder hebben we hier gaskachels, maar we hebben twee extra kleine electrische radiatortjes die gebruiken wel veel stroom, maar die gebruiken we gewoon zo min mogelijk maar wel om even wat bij te warmen."	much energy. The microwave uses a lot of energy I think, but that's not turned on continuously, yeah it's plugged in the socket but when it is not running it's of course just very little power that runs through it for the alarm or the clock... The refrigerator and freezer use quite some power, we also have gas stoves here, but we have two additional small radiators which use a lot of power, but we use them just as little as possible, to heat a bit of course."
	"De grootste dingen zijn waarschijnlijk dat ik vaak mijn computer overdag heb aanstaan omdat ik daarop studeer. En dat gebruikt veel energie want ik heb geen laptop, dus dat is een stuk minder, een stuk meer energie verbruikt dat gewoon. En ik douch altijd vrij lang, dat kost ook veel energie. Ik denk dat dat de twee grootste dingen zijn. En dan ook kleinere dingen, zoals dat mijn muziek nog wel eens aanstaat enzo en dergelijke."	"The biggest things are probably that I often have my computer turned on during the day because I need to study. And it uses a lot of energy because I don't have a laptop, so that's a lot more energy to normal. And I always shower quite long, that takes a lot of energy. I think those are the two biggest things. And then smaller things, like my music is sometimes on and the like."
4	"Ik ben een beetje een van die mensen die altijd zegt, die altijd het idee wel heel leuk vind van energiezuinig zijn en besparen, maar als het puntje bij paaltje komt dan douch ik nog steeds eigenlijk veel te lang. Zeg maar dat ben ik een beetje. Dus ik probeer wel altijd om bijvoorbeeld het licht achter me uit te doen en mijn computer uit te zetten als ik wegga en dat soort dingen. Maar tegelijkertijd heb ik wel een aquarium wat 24/7 warmte staat te stoken en ik douch ook wel gewoon langer dan gemiddeld omdat ik hou van douchen, zeg maar dat. Dus ik probeer wel om er zuinig op te zijn, maar niet als het weer mijn eigen, ja als ik daar echt heel veel voor moet aanpassen dan weer niet."	"I'm kind of one of those people who always says, who always really likes the idea to be energy efficient and save money, but when it comes to the crunch I still shower much too long. Well that's how I am. So I always try to, for example, to switch off the light behind me and to turn off my computer when I leave and the like. But at the same time I have an aquarium that is heating 24/7 and I shower longer than average because I love showering. So, I do try to save, but not when my own, yeah if I need to adjust a lot, then not."
	"Ik probeer erop te letten om netjes de lampen uit de doen als ik mijn kamer uit ga, en om de verwarming uit te doen als ik die niet nodig heb. Maar verder doe of laat ik er geen dingen om. Het is niet dat ik geen tv ga kijken, omdat ik denk dat het energie kost. Als ik lekker wil koken, maak ik ook gewoon lekker een stoofpot, ook al weet ik dat dan een halve dag lang het gas staat te branden. Ik laat er niks om."	"I try to make sure that I always switch off the lamps when I leave my room and to turn off the heating when I don't need it. But otherwise I don't care much. It's not that I do not watch TV, because I think it takes energy. If I want to cook well, I just make a nice stew, even though I know that then the gas will burn half the day. I don't give up things for it."
	"We hebben nou net een nieuwe droger gekocht omdat die al zo oud was en die zjin, die apparatuur, daar letten we wel natuurlijk op het energieverbruik, dat het A+++ is, dat minder, B. heeft er wel erg op gelet dat het minder stroomverbruik is."	"We have just bought a new dryer because it was so old and it is, that equipment, of course we pay attention to energy consumption, that it's A +++, so that less, B was engaged a lot to make sure that it uses less power."
5	"Voor mij ben ik thuis aan het uitrusten om daarna weer weg te gaan om leuke dingen te doen en misschien ook om een beetje dingen voor te	"For me, at home I'm resting to leaving afterwards for doing fun things, and perhaps also to prepare some things, so to

	bereiden, dus om een beetje te werken thuis, maar dat is weer, eigenlijk komt alles neer op rust. ja, een plek waar ik tot rust kan komen misschien."	work a bit at home, but that's, basically everything is about resting. So yeah, a place where I can relax, perhaps."
	"Voor mij is het misschien meer een definitiekwestie: dit is mijn huis, prima. Dan kom ik na een dag hard werken thuis, ik gooi mijn tas in de hoek, ik hang mijn jas op, ik zet een kop koffie, en dan ben ik thuis. Dus ik denk dat het voor mij belangrijk is dat daar de dingen aanwezig zijn die ik graag wil gebruiken in mijn vrije tijd. En dat is mijn tv, mijn laptop, mijn bed om in te slapen, mijn mes om mee te koken."	"For me it's maybe more a question of definition: This is my home, fine. Then I come home after a hard working day, I throw my bag in the corner, I hang my coat on, I make a cup of coffee, and then I'm home. So I think it's important to me that things are here which I want to use in my spare time. And that's my TV, my laptop, my bed to sleep in, my knife for cooking."
	"Gewoon hier mijn gang gaan, mensen om mee te praten, of niet als ik niet wil. Dat vind ik leuk."	"Just going my own way here, people to talk to, or not if I don't want to. That's what I like."
6	"S. en J. die doen elektrotechniek en zulke dingen. Die zijn helemaal pro technische... computer, licht en lampen, weet ik wat allemaal, die snappen dat. Dan is het van, he, ik heb hulp nodig en dan helpen ze."	"S. and J. are doing electrical engineering and things like that. They are all pro technical… computer, lights and lamps, those things, they understand that. Then it's like, hey, I need help, and then they help."
	"We hebben twee technische mensen die goed zijn met zeg maar, met techniek en met eh... computers en dergelijke, die goed zijn met techniek en met computers en dingen, dus die regelen eigenlijk alles. Als er iets kapot is dan gaan we naar hun toe en dan zeggen we, ohh het is kapot, en dan lossen zij het op. En als iets van mijzelf kapot is, dan probeer ik dat meestal eerst zelf op te lossen en als dat niet lukt dan ga ik ook naar die mensen toe zeg maar, dan weten zij het meestal wel."	"We have two technical people who are good with technology and with computers and things like that, so they actually arrange everything. If something is broken then we go to them and then we say, ohh it is broken, and then they fix it. And if something from my things is broken, I first try it myself and if that does not succeed then I go to those people and they usually know what to do."
	"Aangezien ik daar wel affiniteit mee heb, denk ik dat ik wel één van de mensen ben die er voor zorgt dat het hier ook technisch allemaal wel in orde is." ["En wat doe je dan bijvoorbeeld? Qua die technische dingen?"] "Ik zorg ervoor dat mensen in de woonkamer leuk TV kunnen kijken of muziek kunnen luisteren en dat dat allemaal goed werkt en goed klinkt. En als er iets kapot is aan broodroosters of wat dan ook, dan repareren we dat eventjes. Ik denk dat ik binnenkort ook het koffiezetapparaat even ga pimpen, dat er een timer in komt, dat we weten hoe lang er koffie is gezet."	"Since I do have an affinity with that, I think I'm one of the people who make sure that technically everything is okay." ["And what do you do for example? With these technical things?"] "I make sure that people in the living room can nicely watch TV or listen to music and that everything works well and sounds good. And if something is broken, the toasters or whatever, then we just fix it. I think soon I'm going to pimp the coffeemaker, that it gets a timer so we know when the coffee was made."
7	"Ik denk dat sommige mensen het wel en andere mensen het niet doen, en uiteindelijk wordt er niet echt veel energie bespaard, aangezien er toch zoveel spullen altijd aan staan. In zo'n huis als dit... het wordt wel een beetje gedaan, maar uiteindelijk zal het echt niet uitmaken, naar mijn mening."	"I think that some people do it and others do not, and ultimately not really much energy is saved, as there are always so many things turned on. In such a house like this ... it will always be done a little bit, but in the end it really will not matter, in my opinion."
	"De penningmeester heeft wel het overzicht van getallen. R. heeft dan de lampjes geintroduceerd. Zelf doe ik heel vaak, als ik ergens zie dat het	"The treasurer does have the list of the numbers. Then, R. has introduced the bulbs. Personally, I often do, when I see

	licht aan is dan die ik het licht uit. Zulke dingen. Dus het is een beetje allemaal.”	that somewhere the light is on then I turn off the light. Such things. So it's a bit like all of us.”
	“Ik probeer soms wel mensen ervan bewust te maken zo van, jo, staat het licht in de woonkamer nou nog steeds aan, doe dat eens uit als je weg gaat, staat het licht in de badkamer nou nog steeds aan, doe dat uit als je weggaat. Maar verder wordt er eigenlijk niet op gelet.”	“I sometimes try to make people aware of it, like, is the light in the living room still on, just turn that off when you go away, is the light in the bathroom still on, turn it off when you are leaving. But further it’s not really considered.”
8	“Ja ik hou niet zo veel van data verzamelen en dat mensen dan jouw data kunnen zien. Voor mij is het beter als het een beetje anoniem blijft, en vertrouwelijk. Ik wil niet dat te veel data over mijzelf wordt verzameld.”	“Yeah I don’t like data collection and that people can see your data. For me it's better when it remains a bit anonymous and confidential. I do not want that too much data about myself is collected.”
	“Ik vind het heel goed om energie te besparen, en dat is aan twee kanten. Aan de ene kant scheelt het natuurlijk geld, maar daar ben ik niet zo heel bewust mee bezig, maar ik zou hier wel ook mijn eigen geld voor over hebben als het uiteindelijk energie zou kunnen besparen. Dat is het hele verhaal achter de smart grids, dat het uiteindelijk energie scheelt als je de pieken en dalen elkaar laat opheffen in energiegebruik. Dus daar zou ik heel erg voor zijn.”	“I think it’s very good to save energy, and that's for two reasons. On one hand that saves money of course, but I'm not very keen on that, I’d even would spend some money on it if it eventually could save energy. That's the whole story behind the smart grids, that ultimately energy is saved when the peaks and valleys are averaging in energy consumption. So that I would favor very much.”
	“Ik denk dat de apparaten die echt wel redelijk wat stroom gebruiken, bijvoorbeeld de ijskast en de vriezer, en die staan dan over dag ook natuurlijk aan, maar daar kan je ook niet van zeggen ik doe ‘m even uit, want dan bederft je voedsel. Dus dat zijn ook wel dingen waarvan je denkt je kan er niets mee. Maar ik heb wel zoiets van, voor de vakantie heb ik zoiets van, ja dan kan je net zo goed als je langere tijd hier niet bent, dan is het handig als ‘ie gewoon leeg is, je koelkast, en dan zet je gewoon je koelkast, trek je de stekker er uit, klaar. Dus daarom vind ik het een beetje lastig inderdaad omdat het dan, hoeveel het zegmaar daadwerkelijk dan zou kunnen opleveren.”	“I think that the devices that use quite much power, such as the refrigerator and freezer, and they are of course turned on all day, but you cannot just turn it off because then you’d spoil the food. So that are things where I think you cannot do anything with it. But I'm like, before the holidays I’m like, yeah, when you’re not here for some time then you might as well, then it’s convenient if you just empty your fridge and pull out the plug, done. Thus, therefore I find it a bit difficult indeed because then, how much would it actually yield.”