



Article

Innovation adopters: a new segmentation model

The case of photovoltaic in the Netherlands

Véronique Vasseur^{1,*}

¹ International Centre for Integrated Assessment and Sustainable Development, University Maastricht / P.O. Box 616, 6200 MD Maastricht, The Netherlands

E-Mails: veronique.vasseur@maastrichtuniversity.nl

* Author to whom correspondence should be addressed; Tel.: +31-433-883-223; Fax: +31-433-884-916

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Abstract: The adoption of photovoltaic (PV) is characterized by the number of individuals or households that decide to adopt or reject this technology. In this research, we analyzed the innovators who have adopted a PV system, which kind of people adopt it and what are for example their demographic characteristics. We also took the people who rejected a PV system into account, what kind of people are they. We introduced a new segmentation model which allows us to answer the question whether adopters and rejecters of a PV system consider the same or different values/attributes. The model consists of four segments which is determined by two axis: the view citizens have on the technology (positive versus neutral or negative) and the decision making process of major technological innovations. The four segments are voluntary adopters, involuntary adopters, potential adopters and rejecters. The model gives more specific insight in the adoption of PV but can also be used to insight in the adoption of other technologies and/or in other countries.

Keywords: Technology adoption; photovoltaic (PV); The Netherlands.

1. Introduction

Solar energy systems, i.e. photovoltaic (PV), continue to gain attention in the Netherlands as consumers seek alternatives to increasingly expensive conventional energy sources. Concerns about energy usage and energy costs is expected to further the consumer demand for PV, accompanied by a rapid expansion in the acceptance of these systems in the future years. The adoption of PV is driven by this consumer demand and is characterized by the number of individuals or households that decide to adopt or reject this technology. We are interested in the innovators who have adopted a PV system, which kind of people adopt it and what are for example their demographic characteristics. But also the people who rejected a PV system are of importance. What kind of people are they. Given the current activity and interest in solar energy and the future growth expected in this industry, it is important that we are able to identify these people to create insight in the adoption process. Little scientific research is presently known concerning the individuals adopting a PV system.

In this research, we focus on PV as it is one of the most promising low carbon energy sources. While the worldwide application of PV is growing fast the Netherlands is lagging behind which clearly constitutes a case of slow diffusion. By studying this case, we can find out which kinds of people use the technology already and which kind of people reject the technology. We can use these insights to prevent similar tragedies of slow technology diffusion for other technologies and/or in other countries. Therefore, the research question that will be answered in this paper is: *which types of consumers can be distinguished in relation to PV adoption?* Thus, instead of looking at what technology can do for people, this research puts user behavior into a daily context as a starting point. Can groups of technology users be recognized that are for example 'green buyers' or 'materialists'? And what kind of people are they? The preference of individuals for example on climate change gives insight in factors that are likely to determine groups of users.

By taken into account different typologies of the Dutch population which are used in the building market in the Netherlands, we introduce a typology which can be used for analyzing the diffusion of technological innovations, in particular PV. Different typologies to classify people exist. Some researchers prefer to highlight the connectedness of different sub-typologies within a typology, then the term segmentation instead of typology is often used. Segmentation is defined as a process of dividing one population into smaller sub-populations (i.e. segments or groups), which are characterized by different needs, characteristics or behaviors, including their response to the way they are approached and affected [1]. In this research, we are interested in the different ways of thinking, beliefs and perception of people which make the concept of segments more practical as it highlight the interconnectedness of parts related to a larger substance (the Dutch population). So, the objective of this study is to introduce a segmentation model which allows us to answer the question whether adopters and rejecters of a PV system consider the same or different values/attributes. The model gives more specific insight in the adoption of PV but can also be used to insight in the adoption of other technologies and/or in other countries. Moreover, the research method is accessible and workable for other researchers who will gain insight in diffusion processes.

Section 2 offers a theoretical background; we discussed some theory of market segmentation and give an overview of the different segmentation models used in the building market in the Netherlands and their characteristics. The different segmentation models are from commercial research centers and do not communicate their research method. Nevertheless, an overview of the different segmentation models is given with some characteristics of the lifestyle research. At the moment, there is no universal segmentation model used and no research is available that the different models compare.

Section 3 offers the research method and data collection. Based on the gained insights in existing segmentation models used in the building market in the Netherlands, we introduce a new model in section 4 which can be used for analyzing the diffusion of PV in the Netherlands. The overall purpose of this section is to determine empirically how the groups differ from each other. We take the demographic characteristics, geographical characteristics, cultural beliefs (physiographical characteristics) and lifestyle characteristics (physiographical characteristics) into account.

Section 5 offers a reflection of the new segmentation model, we analyze how the n model met different criteria for good segmentation. Finally, section 8 provide a discussion and conclusion.

2. Theoretical background

Consumers have different personal characteristics and traits, and do not all adopt innovations (a new technology) at the same time [2]. Beal et al. [3] divide the diffusion of new ideas into five stages; awareness, interest, evaluation, trial, and adoption. Interesting in Beal and Bohlen's discussion of these five stages is how the most common way for people to learn about new technologies change at each step in this process. When it comes to individuals, Beal, Rogers and Bohlen [3] introduced a technology adoption lifecycle which divided people into categories that are determined by how soon they adopt new technologies. This is where they divided people into the categories of innovators, early adopters, early majority, (late) majority and laggards or non-adopters. The innovators, early adopters or early majority are individuals or firms investing at an early stage of the diffusion of new technologies. They have a large network, access to information, investment capital, an educational level or experience above average. The (late) majority and non-adopters or laggards are people investing on a later stage, they are older than people investing at an early stage of the innovation diffusion and they have a smaller network and are less educated. See Table 1 for a more elaborated description of the different categories.

Table 1 Categories of technology adoption cycle [3]

Name	Description
Innovators – 2.5%	First to adopt in a very early stage of the innovation process. They are willing to take risks, often have substantial financial resources and a technical knowledge
Early adopters – 13.5%	Role model for other members of the social system. They are aware of their important position and try to maintain this position by making quick judicious decisions which will trigger the mass to adopt an innovation
Early majority – 34%	Adopts a new technology when they see that the implementation was successful in the early adopters group. This group takes its time to make a deliberate decision in order to avoid the start-up problems of an innovation
(Late) majority – 34%	Adopts an innovation when there is a pressure from the environment or when the innovation has proven higher performance
Laggards / non-adopters – 16%	Last to adopt an innovation. They are very conservative, isolated from the rest of the social system and often have limited resources

The technology adoption cycle should be viewed as a relative concept. It seems to be straightforward that the group of innovators depends on the technology in question, it does hardly account for differences in the circumstances of users and difference of the preferences. The first consumers of a WI are not the same ones as the consumers of an electric tooth brush. A study by Pedersen (2000) showed that even inconsistency in the purchase of various green products and/or technologies exist. He intends that the purchase of a green product can not be predicted based on the purchase of another green product [4]. Thus, it is not because, for example, buying an electric vehicle that one will also buy solar panels for example. The opposite is obviously also true: it is not because a polluted product (e.g. a plane trip) that one does not buy green products (e.g. solar panels).

As mentioned before, in this research we are interested in a segmentation model for PV in the Netherlands. Different authors have discussed market segmentation e.g. Abell and Hammond [5], Gankema and Wedel [6], Hessing and Reuling [7]. It is a common view that a good segmentation has to comply with seven criteria.

- Identifiable; it should be clear to which segment somebody belongs
- Accessible; people should have the opportunity to freely choose to which segment they want to move
- Size (big enough; there should not be too much groups consisting of only a few people
- Heterogeneous; the segments should differ clearly and that the differences between the segments should be clear enough
- Stable; the segments are not allowed to change too often or easily
- Homogeneous response; members within a segment should react in a comparable way to arousals, e.g. advertising and information
- Influential; the typology should offer ideas on how human behavior within each segment can be steered

The segmentation itself is based on a limited number of characteristics. There are four major groups of characteristics used within the private market [8]:

- Demographic characteristics: age, family composition, education, occupation and income
- Geographical characteristics: city, region, province and postal code
- Psychographic characteristics: activities, interests and opinions
- Behavioral characteristics: motive to buy: price, esthetic, functionality, idiosyncratic preferences

These characteristics can be general or (product) specific and direct observable or derived. General and direct observable segments are well identifiable, accessible and stable e.g. age. The problem is that the relation with the dependent variable (to influence the behavior, the purchase of services, consumption patterns, etc.) is usually weak. In other words, the response is not homogeneous (enough). If segments are determined using psychographic variables such as personality characteristics, lifestyles, etc. than they are talking about general derived segments [7].

Due to individualization, social classes and others socio-demographic factors are too limited to explain behavior of customers and to illustrate a differentiated society. There is a need for

understanding the perspective and perception of the customer. The origin of segmentation models, e.g. Mentality-model and WIN-model, are based on values, behaviors, knowledge and lifestyle which are grouped into clusters.

Six major research centers in the Netherlands have each developed a segmentation model based on personal values and lifestyle. Every segmentation model is already used in a case related to the building market, e.g. municipality Almere by Experian. These research centers used the models to help their customers with the segmentation. In the past, a disadvantage of these models was that there was almost no connection possible to reach segments of the market. In recent years, research centers have coupled their segmentation model with large address files or large self-made databases. In this way, the translation of the results to reach potential customers is easier.

The different segmentation models are:

- Valuebox-model of NFO-Trandbox
- Mentality-model of Motivaction
- Mosaic-model of Experian
- Win-model of TNS/NIPO
- Censydiam-model of Synovate
- BSR-model of SmartAgent Company

Besides above mentioned segmentation models, there are more models. But, as earlier mentioned, our research focuses on PV in the Netherlands. Therefore we only take segmentation models into account from Dutch research centers which are already used in the building market.

In the section below, the different segmentation models are discussed. We focused on the underlying idea of the model as the research method is not communicated since it is confidential. An overview of the classification of the different segmentation models is given in Appendix 1.

2.1. Valuebox-model of NFO trendbox

Trendbox is a strategic market research agency, specializing in qualitative and quantitative research on brands, people and their motives. In 1990 Trendbox started the Life & Living project, an ongoing study where the attitudes, behavior and mentality of the Dutch are tracked over time. Because of the continuous nature of Life & Living, NFO Trendbox is able to identify the status quo, recognize and analyze coming trends and translate the findings to the future. Trendbox distinguishes six clusters of segments in which social groups of the Dutch population are classified, called the valuebox-model [9-11].

2.2 Mentality-model of Motivaction

Motivaction, a Dutch research centre, developed the mentality test which is a value and lifestyle research method and focuses on marketing and policy questions. Results are applicable to e.g. sustainability issues, mobility, media, and politics. Within the typology eight social environments are distinguished (see Appendix 1) which differ in terms of status (low importance, middle importance and

high importance) and values (traditional, based on conservation; modern, based upon possession and spoil; or postmodern, based on self-development and experience) [12].

Dutch society is highly individualized and there is a wide variety of lifestyles, citizens are also more mature and become more critical. How can you as a policymaker, advisor or manager keep in touch with what people moves? In order to deal with this question, Motivaction introduced four styles of citizenships (dutiful, responsible, pragmatic and outsiders) in collaboration with the Commission Future Government Communication and Scientific Council for Government Policy. The citizenship styles are based on the Mentality test of Motivaction which is conducted since 1997 in the Netherlands among Dutch people between 15 and 80 years old. The citizenship styles do not only provide insights into the opinions of people and the activities they undertake, they also give insight into the motivations, the needs they have, how they can be involved in the public domain and how they can most effectively be addressed [13]. So, the different styles of citizenship can represent the attitude towards government and politics.

2.3 Mosaic-model of Experian

MOSAIC is a geo-demographic segmentation system developed by Experian and marketed in over twenty countries worldwide. In the Netherlands, Mosaic has divided 16 million Dutch people into 10 groups and were classified into 44 segments (different types of consumers). This classification has been based on socio-demographic and socio-economic data, lifestyle, preferences, and (buying) behavior [10, 14].

2.4 WIN-model of TNS/NIPO

The WIN-model is a value and socio-demographic characteristics based segmentation of the Dutch population. The different values that people find important in their lives seem to be related to different ways of life, housing, dress, think, consume and vote. Scores on a vertical (focused on others) and horizontal (exploring possibilities) axis is used to determine the classification of segments [7, 15]. The model distinguishes eight groups in society, which are very different in terms of lifestyle, attitudes, motivations and behavior [15].

2.5 Censydiam-model of Synovate

Censydiam model is based on consumer motivation studies, including decision to buy. Motivations are fundamental human desires that drive behavior. The model is a basis for systematical understanding of people motivation in their connection with brand positioning and communications. The model is built around two main axes: personal dimension (how feel in relation to ourselves) and social dimension (how people feel in relation to other people). Around these axes life values are placed [16].

2.6 BSR-model of SmartAgent Company

SmartAgent is a perception and consultancy center. SmartAgent gains experiences of people using the social-psychological model, Brand Strategy Research (BSR) model, which is applied in qualitative and quantitative research. The BSR model explores and structures the underlying values, needs and

motivations of people within a particular domain. The model is visualized by two behavioral dimensions that determine the Western behavioral science: the sociological (x-as) and psychological dimension (y-as). In this way, four quadrants emerge, in other words four experiences from which people think and act [17, 18].

In cooperation with MarketResponse-Amersfoort (market research center) and Kolpron Consultants-Rotterdam (focuses on market research and advice in the areas of the built environment), two living experience are investigated by SmartAgent. The studies, conducted in 1998 and 2000, form the basis for a subdivision into six experience profiles (see Appendix 1). Each profile describes a social group with a similar set of values and behaviors related to housing behavior and housing preferences. People score on all clusters in a given ratio. Based on such profiles, the preference for specific living environments can be established. In this way, there is a direct relation between lifestyle and living environment [17, 18].

2.7 Overview and characteristics of the different segmentation models

As earlier mentioned, the described models are from commercial research centers who do not communicate their research method. Currently, there is no universal model used and there is no research available that the different segmentation models used in the building market in the Netherlands compare. Ouwdehand [19], however, analyzes the differences and similarities of the different methodologies but a comparison of the different segmentation models is missing. Offermans [20] compares cultural theory perspectives with six other typologies to analyze the extent to which cultural theory perspectives and presumptions can be recognized in other typologies. It is not our purpose to be exhaustive, but rather to broaden insight in the applicability of a segmentation model and identify its weaknesses and strengths.

First, all the discussed models are constructed with survey-research. The research centers make large files with data from tens of thousands of respondents on for example their values. These data are often coupled with questions such as which newspapers are read and what television programs being watched.

Second, all models are based on scientific insight, mainly on the work of Rokeach and Bourdieu. Rokeach argues that values play an important role in making choices and behavior. Rokeach makes a distinction between ends values (what you want in life) and instrumental values (how want to get there). Segmentation models form a representation of what is important in life, e.g. focusing on yourself or focusing on others (WIN-model).

Bourdieu connect social characteristics such as income and occupation with a preference to a wide range of areas such as politics, art and car choice. He uses a two dimensional frame in which both socio-economic position and lifestyle characteristics were embedded. Motivation for example presents also lifestyles in a two dimensional space.

Third, three models distinguishes eight lifestyles, two distinguishes six lifestyles, and one model distinguishes ten main lifestyles and divide them further. It is still remarkable that all typologies encompass at least six categories, while in theory the number of segments is determined by the number

of axes being used. Furthermore, if the number of categories would be extended, that might lead to difficulties regarding the criteria of size and heterogeneity (criteria of Gankema and Wedel as described in the introduction). If the number of categories is too big, some groups might be too small and/ or some groups might be too similar.

Fourth, it can easily be said that a certain lifestyle of one model resembles a lifestyle from another model. In general, we see in all models a vanguard for modernization and individualization. The comfort oriented lifestyle of Mentality-model resembles for example the uncomplicated beneficiary of Valuebox and the enjoyment of Censydiam-model. Probably, more similarities can be found, however, the aim of our research is not to compare the lifestyles.

Fifth, the criterion of heterogeneity of Gankema and Wedel, indicating that each lifestyle should differ clearly from others, is difficult to analyze. In the BSR-model, Censydiam-model and Valuebox most lifestyles were easy to distinguish, however, for the other models it was more difficult to distinguish the differences between the lifestyles. In the WIN-model for example the differences between the careerist/ luxury seekers and professionals were hard to detect. The stability criterion was met by every typology, since every typology acknowledged the relative robustness of segments for change. However, if the criterion of heterogeneity is not met, the hypothesis is that segments may change more often and faster. Due to their similarities, people may move to other (similar) segments if the interpretation of only one or two values changes. The more segments differ from each other, the more surprises are needed to leave one segment and support another one. Heterogeneity and robustness for change seem to be reinforcing factors. The accessible criterion is also met by every typology, as in all models individuals have the opportunity to move in and out a certain lifestyle. This means that all models have multi direction of change as a model with only one direction of change does not comply with this criterion.

Sixth, the discussed models were roughly presented in two ways, namely based upon a ranking of values and based upon a description of what people value and reject. The WIN-model (based upon the work of Schwartz) is an example of the first category as it states that all people on earth share the same set of values, however, the importance attached to every single value, differs from person to person. People with comparable value rankings come together in one segment. Mentality-model is an example of the second category as it describes what people value (e.g. tradition, modern) and the status (e.g. high importance) [20].

Seventh, conclusion about the validity and reliability of the six segmentation models is not possible. The commercial research centers do not disclose relevant information to analyze this.

3. Research method and data collection

With the elaborated review of the different segmentation models in mind, it is intended to introduce new model which can be used for analyzing the diffusion of technological innovations. Or in other words, a model which will shed light on the analysis of relevant factors and attributes considered by adopters and rejecters of PV. Inconsistency exist within the different models of the different research

centers which makes it hardly impossible to derive which people would like to adopt or not adopt PV. It still depends on the technology in question whether people are willing to adopt, even within a group 'green buyers' it is impossible to predict the decision. Therefore, we determined empirically a new segmentation model for technological innovations. Different groups of users are distinguished based on the knowledge we have obtained from the comparison of the different segmentation models. The groups build upon the results and insights of our field study on the perception of solar energy in the Netherlands. The data gathering used for this survey took place in September 2011 and is collected via an internet questionnaire. The response consisted of 817 completed and usable questionnaires. Various bivariate and multivariate techniques were used to analyze the data. Crosstabs were used to evaluate findings related to personal demographic and geographic characteristics, cultural beliefs and behavioral characteristics. In this research we take the demographic, geographical and psychographic characteristics into account as it is not our purpose to analyze in this paper the motive to buy (behavioral characteristics), but rather to broaden insight in the people who adopt or reject a PV system. Therefore, we decided to take this group of behavioral characteristics not into account.

In this research we use the introduced model to analyze whether PV users are identifiable as small number of relatively homogeneous groups of technological users, based on their adoption or rejection of a specific technological innovation. The introduced model is tested with the criteria of o.a. Gankema and Wedel, namely identifiable, accessible, size, heterogeneous, stable, homogeneous response, and influential. Our focus is placed on demographic and geographic characteristics, cultural beliefs, consumer practices and experiences (psychographic characteristics) rather than on motivations, feelings or intentions. We are interested in the personal characteristics of Dutch citizens in relation to sustainable energy sources and in particular PV. Can groups of PV users be recognized and what kind of people are they? In order to gain insight in PV users the following dimensions are important.

- Demographic characteristics. In our questionnaires we included questions about age, possibly income, education and gender to analyze if some characteristics occur more often in a specific group.
- Geographic characteristics include the housing type, housing situated, ownership and number of residents per dwelling as these characteristics influence where PV systems appears. The domestic sector in the Netherlands is divided over three types of ownership. Each represents a different type of decision maker with respect to the purchase of PV: (1) owner-occupied sector in which the residents themselves are the decision makers; (2) private rental sector in which private landlords make the investment decision; (3) public rental sector in which housing associations make the investment decision. Broadly five types of houses can be distinguished in the Dutch domestic sector: (1) detached (free standing), (2) middle of a row, (3) semi-detached, (4) apartment, (5) farms. Furthermore, a house can be situated in a city, village or countryside.
- Psychographic characteristics consist of two parts, cultural beliefs and lifestyle characteristics. Cultural beliefs includes to what extent people make decisions alone or dependent of others. Have neighbors, family or friend an important role in decisions and / or in the behavior or are they autonomous. It also includes to what extent behavior is determined by habits that exist for decades. Traditional means that people conform themselves to habits, rules and expectations from a group. The opposite, modern, refers to societies in which not a lot of habits, rules and expectations exist. Nineteen questions regard personal preference were asked. Answering each

question implied making a choice between two opposite possibilities, agree or disagree. Depending on the answer, an axis received either one or zero point. One point was ascribed when choosing answer related to the positive axis and zero points for choosing answer related to the negative axis.

The lifestyle characteristics give an insight into attitudes, norms and values of people. More specifically, it attempts to predict specific buying habits and preferences of consumers. Often there is a discrepancy between what people say they wish to do and their actual behavior. Therefore, we asked their impression on their own lifestyle. Lifestyle characteristics used in this research are: recycling of paper, avoidance of unaddressed advertising, energy efficient equipment (A-label), avoidance of car use and water conservation. We asked the respondents to indicate their contribution with regard to sustainability within their own lifestyle with a number of indicators using 4-points Likert-scale ranging from (almost) always to never. The respondents which answer the question with (almost) always or regularly are seen as people who behave sustainable on that question.

4. A segmentation model for PV in the Netherlands

At the moment, an investment in PV requires a considerable run of money. Citizens need an average to above average income for the purchase of PV. The payback of PV is around ten years, the ideal situation is that the citizen has this time still in prospect. The dimension life situation is not straight forward, in both situation you can buy a system. However, the context of being single or having a family can make a difference, for example a well-educated single can afford a system while a single earner family-man can not afford the same system. Also the other way around is possible. As a citizen has a home in the private or public rental sector, it is likely that these people do not buy PV panels by themselves while for an owner of a house it can be profitable. The difference in type of citizen has an influence on the purchase of such innovative technologies; a modern citizen shall easier buy an IPOD than a traditional citizen.

However, in order to understand the meaning of technology for an individual it is not sufficient to only look at the above mentioned dimensions (e.g. income, age). More important is to obtain insight into the usage of sustainable technologies and how sustainable minded people are. Therefore, the attitude of the citizens we are dealing with is a strong determining dimension in this research, vertical axis in Figure 1. This dimension refers to the view citizens have on the technology, positive versus neutral or negative, while the above mentioned dimensions are largely influenced by external circumstances in which the attitude plays no role. Income, life phase and home ownership may in itself be decisive factors. The second determining dimension in this research refers to the decision making process of major technological innovations, see horizontal axis in Figure 1. An important aspect is the consideration of the adopters and non-adopters. Taking these dimensions together, we can construct a segmentation model for PV in the Netherlands, see Figure 1. The number of segments is determined by the number of axis used which corresponds with segmentation literature. The figure shows that different attitudes and individual preferences (adoption or not) can be distinguished in four groups: voluntary adopters, involuntary adopters, potential adopters and rejecters.

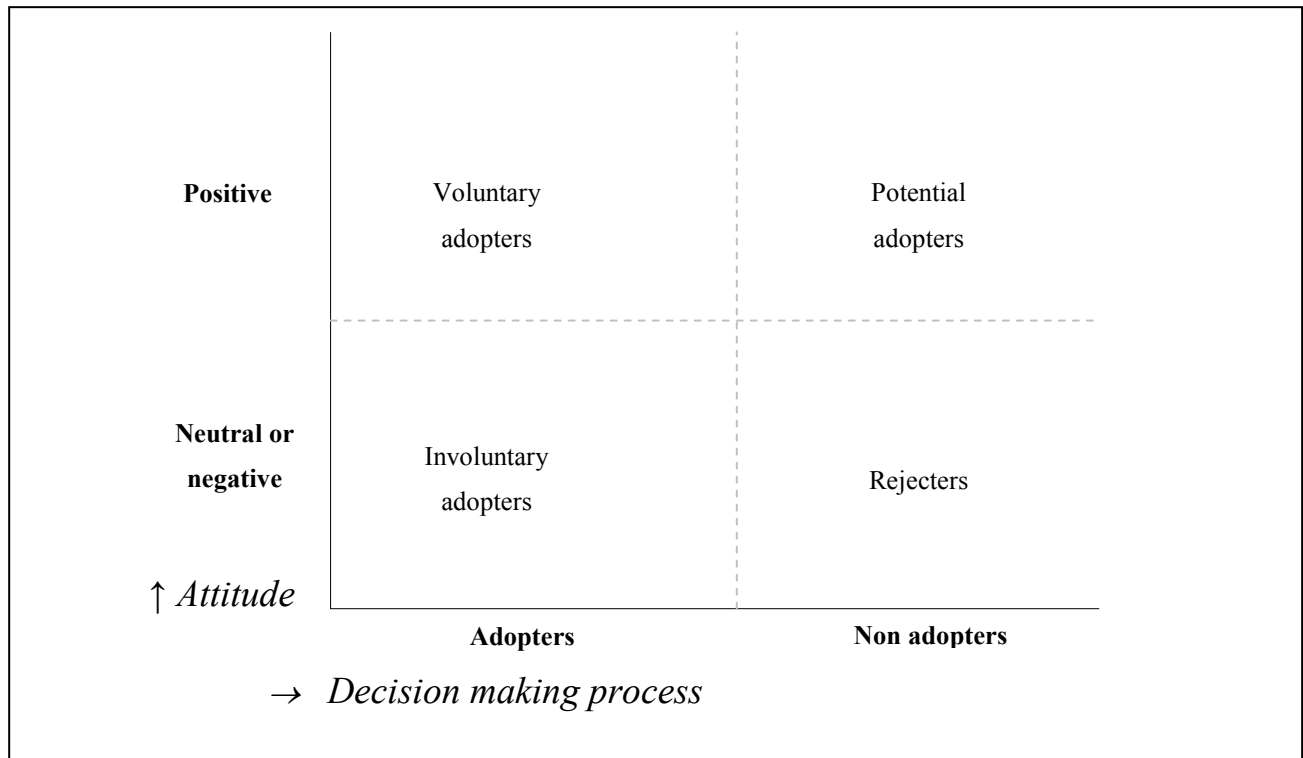


Figure 1 Segmentation model for PV in the Netherlands

Better understanding of the adopters (voluntary and involuntary) and non-adopters (potential adopters and rejecters) allows us to determine how the groups differ from each other. In this way, we can compare the choices and considerations for the different adopters. In the section below, the different adopters are discussed according to the characteristic groups. An overview of the characteristics is also given.

4.1 Demographical characteristics

The age spider diagram (see Figure 2) suggests that the majority of the voluntary adopters are located in the category 50- 59 year while the involuntary adopters are concentrated around age 40. Non adopters appear more concentrated from categories 40 to 59.

Concerning income, the majority of the respondents have an income between 15000 and 36000 euro per year. There is no significant difference between the different groups in this category. As expected, the respondents with an income less than 15 000 euro per year are respectively represented by the group rejecters, involuntary users, potential users and finally voluntary users. So the attitude of the people with the lowest income is more negative or neutral than the people with an income between 36000 and 60000 euro per year. This latter group is more represented by the respondents who have a positive attitude for PV, the group voluntary and potential adopters. These results show that voluntary adopters of PV have higher income than the average population. This is in line with the results of Labay and Kinnear [21], who examines PV within an adoption and diffusion of innovation frameworks in the State of Maine. A case study on the city of Groningen from Jager [22] comes also to similar findings. This study analyses factors that lead to a faster diffusion of PV in society from a behavioral perspective.

With regard to education, we found that adopters, especially voluntary adopters, have a higher education than the non-adopter. Potential adopters and rejecters appear to be very similar. In gender, the adopter and non-adopters appear to be also very similar.

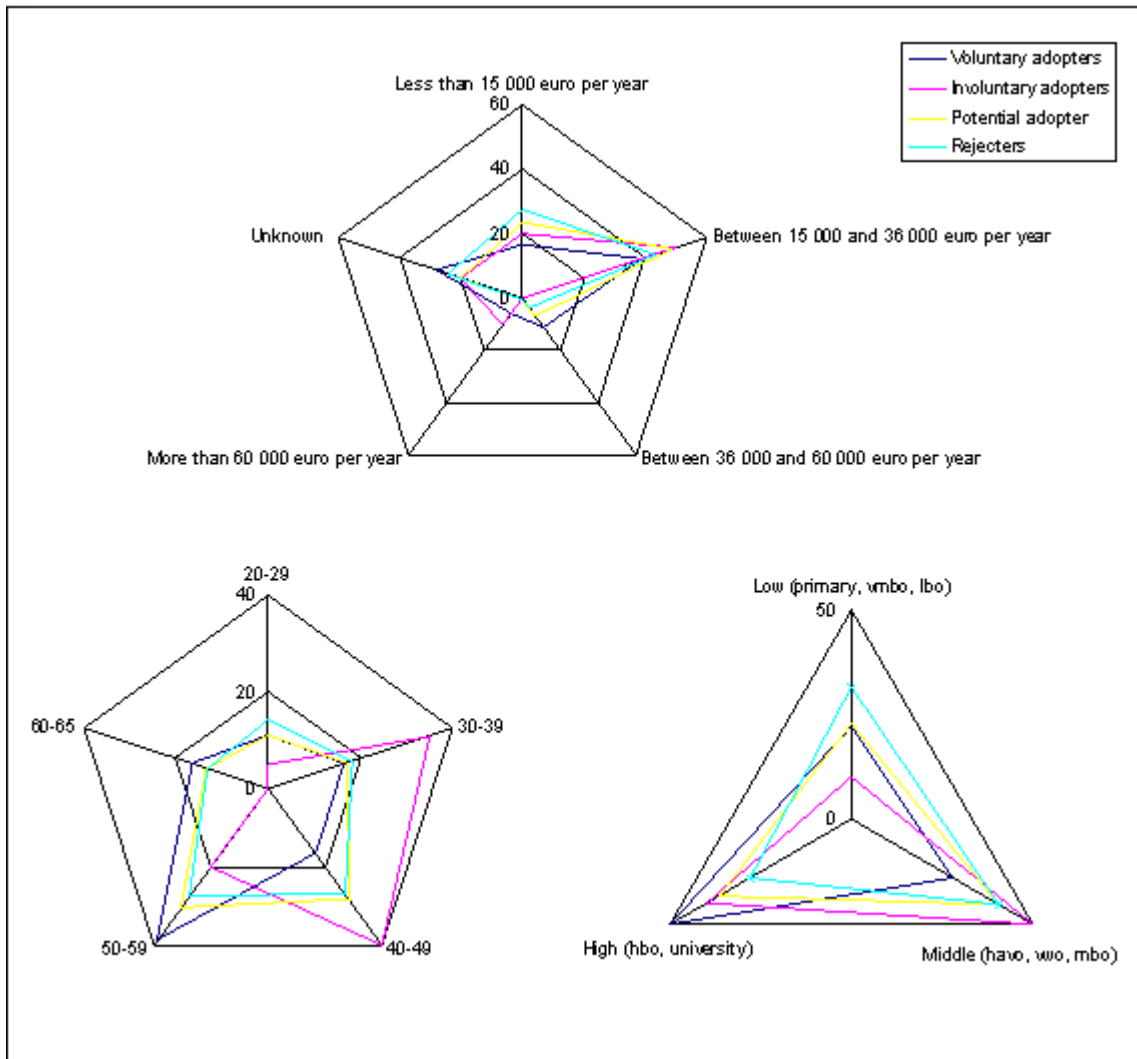


Figure 2 Age, income and education of all the respondents divided over the different adopter groups

4.2 Geographical characteristics

In Figure 3 the spider diagram of the different geographical characteristics is given. We see that the respondents who have an own house has a more positive attitude than the respondents who rent (public or private). The majority of the home-owner is voluntary or potential adopter. The majority of the group of adopters (voluntary and involuntary) lives in the city while the group of non-adopters (voluntary adopters and rejecters) lives in a city. Concerning housing type, the majority of the respondents in every group lives in a middle of row dwelling. But, detached dwellings are even popular for the group voluntary adopters, and semi-detached dwellings are almost even popular for the group involuntary adopters. The second selected housing type of the group rejecters is the apartment which can be identified as physical barrier as it is assumed that this group of people does not consider the option of solar PV panels individually. The last characteristic we discuss are the number of residents. The majority of the voluntary adopters live with two people in a dwelling while the group of

involuntary adopters lives with 3 or 4 people. Potential adopters and rejecters appear to be also very similar.

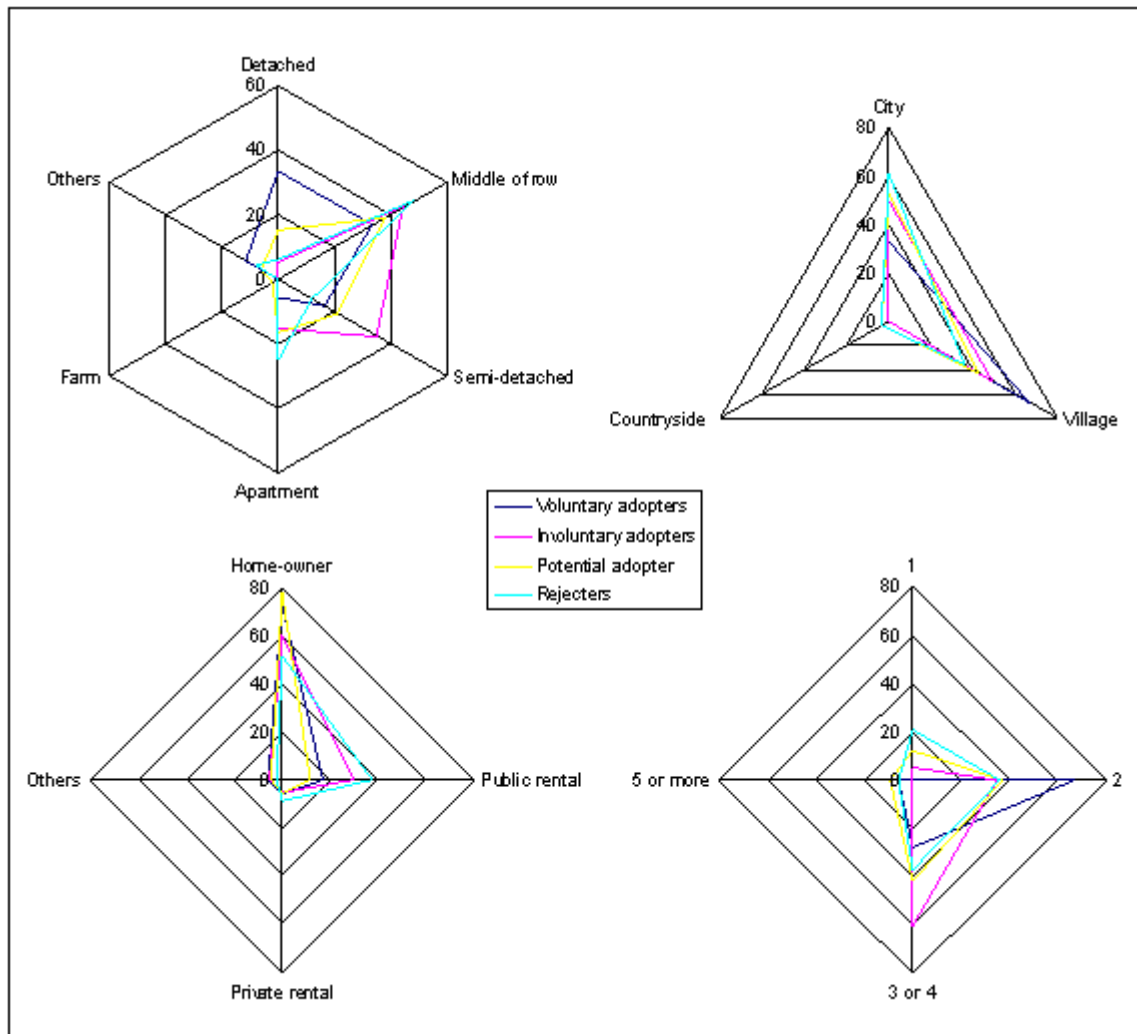


Figure 3 Housing type, housing situated, ownership and number of residents of all the respondent divided over the different adopter groups

4.3 Psychographic characteristics

The spider diagram (Figure 4) suggest that climate change is a concern for people with a positive attitude for PV, thus the voluntary and potential adopters seem fairly similar to each other and fairly different from the involuntary adopters and rejecters. Comparing the decision making process of adopters with non-adopter, we see that voluntary adopters take big decisions independent of others and that this group of adopters do not take considerable time for big decisions, yet quit different form the other three groups. Finally, all the respondents answered that rules are necessary in daily life, but the adopters with a positive attitude score a little bit higher than the respondents with a neutral or negative attitude. The majority of the respondents answered that traditional norms and values are import.

Furthermore, the findings indicate that recycling paper, buying energy efficient equipment (A-label) and use water wisely are major issue perceived by all the respondents. Remarkable, the avoidance of unaddressed advertising is notified as not common by the majority of the respondents. With regard to the different adopter groups, we see that the adopters are more sustainable minded than the non-

adopters. Within the group non-adopters, rejecters have indicated that they are less sustainable minded on all the analyzed characteristics than the potential adopters.

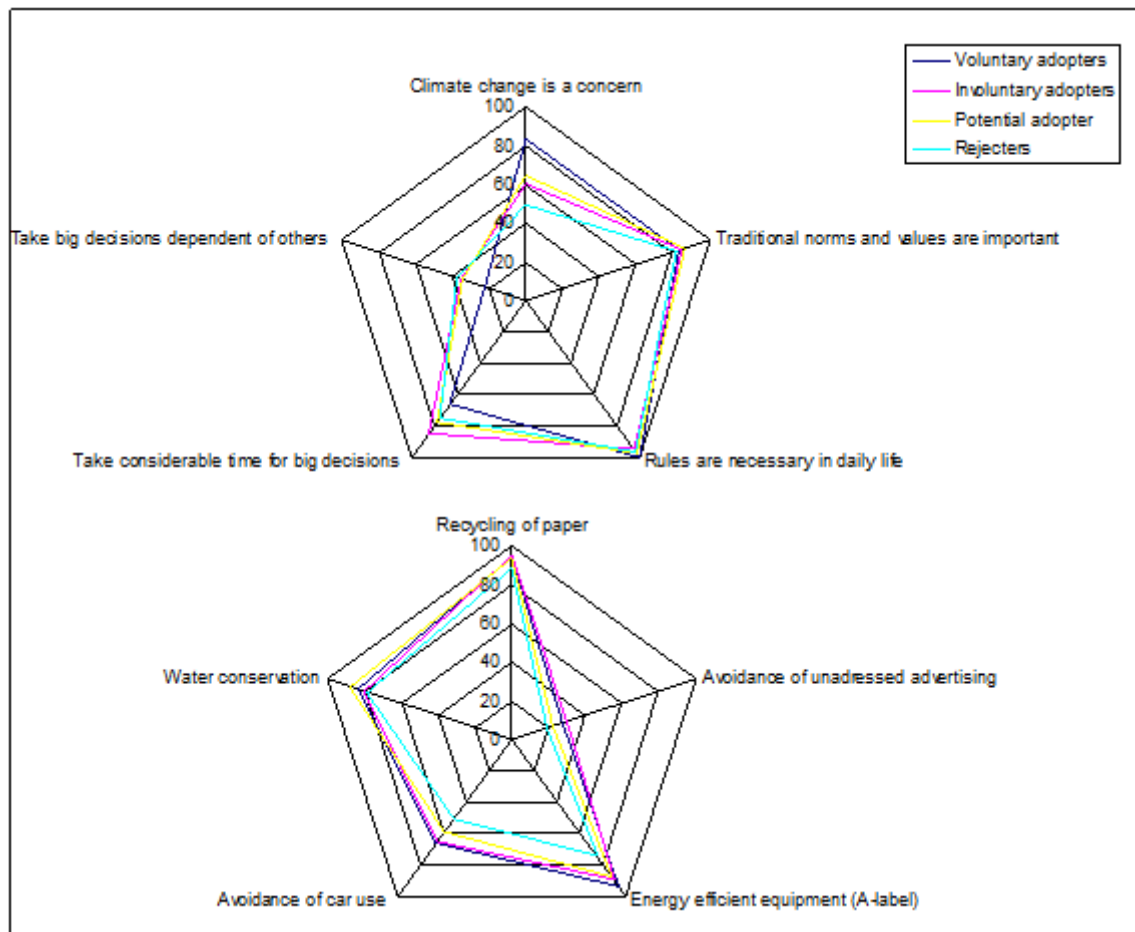


Figure 4 Cultural beliefs and lifestyle characteristics of all the respondent divided over the different adopter groups

4.4 Overview of the characteristics

Table 2 gives an overview of the demographic characteristics, geographic characteristics and psychographic characteristics (cultural beliefs and the importance of the different attributes for PV of the different lifestyles).

Table 2 Characteristics of the different lifestyles

	adopters		non adopters	
	voluntary	involuntary	potential adopters	rejecters
Demographic characteristics				
Age	50-59	30-49	40-59	40-59
Income	On average higher	On average higher	On average lower	On average lower
Education	high	high-middle	middle	middle-low
Gender	similar	similar	similar	similar
Geographic characteristics				
Home-owner	me	rental	me	rental
Housing situation	more in a village	more in a village	more in a city	more in a city
Housing type	middle of row / detached	middle of row / semi-detached	middle of row / semi-detached	middle of row/ apartment
Number of residents	2	3 or 4	similar	similar

Psychographic characteristics (Cultural beliefs)				
Climate change	more important	less important	more important	less important
Traditional norms and values	important	important	important	important
Rules	necessary in daily life (100%)	necessary in daily life (98%)	necessary in daily life (95%)	necessary in daily life (96%)
Time needed for making big decisions	less considerable	considerable	considerable	considerable
Taking big decisions (in)dependent of others	independent	more dependent	more dependent	more dependent
Psychographic characteristics (Lifestyle characteristics)				
Recycling of paper	(almost) always	(almost) always	(almost) always	(almost) always
Avoidance of unaddressed advertising	occasional	occasional	occasional to a lesser extent	occasional to a lesser extent
Energy efficient equipment	(almost) always	(almost) always	(almost) always	regularly
Avoidance of car use	regularly	regularly	regularly to a lesser extent	regularly to a lesser extent
Water conservation	(almost) always	(almost) always	(almost) always	(almost) always

5. Reflection

To test whether the introduced segmentation models can be used as a good segmentation for technological innovations, we analyze how the segmentation models met the seven criteria of Gankema and Wedel (identifiable, accessible, size, heterogeneous, stable, homogeneous response, and influential). The typology scored well on most of the criteria. It is clear to which segment somebody belongs, the segments were easy to distinguish (heterogeneity) and stable, the groups are big enough and gave in general homogenous responses in the questionnaire. The criteria which was met least, was the criteria of accessible, indicating that people have the opportunity to move in and move out a certain group. It is obvious that it is not logical to move from the group voluntary adopter to the group potential adopters, expect when you moved to another dwelling. However, to a certain extent it is possible to move in another group. Potential adopters, for example, can become adopters of the technology and rejecters of the technology can also become potential users which in turn can become adopters of the technology, see Figure 5.

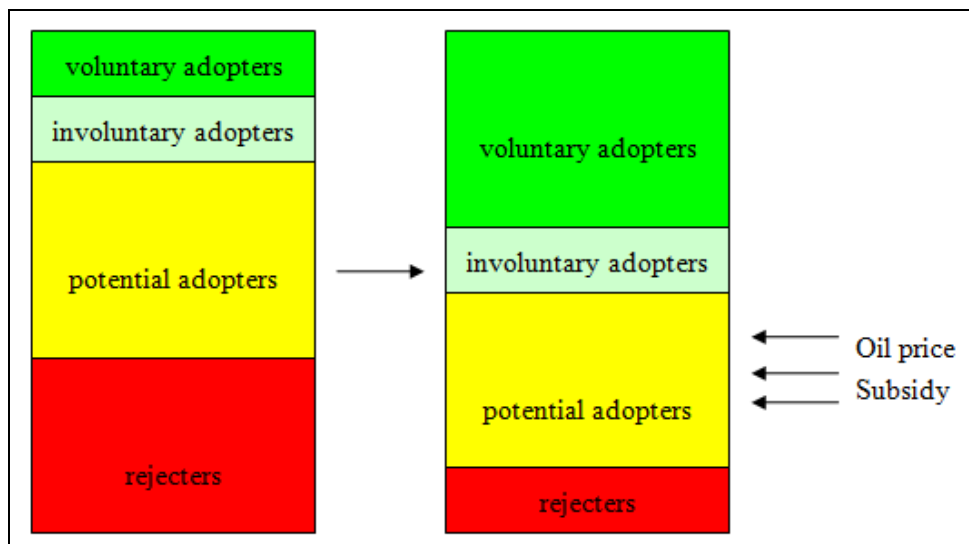


Figure 5 Accessibility and influentially of the different groups

The last criteria, influentially, is more or less connected to the accessibility of the typology. Every group should give a description about preferred policy-options and/or aspects where people in the group strive for. A favorable grant, for example, can have an influence on the behavior of people within a certain group. The grant can stimulate potential adopters to become voluntary adopters.

Coming back to our comparison of the different segmentation models, this model is also constructed on survey research, based on scientific insights and the number of groups (segments) is determined by the number of axis used.

Furthermore, the new segmentation model offers opportunities for analyzing, exploring and visualizing beliefs and perspectives of people who are in the adoption process of a PV. It give more specific insight in the different beliefs and perceptions of the adoption of PV, however the model can also be used to gain insight in the adoption of other technologies and/or in other countries. The segmentation method can be used to classify, interpret and analyze these different beliefs and perspectives. In this way they can be used to analyze the response in order to contribute to the Dutch energy system in the years ahead and the future social acceptance of different technological innovations. By doing this, insights can be provided how the government's policy or service can align the needs of the customer (citizen) as well as how suppliers of this technology can optimize their product based on identified consumer beliefs and preferences.

6. Conclusion and discussion

The overall purpose of this paper was to introduce a new segmentation model which can be used to determine empirically groups of PV technology users. There are four groups determined based on the knowledge obtained from the comparison of the different segmentation models used in the building market in the Netherlands. The use of questions about beliefs and attribute preferences helped to group people into different groups and compare the choices for such groups. The empirical analysis, based on a questionnaire among 817 Dutch households, resulted in new introduced segmentation model. The model consists of four segments which is determined by two axis: the view citizens have on the technology (positive versus neutral or negative) and the decision making process of major technological innovations. The four segments are voluntary adopters, involuntary adopters, potential adopters and rejecters. The groups (segments) met the set criteria for good segmentation and differ from each other with respect to the demographical, geographical and physiographical characteristics. Voluntary adopters are on average middle-aged, high educated, take big decision independent of others and take care of the environment by for example recycling paper and avoiding the car on a regularly basis. The opposite are the rejecters who have on average a lower income, take big decisions dependent on others and need also considerable time for big decisions.

Our results are not in line to classic diffusion research such as the theory of Rogers [23]. People with the highest socio-economic status who are the least guided by others in their decision making do not necessarily fall into the first groups of adopters as defined by Rogers. In this research the group of voluntary adopters is in line with this thought, but the involuntary adopters are in contrast. Also, Rogers' group of households that never will adopt a system is not in line with our research. This group should have a low socio-economic status which are set to belong to the group of households that is

least guided by others in their decision making. In this research, the group of rejecters is more guided by others in their decisions and has middle to low socio-economic status.

Insights regarding both adopters (voluntary and involuntary) and non-adopters (potential adopters and rejecters) of PV are provided in this research. Three of the four major groups of characteristics are taken into account: the demographical characteristics, the geographic characteristics and the physiological characteristics. It would be beneficial to study the four groups further to better understand their motivations to (not) purchase a system, thus taken into account the behavioral characteristics. By doing this, insights can be provided how the government's policy or service can align the needs of the customer (citizen) as well as how suppliers of this technology can optimize their product based on identified consumer preferences and frames.

It is possible that a small number of the respondents who do not adopt a system have for example not enough knowledge to fill in the questionnaire, because they do not want it, can not afford it or do not understand it. These people are also included in this research and impossible to omit. This is seen as a limitation to this research.

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Conflict of Interest

The authors declare no conflict of interest.

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Appendix 1

Valuebox-model of NFO trendbox	
Order and decency	Women in traditional families, average income, low to secondary education, orderly, dutiful, polite emphasis on social rules, security, safety, cost-conscious and thrifty, preference for familiar and stable environment
Purposeful adventure	Young single men, high income, high education, city dweller, preference for varied and comfortable life, perceptive and logical thinking, little orderly, positive future vision, ambitious
Center	Average Dutch people
Uncomplicated beneficiary	Young men, secondary education, need for order and discipline, ambitious and career oriented, positive future vision, longing for weekend
Sober philosophy	50+ living alone, high education, seeking for freedom and peace, inner harmony, self-respect and creativity, social interest, open-minded, environmentally conscious
Spiritual	altruists women 50+, two-person household, secondary education, family is important, equality, fairness and security, helpful and forgiving, traditional, carefully selected diet, frugal and cost conscious
Mentality model [12]¹	
Traditional citizens	Traditional values, family is cornerstone and most important, harmony and rest, acceptance of authority and rules, disciplined, risk averse, soberly, traditional division of roles
Comfort oriented	Material wealth, freedom, entertainment, no responsibility, little ambition, longing for appreciation, impulsive, consumption minded, outward appearance very important
Modern citizens	Balancing between traditional values and change, family cornerstone, social status important, authority and rules, longing for appreciation, security, income and experience, technology minded, regularity, traditional division of roles, risk averse, consumption and entertainment
New conservatives	Traditional values, protecting social status, hierarchical, critical, interested in politics and history, work is more important than private life, culture and arts, soberly, risk averse, etiquettes
Cosmopolitans	Success, self development, internationally oriented, interested in politics, tolerant, work is central motive, ambitious, materialistic, technology minded, impulsive and adventurous, status and etiquettes, arts and culture, focused on like-minded, consumption
Upward mobiles	Career, gaining social status, freedom from tradition and duties, change and modernization, international, longing for appreciation, work and achievement, income, materialistic, consumption and entertainment, technology minded, impulsive and adventurous, freedom, focused on like-minded
Post materialists	Self development, solidarity, attention for immaterial values, interested in social life and politics, reflexive, critical, solidarity, tolerant, international, balance between work and private, being societal useful, principle, not consumptive and not entertainment focused, sober, arts and culture
Post modern hedonists	Freedom, independency, carpe diem, new experiences, tolerant, equal changes, not interested

¹ Description of the different groups adopted from Offermans (2010).

	in politics or society, work subordinate to private, impulsive, adventurous, without obligations, arts and popular culture, experience focused, friends more important than family
Mosaic model	
Free spirited	Young, single, living alone or sharing a house with friends, well educated, multicultural, involvement in the neighborhood is low, public transport, social, without obligations, aware of social development and new by watching the news, public transport
The developed urban dweller	Quite young, begin of career, well educated, urban nomad, social, no family life, cultural, reading newspapers, interested in society
Go-getter	Young (<34), live alone, low educated, relatively low income, high-rise buildings, broad interested, arts and culture, no car, not often on holiday
Dynamic families	Ambitious, self development, well educated, successful career, above average salary, live in the middle of the Netherlands, new housing estate, longing for appreciation, well-filled wallet is important, entertainment focused, sport/family car
Modal citizens	Family cornerstone, middle aged, executed jobs, below average to average salary, live often in the West of the Netherlands, terraced house, used family cars, watching action movies, regularly to cafeteria
Successful families	Family cornerstone, children of all ages, above average salary, secondary - well educated, free profession or management function, live in a neighborhood near a town, child friendly neighborhood, owner-occupied house, enjoying life
Traditionalists	From conservative to liberal and from young to old but they have one thing in common: all work hard for a good life and family life, all kind of jobs, low - secondary educated, owner-occupied houses, semi-detached homes, comfortable, high social cohesion, above average on holidays with own caravan, support charity
Rural family life	Farmers and families of middle age, low-educated, above average salary, owner-occupied houses, detached house, more than one car often high price, modern equipment, no designer clothes
Well-off people	Well educated, career, well-paid professionals, far above average income, spacious villa, highest social class with status and etiquettes, luxury, shopping in exclusive stores, making long journeys
Pension beneficiary	Pensionable age, enjoy the little things in life, lower social class, low educated, apartment, cultural trips, volunteer work, buy traditional products
WIN-model²	
Engaged	Harmony, stability, sociable person and prefer to do activities together with a group of other people, deliberate and well considered, when making decisions you think about the impact for the environment, more elderly people with a reasonably high level of education, interest in arts, nature and politics, not materialistic and not interested in new innovative technologies
Care takers	Focused on well being of others, social person receiving energy from helping fellow human beings, sober, generous for others, traditional values and traditions which provide rest and security, no need for change, self effacing, community people, like to do meritorious work for the (church) community, not very creative, prefer implementation over preceding

² Description of the different groups adopted from Offermans (2010).

	development processes, both reading and television watching, regional newspapers, up to date for social and political situation, fairly cheap products who are reliable, social.
Conservatives	Focused on your own environment, security, family is most important, do not like to attract attention or seeing anybody else doing so, confirmation to rules and norms, bit impulsive, tidy people, preference for unconstrained entertainment like television, disappointed with society and politics, not really materialistic, but in favor of luxurious, modern stuff, confirmative.
Hedonists	Pleasure and enjoyment on physical and emotional level, more sportive than creative, challenge, risk, adventure and excitement, not a worrier, impulsive and showing things very easily (lazy), likes to go out in a group, not interested in social issues and politics, prefer watching television over reading, like to spend money on going out for diner, new and novel objects.
Luxury seekers/	Ambitious, success, appreciation, comfort is highly valued, not somebody who keeps seated, seeking challenges and does not really matter about (behavioral) rules, not very religious, ego centered, not involved in other's businesses, judge quickly and talk straight from the shoulder, interest in society, both television watchers and newspaper readers (mainly telegraaf), possess lots of modern objects and willingness to show these to others, technological developments can not go fast enough, sensitive for trends, and you will be the first one possessing a novel object, achievement.
Professionals	Ambitious, independent, educated, self development, working hard and a quick and creative thinker, free liver ("life enjoyer"), stimulating and challenging life, often double earners, high income, buying luxurious, tasteful, trendy objects and sensitive to technological novelties, giving money for good causes, critical but receptive for new things and point of views, watches a lot of actualities and background programs on television, up to date for social issues and politics, self destination.
Broad minded	Progressive and educated, lots of ideals who are mainly left wing, worried about social problems and trying to better the world, starting with yourself, environmental consciousness, keen on freedom, appreciate to make once own choices and to have a varied life with some risks, self development, make great demands on oneself and others, receptive for the world around, understanding, profundity, dislike prejudice, read a lot, politics and social issues come from the bottom of the heart, flexible, modern, engaged.
Balanced	They are an average of all people. When it comes to interests, life style and so on, they are exactly in the middle or other people.
Censydiam-model of Sensovate	
Vitality	Achieving independence
Enjoyment	People try to maximize satisfaction of their physical and emotional needs
Conviviality	The need to open up socially, to really share emotions with others, to have a good time together
Belonging	The need to feel part of a group, to feel accepted and supported by their loves one
Security	The need for comfort, tranquility, and relaxation
Control	Control is exercised, behavior is void of emotions and feelings
Recognitions	The need to be different, to stand out from the crowd, not drift with the current
Power	The need to achieve success and status in life

BSR-model	
Yellow - Harmony	Commitment and harmony, group oriented, open minded, family
Green - Protection	Security and safety, group-oriented, less open, smaller world, less educated
Blue - Control	Ambition and control, performance, career, status, well-educated
Red – Vitality	Freedom, flexibility, independence, well-educated, active lifestyle, cultural development, travelling
Experience profiles based on BSR-model	
Living together	Prefer quiet neighborhood, plenty space in and around home, focusing on family, a preference for traditional design
Withdrawals	Looking for safe and quiet neighborhood, advanced age, strongly focused on the district
Dynamic individualist	Luxurious and exclusive (large and green) living, carrier-/ego-oriented, sports, performance and career-oriented
Anchored	Commitment to peace and security
Quiet luxury	Preference for quiet and safe living environment, focusing on social quality of the neighborhood, living with like-minded
Unattached	urban nomad, idiosyncratic, non-conformist, well educated, not materialistic, active sports, interest in culture and politics, need for privacy and anonymity