Deliverable 2.3
MAPPING CONSUMERS' NEEDS TO THE TAXONOMY MODEL

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D2.3: MAPPING CONSUMERS' NEEDS TO THE TAXONOMY MODEL

Summary

This deliverable presents a market segmentation of the pilot case consumer groups. These are 1) households and 2) energy managers. The aim of the segmentation is to identify groups of end consumers and professionals that share similar behaviours or needs for information in order to save energy. The defined segments are mapped onto the previously identified behavioural model of Triandis (deliverable 2.2) and onto the user requirements of the use cases.

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List of Acronyms and Abbreviations

B2C: business-to-consumer

B2B2C: business-to-business-to-consumer

B2B: business-to-business

HVAC: heating, ventilation and air conditioning

iESA: interactive Energy Savings Account

WP: Work Package

Executive summary

This deliverable D2.3 identifies segments of consumers of the use cases defined in D2.1, i.e. B2C (Estabanell), B2B2C (Senercon/co2-online) and B2B (Dexma). It defines five main segments of consumer groups for households (customers of Senercon and Estabanell) that are refined in a total of 30 sub-segments and three segments for energy managers (customers of Dexma). The households are segmented according to their motivation and their ability to enact change (ownership and income level) concerning energy saving measures, whereas the energy managers are segmented according to their specific need for information. The consumer segmentation is needed in order for eco-bot to handle different user types. Eco-bot can classify the users into the respective segment by asking relevant questions, as outlined in this deliverable. Once the user is allocated, eco-bot can give tailor-made advice to the users and suggest energy saving measure(s). The deliverable also gives insights into the drivers of high and low energy consumption levels in households. It also highlights the spectrum of energy saving measures (energy saving behaviours and investments) in the pilot countries Germany and Spain with residential consumers. The identified segments of households and energy managers are mapped onto the relevant factors of the previously selected Triandis' model (in D2.2). Additionally, the segments are mapped to the list of user requirements provided by Senercon, Estabanell and Dexma. This mapping will be further adapted in WP3, where more consumer characteristics will be identified to refine the consumer profiles. The deliverable will be exploited in WP4 for the back-end knowledge platform that will produce personalized recommendations and in WP7 in business case workshops. Furthermore, it serves as a basis for further clustering after the collection of smart meter data.

1. Introduction

This report presents the key findings from thorough literature research combined with input from the three use cases (B2C, B2B2C and B2B) regarding their user base. The findings shape the segmentation of the use case consumer groups of Estabanell, Senercon and Dexma.

The consumer segmentation defined in this deliverable is needed in order to understand a user's motivation and ability to enact change in terms of energy saving measures. Such information is needed for the development of tailor-made recommendations that eco-bot will give. By asking relevant questions, eco-bot finds out which segment the user belongs to. Eco-bot is then able to provide the user with the correct advice according to his / her user profile (i.e. motivation, ability to enact change). The initial questions needed for the allocation of a user to a segment are presented as part of this consumer segmentation for both residential and business consumers.

A mapping of the defined segments to a behavioural model selected in the previous deliverable allows for a basis of the scheme to handle different types of users. It will be further elaborated in WP3 of the project. As the user requirements (i.e. what the users require eco-bot to do) are essential to build the features of eco-bot, their relevance for the development of the segments is illustrated in this deliverable as well.

The deliverable is divided into six Chapters. Chapters 1 to 3 present the introduction, the aim of the deliverable and the methodology. Chapter 4 describes the market segmentation approach that is applied. It presents the segmentation of the residential sector and illustrates the key findings of household energy consumption and energy saving measures, while pointing out country-specific differences among the three use cases, which should be taken into consideration. It will feed into further development of the eco-bot project. The Chapter also outlines the segmentation of the business consumers. Chapter 5 presents the mapping of the identified segments of both the residential and the business consumers to the behavioural model. It also frames the relevance of the segmentation to the user requirements in a mapping. The final section (Chapter 6) concludes with a summary of outcomes and the key implications arising for the further development of eco-bot.

2. Aim of this deliverable

The aim of this deliverable is to segment the market, i.e. identify and categorize different consumer needs with regard to energy savings. This is undertaken to develop customized engagement strategies for eco-bot within the three pilot settings:

1) **Residential consumers of Estabanell in Spain (B2C):**

Estabanell is an electricity provider (utility). This use case will demonstrate how delivering personalized information on appliance-level and relevant energy efficiency tips can affect the behaviour of utility customers.

2) **Residential consumers of Senercon/co2online in Germany (B2B2C):**

Senercon, together with co2online, reaches residential energy consumers directly via its energy monitoring software. The consumers can register an energy savings account, in order to track their energy use.

3) **Facility/Energy managers of Dexma in Spain and the United Kingdom (B2B):**

Dexma is a building energy management system provider in Spain. It is a leading European Software-as-a-Service platform focused on energy efficiency with over 260 active partners (building managers / energy managers).

For pilot settings 1 and 2 distinct groups of residential consumers are identified and classified into five segments, which are further refined in 30 sub-segments. Each segment has its own characteristics and requires specific information and advice from eco-bot, which has already been shown in D2.1. In these use cases we will show how the more "personal" nature of chat-bot technology leads to more engagement and also how appliance-level consumption information leads to more efficient use of appliances. Pilot setting 3 targets energy facility managers, who are classified in three segments and require different levels of information and advice from eco-bot.

Eco-bot can find out which segment the consumer or facility manager belongs to by asking the questions as outlined in this deliverable in Chapter 4. Subsequently, eco-bot can give tailor-made advice (developed at a later stage in the project). Furthermore, the identified segments are mapped to the most suitable behavioural model (Triandis' model, as outlined in Chapter 5) and its relevant factors to be implemented for eco-bot, which have been determined in D2.2. Additionally, the user requirements in each pilot setting and their relevance for the identified segments are illustrated. With this deliverable we have built groups of consumers and hence, built a basis for a further clustering. The clustering will be undertaken when the demo cases (and the collection of smart meter data) have started, and its dimension depends on the abundance of the collected data.

The deliverable will also feed into WP4, where it will be exploited for the back-end knowledge platform and the production of personalized recommendations and WP7, where it will be used for the exploitation workshops of each pilot setting.

3. Methodology

The deliverable is based on two pillars: 1) a thorough literature review and 2) input by the project partners regarding their consumer groups (pilot settings). The aim is to identify market segments of consumers in order to define first questions for eco-bot to ask and hence allow eco-bot to give customized advice to each consumer at a later stage in the project.

First, the project team carried out an extensive literature review on different types of households, their respective appliance equipment and energy consumption patterns.[1] In the hope of building on existing knowledge of several other Horizon 2020 projects and the objective of creating synergies, the project team identified similar projects. We identified the enCOMPASS project as the one with the most similar project concept. It is still on-going and focuses on the development of "**innovative user-friendly digital tools** for making **energy data consumption available and understandable** for the different users and stakeholders (residents, employees, pupils, building managers, utilities, ICT providers)[2]".

In the progress of our research, we identified numerous and interesting findings regarding consumer needs for energy efficiency and approaches to segment these. But no comprehensive framework or sufficiently commensurable approach could be taken as a basis to apply and map to the use cases in the pilot settings. Thus, we decided to move forward using an approach where we segment the consumer needs according to their motivation and their ability to enact change, instead of segmenting along the lines of household types (determined by sociodemographic/economic characteristics) and the respective appliance equipment and energy consumption patterns. Our literature research shows (see Chapter 4) that the focus on sociodemographic/economic characteristics does not allow creating the powerful engagement strategies that eco-bot is seeking to develop and apply. Also, segmenting according to sociodemographic/economic characteristics would narrow the consumer needs down to the need for energy at a certain time only.

We believe that the identification of consumer needs goes beyond the need for a certain amount of energy at a given time of the day, especially for development of eco-bot. Hence, we consider the *need for information* (by eco-bot) and include it in our definition of consumer needs. This means not solely that information will be *accessible* but that it is broken down into what the *user actually wants to know and what the user can/or is willing to comprehend*. Such information has to be applicable to the user's situation and respect the users' needs or wants in terms of *comfort* and *cost-savings*.

[1] Studies from peer-reviewed international journals such as Energy, Applied Energy, Energy in Buildings, Energy and Energy Policy, as well as grey literature in form of project reports and databases such as EUROSTAT, Statistisches Bundesamt, INEbase, UNECE Statistical Database, International Energy Agency, Instituto Nacional de Estadística, Deutsche Energie-Agentur (DENA), were examined.
[2] http://www.encompass-project.eu/project/objective/

Consequently, we chose a holistic approach for the residential consumers, as it allows more insights into these forms of needs and wants of the user than smart meter data by itself. The aim of this method is to provide more information for eco-bot to function and to complement the smart meter data (available at a later stage in the project) with insights in the consumers' values, attitudes and motivations. Therefore, the findings of our literature research are complemented by the information about what the pilot case users need eco-bot to do (user requirements).

For pilot settings 1 and 2 (residential consumers of Senercon and Estabanell– B2B2C and B2C, respectively) we specified the segments according to a) the motivation of consumers to save energy and b) ability to enact change (property: tenant vs. owner and income level). Segmenting in this way was found to be the most comprehensive and applicable approach, because a) it offers powerful clues on the willingness of consumer groups to energy saving initiatives through tailored messages and b) it considers the consumers' ability to enact change (scope of action of tenants vs. owners and income level, which is crucial when it comes to energy efficiency investments).

For the pilot setting 3 (energy managers of Dexma- B2B) three segments (user types) were specified, which indicate the precise needs and characteristics of each user type. These user types were suggested by the project partner Dexma.

Further findings presented in this deliverable

Originally this deliverable focused solely on the development of the two market segmentations (for households and facility managers) and the mapping of these on the taxonomy of a multifactorial model. However, our research has shown that insights into energy consumption (e.g. high/low consumption by appliance or category) and energy saving measures (e.g. replacing conventional by LED light bulbs) in the residential sector are nevertheless necessary to develop eco-bot. Hence, we provide condensed information on the most important findings thereof in Chapters 4.1.1 and 4.1.2. This will help eco-bot to focus on the most important questions and narrowing down more quickly which information is pertinent for each user. It is crucial that users of eco-bot will not have to go through too many questions, before they receive energy saving recommendations or other relevant information as this is time consuming. Furthermore, we researched on country-specific differences such as climate and culture when it comes to energy savings, since such differences clearly relate to different consumer needs in the respective countries. Delivering this additional information together with our proposed market segmentation is aimed at developing the most engaging strategies to maximise the potential of eco-bot.

4. The energy market segmentation approach

4.1 Market Segmentation of private households

Market segmentation approaches aim at "grouping people (with the willingness, purchasing power, and the authority to buy) according to their similarity in several dimensions related to a product under consideration" (Brusilovsky). In the case of eco-bot, we investigate energy saving behaviour and investments, while we do not examine a specific product. For this purpose, we have considered approaches that focus on the willingness and/or motivation to save energy. We decided to base our approach on the five consumer segments identified by the study of Frankel et al. (2013).

Eco-bot aims to encourage consumers to save energy through tailored messages; hence, it is necessary to take the consumer's motivation (willingness) into account as well as his or her ability to make a change (purchasing power and authority to buy). The market segmentation according to Frankel et al. covers the energy saving efforts of consumers and the motivation behind this behaviour. Therefore, this approach is a suitable basis for us to build on.

The five segments identified by Frankel et al. are structured according to self-reported extent of energy saving behaviours, with green-advocated energy savers having the most positive energy saving behaviour and disengaged energy wasters having the less motivated energy saving behaviour.

- **Green-advocate energy savers** report the most extensive energy-saving behaviour. They are motivated by their strong pro-environmental attitudes and values. Their interest in new technologies to achieve their energy saving goals is notably high.
- **Traditionalist cost-focused energy savers** report to save significant amounts of energy, driven by the interest of saving cost. Their interest in new technologies is limited, as it is not an interest per se in the technology but again, an interest in potential cost savings.
- **Home-focused selective energy savers** are motivated by the possible home-improvements and show a high interest in new technologies that allow such improvement. Reducing cost is another motivational factor. The cost saving interest has to be understood as a long-term one, in other words, people in this segment are willing to invest in the home to ensure better energy bills in the future.
- **Non-green selective energy savers** are more convenience oriented. Even though they are not concerned about the environment, they are willing to save energy as long as it is easy, and they do not have to think about it. New technologies that allow "set and forget" interventions are therefore welcome.
- **Disengaged energy wasters** do not intend to save energy and are neither concerned with the environment nor with financial aspects regarding energy usage.

Accordingly, there is also no interest in new technologies to support or enable energy savings.

These five segments offer insight in the self-reported energy-saving behaviours and the interest in technology, which can be valuable information for eco-bot as well. This will become more transparent when we outline the questions that eco-bot can ask to classify the user according to the segmentation here.

The study by Frankel has been conducted in the USA. However, this is not a context-specific segmentation that is only pertinent in US-American culture. In other countries the considerations also include environmental concerns, interest in cost saving, convenience and interest in new technologies (e.g. Abrahamse and Steg, 2009, Bradford Mills and Joachim Schleich, 2012; Dieu-Hang et al., 2017; Faiers et al., 2007, Fornara et al., 2016; Poortinga et al., 2003). Furthermore Frankel's approach is not unique in the sense that similar segmentation has been undertaken by other authors. Sütterlin et al. (2011) for example identifies six segments among Swiss energy consumers, namely "the idealistic energy-saver, the selfless inconsequent energy-saver, the thrifty energy-saver, the materialistic energy consumer, the convenience-oriented indifferent energy consumer, and the problem-aware well-being-oriented energy consumer". These segments are based on the same reasoning and can mostly be matched to Frankel's approach, as the following table shows.

Energy savers according to Sütterlin	Energy savers according to Frankel
Idealistic energy saver	Green-advocate energy savers
Thrifty energy saver	Traditionalist cost-focused energy savers
Problem-aware wellbeing- oriented energy consumer	Home-focused selective energy saver
n/a	Non-green selective energy savers
Selfless inconsequent energy-saver	n/a
Convenience oriented energy indifferent energy consumer/ and materialistic energy consumer	Disengaged energy waster

Table 1: Matching of Sütterlin's energy savers to the ones of Frankel et al. (2013)

While this reasoning and the considerations are inter-culturally valid, we recognize that the three use cases take place in different countries, which we further elaborate in Chapter 4.2, by taking into account the input by the project partners and their residential consumer base in Germany and Spain.

It is important to note that these categories directly refer to the interest and willingness of consumers to engage in energy-saving activities, which is of primary importance for the mode of engagement proposed by eco-bot and not to the level of consumption itself. A poor disengaged energy waster may still consume less energy than a rich idealistic energy saver, but would need to be engaged very differently.

Building upon the five segments of Frankel's approach allows us to capture the motivation of the consumers. Motivation is a key factor. The literature on the adoption of energy saving measures emphasizes that socio-demographic/economic factors have been in the centre of many studies, while psychological factors such as attitudes and motivation play much larger role in influencing behaviour (Bradford Mills and Joachim Schleich, 2012; Faiers et al. 2007; Lacroix and Gifford 2017). Abrahamse and Steg (2009, p.719) even stated: "Household energy savings appeared to be mostly associated with psychological factors, whereas socio-demographics did not come into play". The important aspect as shown in Abrahamse and Steg (2009) is if overall consumption levels are considered, then socioeconomic/-demographic factors tend to dominate, and if changes in consumption levels are considered, then psychological factors are dominant. As **eco-bot seeks a) to induce change and b) to do this by actions targeted at the individual** rather than at the macro level, it is appropriate that motivational factors should play the larger role.

Motivation is a strong driver for change, however, in order for energy savings to happen, it is not enough to simply be motivated; one also needs the ability or the power to implement the decisions towards saving energy and enact the change. Consequently, we decided to divide each segment of Frankel's approach into several sub-segments: one being the owner (a) and one being the tenant (b) (authority to buy). This distinction is essential when it comes to saving energy: tenants and owners do not have the same ability to enact change. Legally the tenants have the right to pay exactly for the amount of energy they have used and can change their behaviour or certain appliances in the dwelling (Scharp 2009, p. 6). However, the insulation of the building, the heating system, water pumps etc. are the property of the owner and thus his or her responsibility and choice (Dieu-Hang et al. 2017). Furthermore, when it comes to energy saving investments (e.g. such as purchasing more efficient devices or even engaging in energy efficient retrofitting), the income of a household plays a major role (purchasing power) (Martínez-Espiñeira et al. 2014, p. 180; Dieu-Hang et al. 2017, p. 142; Trotta 2018, p. 536). Therefore, we divided each one of the ten segments into three classes of income (high, middle and low). For communication purposes and to avoid suggesting changes that cannot be enacted by the consumer in question, this subdivision in finer segments is invaluable for the development of eco-bot.

Our proposed segmentation approach according to motivation and ability/power to make energy savings leads to thirty distinct segments as visualized below.

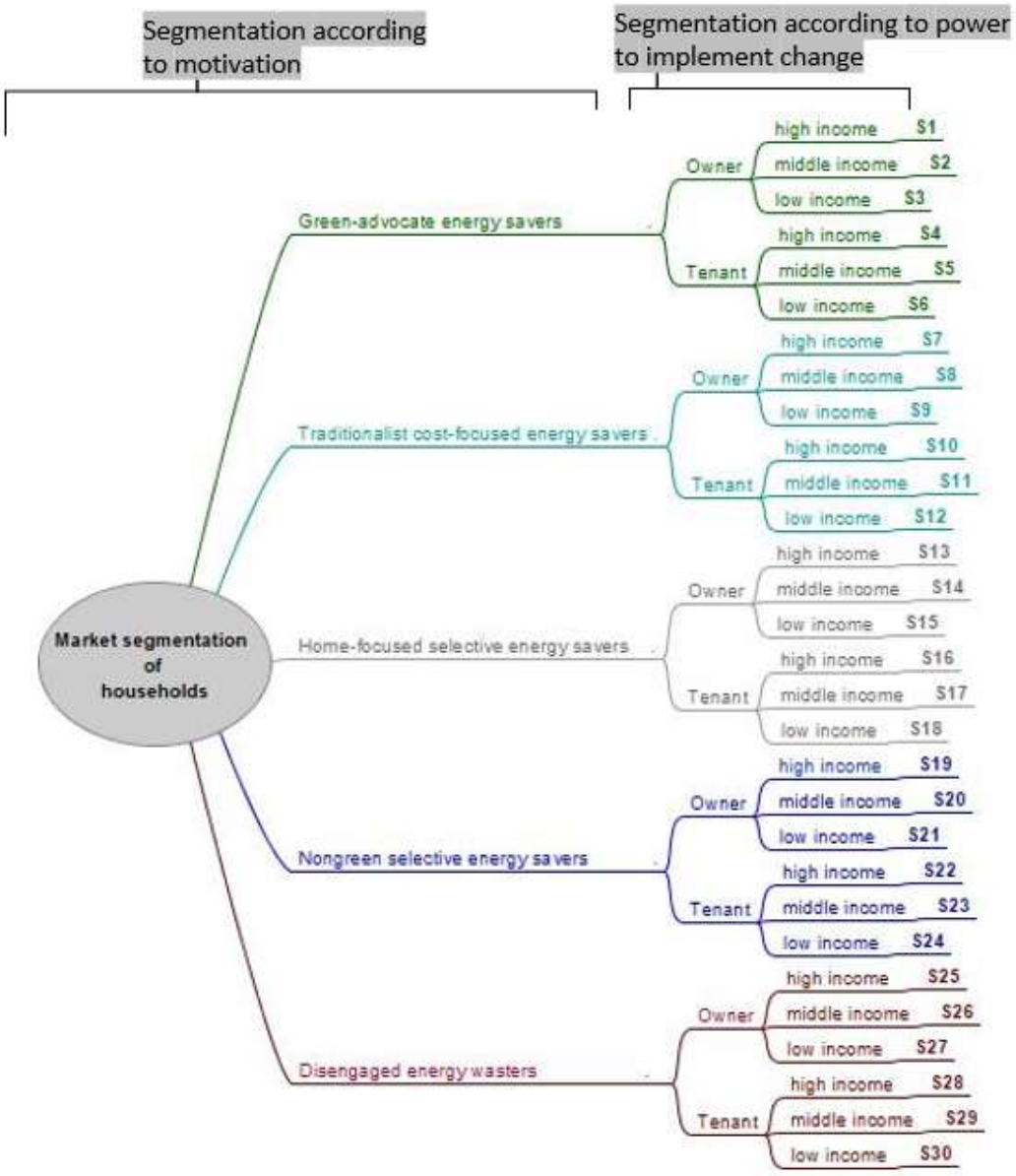


Figure 1: Market segmentation approach: Segmentation according to energy saving motivation and power to implement change

In order for eco-bot to find out in which segment a consumer belongs only three questions are required. One aiming to know the main motivation, another one to know whether the person is renting or owning the place he or she lives in, a third one about the person's income:

1) *What motivates you the most to adapt energy saving measures in your home?*
    a. the belief that I will contribute to a better quality of the environment
    b. saving money on energy bills
    c. improving my home for years to come and keeping it up-to-date
    d. convenient solutions that can be applied easily and will not require me to think about them (set-and-forget)
    e. nothing, I am satisfied with my current energy usage
    f. Other: _____

    Or a variation thereof, such as:

Would you be most likely to adapt energy saving measures if they …

    a. significantly contributed to tackling climate change
    b. significantly reduced your energy bills
    c. significantly improved the value of your home
    d. were easy to implement and you would not have to think about them anymore
    e. None of the above, I am satisfied/do not worry about my current energy usage
    f. _____

2) Do you own or rent the place you are currently living at?

    a. Own
    b. Rent

3) In which range can your household net income be found?[3]

Spain:

    a. 2500 EUR/month and more
    b. Between 1000 EUR and 2500 EUR per month
    c. 1000 EUR/month and less

[3] The answer options that eco-bot will give depend on which country the user lives in. To classify the three income ranges, statistics on the household income distribution (INE Institutio Nacional de Estadística 2018; Statistisches Bundesamt (Destatis); Trotta 2018, p. 532) were combined with up-to-date information on the income for high and low skilled labour (TRADING ECONOMICS a 2018, TRADING ECONOMICS b 2018 and TRADING ECONOMICS c 2018).

Germany:

a. 3600 EUR/month and more
b. Between 2600 EUR and 3600EUR per month
c. 2600 EUR/month and less

As literature shows (e.g. Aigeltinger et al., 2015; Schräpler, 2003; Singer et al., 1993; Tourangeau und Yan, 2007) people are rather reluctant to answer questions on their income due to privacy issues. Therefore, it is particularly important to inform the user on eco-bots privacy policy and how this information will be used. It shall be clearly communicated that eco-bot asks this to avoid coming up with unsuited solutions and offer better tailored service. To avoid drop-outs of the pilot project we recommend that there should be the option to leave this question unanswered.

Further questions can be asked and allow checking whether the answers are consistent.

For example, the interest in technology appears in Frankel's segmentation and is of relevance in the eco-bot project since this will help narrow down which investments will be more likely implemented or not. Also, this helps eco-bot not to frustrate or discourage users who are not as technologically savvy. This can be done by avoiding giving too much insight on technologies or by not proposing investments that would require the user to engage with new technologies more than he or she is willing to. Possible questions are:

How interested are you in new technologies or service programs to improve energy efficiency?

a. Very interested, especially if they help tackling environmental problems
b. Very interested, especially if they help improving my home
c. Somewhat interested, if they help me reduce my energy bills
d. Somewhat interested, if they come with a standard setting and I don't have to learn much about them
e. Not interested

Asking the user about their energy-saving behaviours could look like this:

How often do you leave your devices on stand-by?

a. always
b. whenever it is convenient
c. very rarely for certain devices
d. never
e. I don't know

Similarly, other behaviours as recycling, switching off the lights in the room that one is not using or setting the room temperature lower can be inquired. Or a list of energy-saving behaviours can be proposed asking the user which one of these he or she applies and how consistently.

It is important to know though that self-reported behaviours are mostly affected by social desirability concerns (Paulhus, 2002; Beckmann, 2005). Ewert and Galloway (2009) even proposed the concept of 'environmental desirability responding' (EDR), underlining that individuals sometimes project an image that is pro-environment, even when this does not always reflect their actual behaviours (Trotta 2018, p. 538). In the case of eco-bot the self-reported energy saving behaviours are not that important since eco-bot aims at helping people engage in energy efficiency strategies. Accordingly, motivation is more important than what people claim to have done in the past. Motivation in turn does not automatically translate into actual energy-saving behaviour changes (e.g. Blake, 1999; Courtenay-Hall and Rogers, 2002; Flynn et al., 2009), yet it appears to be a relevant condition for action (Trotta 2018, p. 538). And this action will be facilitated through eco-bot's individualized advice and help.

Eco-bot is supposed to communicate with the users in natural language, just like a human. The dropdown menu of answers does not necessarily correspond to that. However, this might be acceptable for classifying the user in the very beginning. Alternatively, eco-bot can ask the questions openly first and then provide different possibilities of answers when the user seems to have difficulty answering. Moreover, the possible answers that we provided here can help eco-bot identify to which field the answer of the respective user corresponds.

It shall be underlined that our market segmentation provides important insight when it comes to personalizing the energy saving advice given by eco-bot. In other words, understanding the motivation and power of consumers in order to communicate effectively and thus triggering change can be achieved by applying this segmentation. However, **this implies that the segments do not provide information on the amount of energy used in each segment.** For instance, it can neither be derived that all Green-advocates have the same energy usage, nor can be known if their energy usage is high or low. One can be very motivated to save energy and exhibit energy saving behaviours, but having a higher energy consumption (e.g. by living in a big house in the country side) than someone who does not care about energy use (e.g. being part of the disengaged energy wasters segment but living in a small apartment in the city).

Since eco-bot would however benefit from an understanding of residential energy consumption levels, the next Chapter is dedicated to providing such information.

4.1.1 Insights into energy consumption in the residential sector

Eco-bot requires an understanding of energy consumption. Therefore, we compiled the results of various international studies across the world on energy consumption into a data set (see annex A). In this data set we also gathered the scarce information on which appliances tend to be used more in which type of dwelling or household. For a better overview we extracted the most significant information in the following table (Table 2). It

shows the criteria that are commonly associated respectively with high or low energy consumption. We incorporated studies from outside Europe to get an idea of which findings appear to be consistent across different cultural and geographical contexts. Furthermore, to assess the state of the art and consolidate our findings, we referred to studies that used a systematic review approach (e.g. Hayn et al., 2014; Jones et al., 2015; Jones and Lomas, 2016). All the criteria that appear in the table below are criteria we found in several different studies across different geographical contexts.

For eco-bot it is especially important to know, that when it comes to electricity consumption, the household composition is the main influencing factor (Brounen et al., 2012; Trotta, 2018). Dwelling characteristics play a major role on residential gas consumption for space heating (Steemers and Yun, 2009; Trotta, 2018). Accordingly, when eco-bot notes high electricity consumption it should focus on asking questions about the household composition (i.e. number of people in the household and their socio-economic status). Depending on the segment that the user in question is part of, eco-bot can then move on and give specific advice. For instance, installing double-glazed windows is one of the measures with the highest energy-saving potential (Ramos et al., 2016, p. 377). Eco-bot should only suggest such an investment to owners in the higher income range (S1, S7, S13, S19, S25), as it is also a very costly energy efficiency investment. Furthermore, studies have shown that income plays a major role in this particular investment: "the (average) predicted probability of installing double-glazed windows would increase from 46% to 56% if households moved to next higher income bracket" (Martínez-Espiñeira et al., 2014, p. 180). The big advantage is that the installation of such glazing does not require changes to the building structure itself and is therefore an easy way to improve the building envelope (Ramos et al., 2016, p. 377). This could particularly resonate with Home-focused selective energy savers, owning the dwelling and having a high income (S13).

HOUSEHOLD RELATED CRITERIA	Drivers of HIGH Energy Use	Drivers of LOW Energy Use
Household size (number of inhabitants)	4 or more	n/a
Household composition	pets teenagers (13 -19 yrs. old) single parent	small children (0-9 yrs. old) families without children two parent household
Income	High income (almost linear relationship)	n/a
Ownership	privately owned[4]	n/a

DWELLING RELATED CRITERIA	Drivers of HIGH Energy Use	Drivers of LOW Energy Use
Location	Rural	Urban
Building type	detached house	Apartments, bungalows, terrace houses
Building age	Older dwellings with poorer energy efficiency building envelope	newer homes (built after 2000)
Floor area	almost linear relationship	n/a
Number of rooms	almost linear relationship	n/a

[4] Studies find that the energy consumption of persons owning and living in a dwelling is higher than when the dwelling is rented. Mills and Schleich, 2009 findings show that home owners are less likely to particularly invest in efficient fridges and dishwashers.

APPLIANCES	Drivers of HIGH Energy Use	Drivers of LOW Energy Use
Room/Water Temperature Regulation/Supply	electrical space heating electrical water heating water pumps air conditioning	 desk/wall fan, dehumidifier
Kitchen/Cooking/Food Storage	chest freezer fridge freezer electric ovens and stoves	microwave kettle
House keeping	dryers dishwashers vacuum cleaner	n/a
Hobby/Entertainment/Relaxation	TV desktop PCs with monitors swimming pools spas, saunas waterbeds terrarium aquarium	n/a
Small appliances - Miscellaneous	n/a	electrical toothbrush chargers

Table 2: Overview of high and low energy use: Condensed information from literature review

Since the studies we reviewed showed controversial findings around age, education and gender, these criteria do not appear in the table (for thorough explanation see Annex A). Furthermore, recent studies reviewing the state of the art underline these controversies: Lacroix and Gifford (2017) cite authors saying that women report more environmental concern than men and then cite sources saying that the opposite holds true, continuing on

with a list of authors, who find that gender does not influence the adoption of environmentally friendly behaviours at all. Similarly they oppose the authors underlining that environmental concern and pro-environmental behaviour decreases in older age, with those who find that older people are more concerned and even exhibit more pro-environmental behaviours. Trotta (2018) does not find education to be significant in his study and cites other authors confirming this in their own research, all the while citing sources stating that they found the educational level of a person to be correlated with their likelihood to make energy efficiency investments. Trotta underlines that these authors suggest that higher education plays out on the income levels and makes energy efficiency improvements more affordable.

A lot of very common appliances (e.g. lighting or washing machines) do not appear in this table either. The controversial findings in the studies here are mainly due to highly differing efficiency levels: While there are certainly inefficient light bulbs and washing machines, huge progress has been made and nowadays very efficient appliances are on the market.

The following graph shows the share of electricity consumption by categories of appliances according to the statistical office of the European Union:

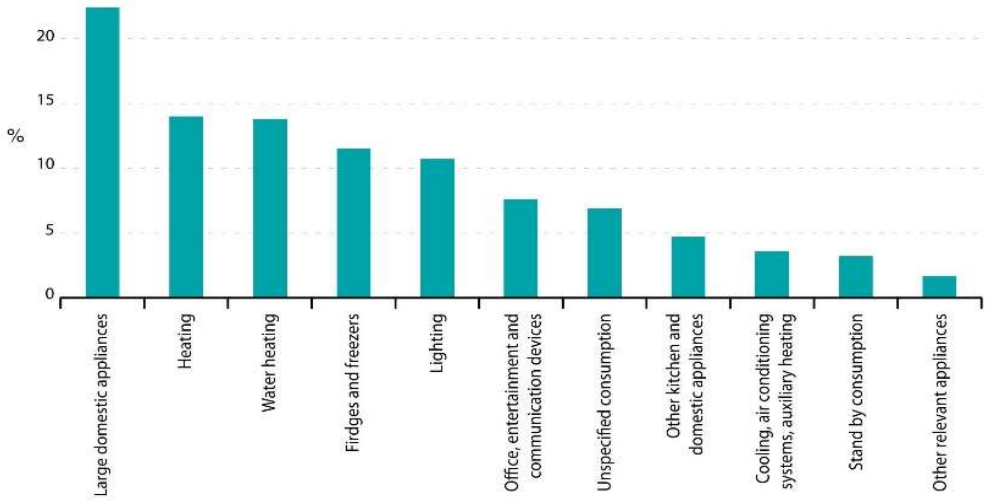


Figure 2: Breakdown of electricity consumption by categories of consumption: Eurostat (2013)

Having provided this insight into residential energy consumption levels, we now want to focus the attention on energy saving potential and consumer needs in the residential sector.

4.1.2 Energy saving potential and consumer needs in the residential sector

Saving energy can be achieved through the adoption of energy-saving behaviours and/or the investment in energy efficient solutions. While the latter has a greater energy saving

potential as a whole and can be more easily influenced by legal frameworks[5] of the respective country than the former, both are equally important to achieve energy savings: "There is evidence suggesting the potential for larger energy savings if technical, infrastructural, and energy saving behavioural intervention changes are applied in combination and mutually reinforce each other via the same goal" (Trotta 2018, p. 530). Solely focusing on energy-saving technologies is misleading, since the resulting increase in energy efficiency is often overcompensated with an increase in energy usage or decreased energy conservation (Bradford Mills and Joachim Schleich, 2012). In that regard eco-bot could be a powerful tool to engage consumers in a more holistic approach by contributing to avoiding or limiting rebound effects.

Energy-saving behaviours require a different amount of cognitive and physical effort and/or come with a more or less extensive comfort loss. This in turn determines the acceptability of changing over to the more energy efficient behaviour (Poortinga et al., 2003). The following table exemplifies the range of energy saving behaviours and the respective effort required and/or loss of comfort:

Low effort/comfort loss	• Switching the lights off, when not needed • Pulling the shutters down at night to keep the warmth of the room • Using the lid when cooking
Medium effort/comfort loss	• Shortening the shower time • Switching all devices completely off instead of leaving them in stand-by
High effort/comfort loss	• Defrosting the freezer to ensure the best performance • Venting the radiator • Set the room temperature lower • Hanging cloths up to dry instead of using the dryer

Table 3: Range of energy saving actions and interlinked loss of comfort

As mentioned before, a change in behaviour requires some effort cognitively speaking and is often connected to a loss of comfort (Trotta 2018, p. 531). That comfort might be the room temperature or even just the fact that one has to remember to do something in a certain way and go ahead and actually do it.

On the other hand, investment in energy efficient solutions does not require changing the behaviour but requires having the money and depends on the kind of investment made by

[5] D 2.2 Taxonomy of Energy Efficiency Models, Chapter 2 (pages 7 ff.)

the owner of the dwelling (Poortinga et al., 2003). Meanwhile the range of possible investments and the respective cost varies widely, as exemplified in the table below.

Low cost investments (often with DIY option)	• Replacing the lightbulbs with more efficient ones • Using insulating foil on leaky windows • Repair a dripping tap
Medium cost investments	• Replacing old white appliances (freezer, refrigerators, dish washer, washing machines) with A+++ labelled new appliances • Installing electronic thermostats
High cost investments	• Double-glazed windows • Wall insulation

Table 4: Range of energy saving actions and interlinked investments

Again, knowing to which of the thirty segments a user belongs will help eco-bot narrow down the questions for the user and give more tailored advice. Distinguishing between two kinds of investments is useful: **energy efficient appliances** and **energy efficient retrofit measures**. In general, appliances in the housing area are usually categorised into 'white" appliances such as refrigerators, freezers, refrigerators-freezers, washing machines, dishwashers and dryers and into 'small' appliances such as TVs, computers, vacuum cleaners, kettles and a number of other appliances small enough to fit into this category. **Investing in energy efficient appliances** means purchasing class-A (or more energy efficient) equipment (IEA 2014a, IEA 2014b). While the investment into **energy efficient retrofit measures** describe larger (monetary and more structural) interventions and improvements to a house (Dixon and Eames, 2013). Usually this involves installations of insulations or the replacement of single glazing to double glazing or changes to the heating system, which are referred to as changes to the building envelope (Gardner and Stern, 2008; Dietz et al., 2009) (Trotta 2018, p. 531).

This illustration makes clear that energy efficient retrofit measures demand higher costs, time and skills than the investment energy efficient appliances. Moreover, such measures are usually performed by highly skilled professionals authorized by the owner and not the tenants of a house (Maller and Horne, 2011). On the other hand, the implementation of energy efficient measures regarding appliances is considered a do-it-yourself (DIY) action, which can be conducted by tenants themselves at a much lower cost (Trotta 2018, p. 531).

Switching to the best available technology (BAT) can lead to tremendous energy savings that can also be implemented by tenants. In the REMODECE project[6] "using best available technology for the 12 countries covered […] amounts to 165TWh per year. These electricity savings are equivalent to 72 million tons CO2 emission reduction per year by switching from present technology, also called Present State (PS), to best available technology (BAT). Projected to the European level (EU-27)[7], the **electricity savings would amount to 268TWh** (or 116 million tons of CO2), **which is around one third of total electricity consumption in the residential sector in EU-27** (based on the total electricity consumption in EU-27, including electric space and water heating, which was 801TWh in 2007)" (Almeida et al., 2011).

The following graph (Fig. 5) illustrates the potential energy savings when switching to BAT for different appliances. The biggest savings are clearly lamps, followed by appliances such as refrigerators and freezers.

[6] Residential Monitoring to Decrease Energy Use and Carbon Emissions in Europe (REMODECE) was an EU project from 2006 – 2008 covering 12 European countries (Belgium, Denmark, France, Germany, Greece, Italy, Norway, Portugal, Switzerland, Czech Republic, Hungary, Romania and Bulgaria). For further information see http://remodece.isr.uc.pt/
[7] Please note that the available projections and derived figures were calculated on an EU-27 basis.

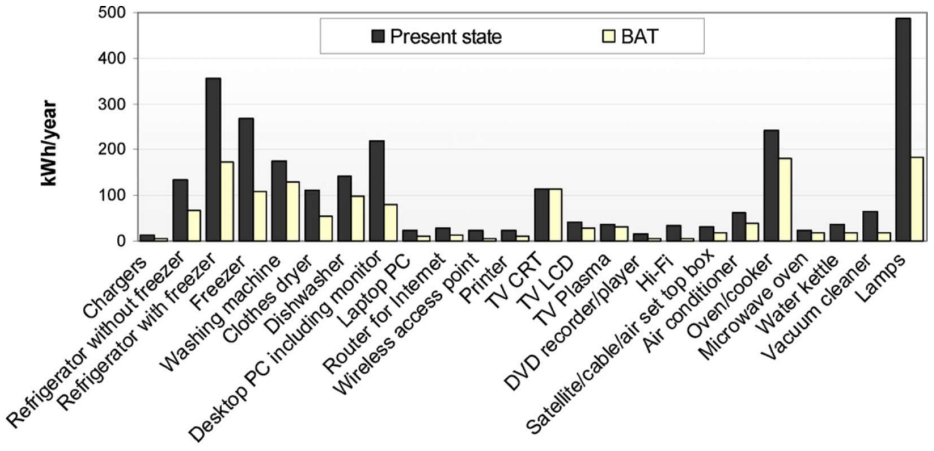


Figure 3: Electricity savings potential per household and appliance, by switching to the BAT: REMODECE 2008.

Changing energy-related behavior and making energy investments depends on a myriad of factors as pertinently outlined in D2.2 (Chapter 7, pp. 176/77). Below you will find the list of causal variables that influence such choices.

Causal variable	Indicators	Examples
Attitude factors	✓ Norms ✓ Beliefs ✓ Values	✓ General pro-environmental predisposition ✓ Personal commitment ✓ Product attributes
Contextual forces	✓ Interpersonal influence ✓ Advertising ✓ Monetary costs/benefits ✓ Regulation ✓ Support policies ✓ Status	✓ Persuasion within communities ✓ High energy prices ✓ Grant programme ✓ Owned/rented house
Personal capabilities	✓ Knowledge and skills ✓ Availability of time ✓ General capabilities and resources / socio-economic data	✓ Understanding of the function of a micro-generation technology ✓ Information gathering ✓ Literacy, money and social status
Habit or routine	✓ Energy consuming behaviour	✓ Switching lights off ✓ Leaving appliances on standby

Table 5: Causal variables influencing environmentally significant behaviour. Martiskainen (2007)

While our segmentation covers attitudinal factors and some contextual forces, it is important to keep in mind how many other factors influence the decision-making process. Eco-bot can engage consumers in a more effective way, when being familiar with the respective situation. This also becomes clear in Triandis' Model (Figure 4), as presented in D2.2 and outlined in Chapter 6 of this deliverable.

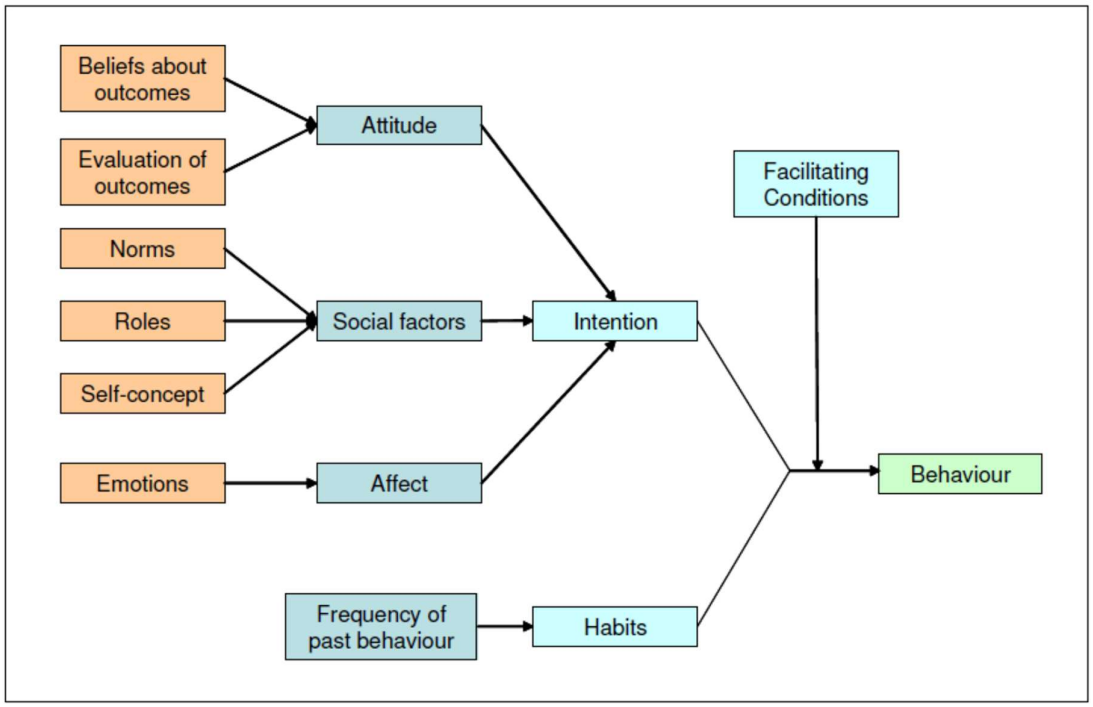


Figure 4: Triandis' Model - Theory of Interpersonal Behaviour, Jackson (2005)

Especially, beliefs about the outcomes, evaluation of outcomes, social factors, habits and facilitating conditions are not necessarily the same in the two countries of the residential use cases (Germany and Spain) and deserve therefore a closer look before we move on to summing up the user requirements.

4.2 Differences related to energy savings in the residential sector in the pilot countries Germany and Spain

4.1.1 Domestic energy consumption and energy-saving

This section exemplifies differences of energy consumption and energy saving measures in the two residential use case countries (Germany and Spain) to underscore the importance for eco-bot to gather such information. By understanding country specific and regional differences of facilitating conditions and barriers, eco-bot will be capable of delivering the best service, which in turn means realizing the most energy savings.

When looking at the overall energy consumption of the three countries, Spain appears as an out layer, being the only country having a net increase of energy consumption (Lapillonne, Bruno, Karine Pollier, and Nehir Samci, 2015; Mendiluce et al., 2009). Therefore, we want to give a short insight, explaining this difference: while Lapillonne, Bruno, Karine Pollier, and Nehir Samci suggest this is due to the increase of cooling appliances, Mendiluce et al. name transport growth, increase of activities linked to the construction boom, and the convergence to EU levels of household energy demand as the explanatory factors. When comparing the structures of household energy consumption of Spanish and other EU households we can find indeed significant differences:

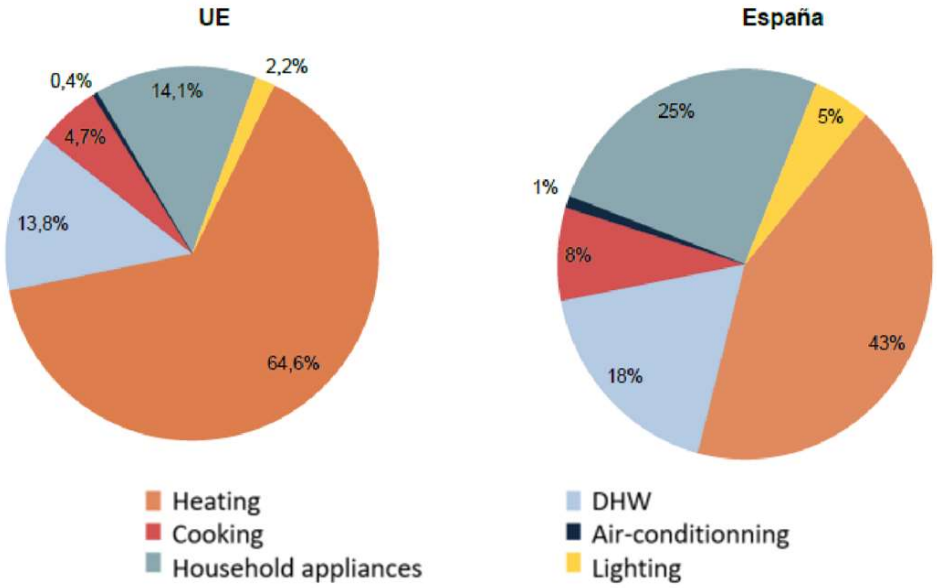


Figure 5: Structure of residential sector energy consumption: by use in Spain and in the EU, Government of Spain Ministry of Energy, Tourism and Digital Agenda 2017

First of all, due to the warmer climate, the share of energy consumption for heating is about 20% smaller than in other EU countries, meanwhile air-conditioning is more common, but only makes up 1 % of the total consumption. The use of air-conditioning is seasonal and will show important peaks during the hottest days of the summer (Government of Spain Ministry of Energy, Tourism and Digital Agenda 2017). The graph also shows that the use of household electrical goods makes up over a quarter of the total consumption, with the refrigerator being the main appliance in usage (Government of Spain Ministry of Energy, Tourism and Digital Agenda 2017). Accordingly, eco-bot should closely monitor the energy efficiency of the refrigerators and suggest maintenance behaviours to increase its performance or when applicable to the situation of the user, the replacement of the appliance.

Spain is the only country of the three use cases where temperatures vary so widely so that different climatic zones can be identified. The IDAE (Spanish Institute for Diversification and Energy Saving) distinguishes between the North Atlantic, the Continental and the Mediterranean area based on maximum, medium and minimum average temperatures along the period 1997–2007 (Ramos et al., 2016). This is a crucial piece of information for eco-bot, since the climatic zones greatly impact the energy usage in the respective households, especially when it comes to heating and cooling.

Having outlined why Spain deserves special consideration due to its climatic variance, we now present how the differences among the two countries of the residential use cases impact acceptability and/or likelihood of the adoption of selected energy saving measures and how this is relevant for eco-bot. We chose to demonstrate this along the aforementioned categories: **Differences in energy-saving behaviours** and **investments** with a further distinction of the latter into investment **in appliances and retrofit measures**.

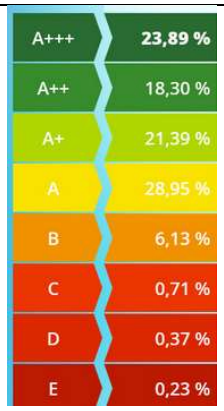
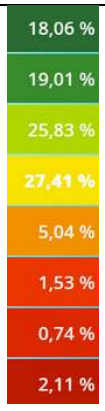
Differences: Energy-saving measures	Reason	GERMANY	SPAIN
Behaviour: Cold wash	**Cultural** (beliefs about the outcomes, habits)	Belief: lower °C -> poorer outcomes (hygiene, cleanliness)	Cold wash
Behaviour: Hang cloths up to dry instead of using the dryer	**Climatic differences** **Cultural (habit)**	Cloths are tumble-dried	Cloths are hung up to dry
Behaviour: Setting lower room temperature with the thermostat when applicable	**Climatic differences and costs** (facilitating conditions) **Cultural** (habits)	Very common	Continental and Mediterranean: less common Atlantic: more common
Investments/Appliances: Purchase according to EU EE labels	**Cultural** **Environmental concern and interest in technology** (attitude, affect, social factors)	 (Gulz 2018)	 (Gulz 2018)
Investment/Retrofit measures	**Facilitating conditions** (state of the existing building stock, legal frame work and economic aid programs, ownership rate, geographical differences)	Improvements and progress less likely	Improvements and progress more likely

Table 6: Differences in energy saving measures in Germany and Spain

4.1.2 Energy-saving behaviours

With regards to energy saving behaviours, Table 6 exemplifies actions related to doing laundry. While in Germany people are reluctant to use cold wash programs, this is common in Spain. The underlying belief in Germany is that lower washing temperatures signify compromises in terms of hygiene and cleanliness (Josephy, 2014). This belief is a clear barrier to save energy in the washing process. When eco-bot has such information at hand it can be more sensitive to these cultural differences and address the respective consumer accordingly. For example, eco-bot could provide evidence-based information on the impact of the washing temperature and give advice for washing programs to choose.

Dry hanging cloths is also more common in Spain than in Germany, which is on the one side related to the climatic differences of these countries but on the other side also to routines. Spanish tend to dry hang their cloths also indoors in a heated room in the winter (Alborzi et al., 2017). Dry hanging one's clothes does not only require more effort, it also takes longer. Eco-bot has to engage the consumer accordingly to his or her motivation. Green-advocate energy savers and Traditional cost-focused energy savers are the most likely to go the extra mile to save energy here.

When it comes to setting lower room temperatures, German households mostly comply with the Energy Savings Ordinance (EnEV), recommending a 20°C room temperature (Umweltbundesamt, 2012; Jahnke, 2010, p. 27). In Spain regional differences have to be pointed out, with the warmer regions (Continental and Mediterranean) routinely setting higher temperatures than the colder one (Atlantic). Ramos et al. (2016) suggest that the reason is the higher marginal costs of heating. Eco-bot can provide feedback on the saving potential and advice when it comes to heating. Especially Green-advocate energy savers and Traditional cost-focused energy savers seem to be an appropriate target group. But also Home-focused selective energy savers are, since the right heating temperature is important for the maintenance of the home, preventing for instance dampness and mould (Heseltine and Rosen, 2009).

4.1.3 Energy saving investments

With regards to appliances, table 6 of the previous section (Gulz, 2018) shows:

- Most often, in 63,58% of the purchases, German consumers purchase green labelled appliances (A+, A++, A+++). The most A+++ appliances are purchased by Germans, compared to English and Spanish consumers.
- B appliances are about twice as popular as in Spain and Germany.
- Spanish consumers mostly (62,9 %) purchase green labelled appliances (A+, A++, A+++).

These differences are partly due to differing levels of environmental concern and interest in technology: In Spain survey results demonstrate that environmental concern "has become a central element of the Spanish belief system" (Gifford and Nilsson, 2014). The effects and

threats of climate change are recognized, especially with the southern Spain facing desertification (Martínez-Valderrama et al., 2016). Moreover, Galarraga et al. (2011a; 2011b) found that the voluntarily implemented subsidy programs of regional governments boosted the share of A+ labelled appliances in Spain. Ramos et al. (2016) notes though that the size of the municipality can impact the access to information on such programs. Therefore it is important that eco-bot ensures that people in small municipalities are aware of the ongoing programs they could benefit from. The Spanish Institute for Diversification and Energy Saving found that only 23% of households received subsidies for appliances (IDAE 2011). When eco-bot localizes a user in a small municipality it can ask specifically if the user is aware of the subsidy programs in the respective regions and guide the user through application processes.

In Germany the high environmental concern is paired with a pronounced interest in technologies and high-quality products. However, Bradford Mills and Joachim Schleich (2012) find that Germans exhibit less energy saving behaviours: "The results suggest that in a cross-country perspective a high level of knowledge of energy use and available energy-saving technologies in a country does not imply the country will also show high propensities for energy conservation behaviour." Bradford Mills and Joachim Schleich (2012) hypothesize that Germans achieve a lot of energy gains through technology and then overcompensate these gains by either using more energy and/or decreasing conservation efforts. Knowing that the rebound-effect seems to be particularly strong in Germany indicates that eco-bot's engagement strategy should focus on ensuring the upkeep of energy saving efforts after the purchase of a more efficient appliance.

4.1.4 Retrofit measures

Based on our literature research we suggest that investment in retrofit measures are most likely to progress in Spain and less likely in Germany. This is found to be due to facilitating conditions/barriers such as the existing building stock, the legal framework and economic support programs, the level of ownership and geographical reasons.

- *Existing building stock*: The two countries need to make significant progress when it comes to the energy efficiency of the building stock. Germany's building stock counts a number of old buildings: "Around 73 % of all dwellings are located in buildings constructed before 1979. Around 14 % of dwellings are located in buildings constructed after 1991. Most buildings (around 46 %) were constructed between 1949 and 1978, which means that their energy and physical building characteristics are likely to be sub-optimal" (BMWi 2017, p. 15). And the Spanish government underlines in its Energy Efficiency Action plan, especially the poor thermal-envelope energy efficiency of the existing buildings (Government of Spain Ministry of Energy, Tourism and Digital Agenda 2017).

- *Legal framework and economic support programs*: While both Spain and Germany have the legal framework and respective programs set in place to improve the

energy efficiency in buildings (D2.2, Chapter 2, pp. 26-28), the overall support varies among the two countries. With Germany being in the moderate level support group, and Spain in the high-level support group (D2.2. Chapter 2, p. 28). We acknowledge that such grouping is a good indicator but not fixed, as unfavourable changes in economic support programs play a role. It shall also be reminded that in spite of the many support programs going on in Spain, the flow of information is important, especially people living in small municipalities need to be informed properly. IDAE found that only 4% of households received subsidies to replace their heating systems and only 3% to improve their home's insulation (Ramos et al. 2016; IDAE 2011). Evidently, there is room for improvement and a tool like eco-bot could be especially powerful in improving the access to information.

- *Ownership rate:* Another facilitating condition that should be accounted for is the rate of owner-occupied dwellings versus tenant-occupied dwellings. In Spain conditions are particularly favourable due to the high rate of owner-occupied dwellings (82%) (Ramos et al., 2016). The German Government refers the structure of the building stock with "around 18 million tenant-occupied households compared to just under 10 million owner-occupied household", as a "major obstacle" to improve the existing building stock (BMWi, 2017).

- *Geographical differences*: Renewable energies can be used for the building sector and while Spain even has a programme to promote the use of biomass (BIOMCASA) (IDAE), the German Government points out that due to the lack of arable land this is not a valid option in Germany (BMWi, 2017). Also the potential of solar-thermal energy is bigger in Spain than in Germany (BMWi, 2017; Arce et al. 2011).

This Chapter introduced our market segmentation approach of private households. We underlined why a segmentation that goes beyond sociodemographic and socioeconomic criteria is necessary and fruitful for eco-bot. Since the segmentation does not allow drawing any conclusions on the respective level of energy consumption in a segment, we shared further insights of the drivers of high and low energy consumption in a first sub Chapter. In a second sub Chapter we elaborated on the different energy saving measures (such as behavioural change or investments). Estimating that country, and in some cases region specific differences, shape the choices of energy consumers to adopt energy saving measures, we drew attention to this fact and its relevance for eco-bot.

The following Chapter is dedicated to the use case of DEXMA and the market segmentation of energy/facility managers.

4.3 Market segmentation of businesses

The aim of this Chapter is to identify user groups of energy managers (of buildings). In the framework of the project, energy/facility managers are energy experts that handle the energy infrastructure of a certain building or a group of buildings. This user group is displayed in the use case of the project partner Dexma in Spain and the UK. An initial list on the needs of facility managers (focusing on super market facility managers) and possible features that motivate them to use eco-bot, have been developed in D2.1. These are further elaborated in this Chapter.

The segmentation of energy/facility managers (and their needs) is carried out in three user types based on the experience of DEXMA within its 250 partners (ESCOS, Utilities, OEMs) that already use DEXMA's Energy Management System called DEXCell EM. Therefore, their needs are completely different, depending on the level of detail they want to get from eco-bot:

1. **User type 1 – Energy/Facility Manager with small portfolio:** This eco-bot user is quite focused on his/her day-to-day work and normally handles **between 1 and 10 buildings** of few sectors[8]. The knowledge about the buildings that he/she handles is quite deep and detailed. The managers require very specific information by eco-bot such as:

    a. How to reduce the electricity bill
    b. How to detect inefficiencies
    c. Decide what kind of energy efficiency measures can be implemented and where
    d. Execute Energy Efficiency projects
    e. Track Energy Efficiency projects
    f. Achieve annual targets
    g. Assist to meetings and provide relevant metrics
    h. Being legislation compliant (Carbon, ISO 50.001, Nearly Zero Energy Buildings)

2. **User type 2 - Energy/Facility Manager with large portfolio:** This eco-bot user needs more of a global overview since he/she handles **between 10 and 10.000 buildings** of several sectors. This user type needs rather less specific information by eco-bot than user type 1. Hence, the same information as for user type 1 might be needed by eco-bot, but in a more global overview.

[8] List of 22 sectors of Dexma's customers: Department-Store Food, Department-Store Other, Education Equipment, Healthcare Centre, Hospital, Hospitality, Hotel, Housing, Industrial Warehouse, Industry, Leisure Equipment, Library, Museum, Office Building, Parking, Photovoltaic Generation, Small Store Food, Small Store Other, Sports Equipment, Other

3. **User type 3 – Executive with large portfolio:** CEOs and CFOs of a utility that handles **between 10 and 10.000 buildings**. This user type wants to use eco-bot to get a global overview of the buildings that are being handled by other people in their organization. Some examples of the information that this user type wants to get is:

    a. Reports on Energy Efficiency metrics
    b. Execute company objectives
    c. Share information among other stakeholders

In order for eco-bot to allocate each energy manager to the respective user type, it needs to ask specific questions. Once knowing the user types eco-bot can give tailor-made advice on energy savings to the respective energy manager.

Primarily, eco-bot needs to ask questions directly related to the energy manager in order to narrow down the characteristics of the user. This set of questions includes:

1. *In which country do you handle your buildings?*
    a. Spain
    b. Germany
    c. United Kingdom

2. *How many buildings do you handle?*
    a. Only one
    b. 2 to 10
    c. 11 to 50
    d. 51 to 99
    e. Over 100
    f. I do not handle the buildings, but I am still interested

3. *What kind of company are you working for?*
    a. ESCO (Energy Services Company)
    b. Utility (Energy Producer/Distributor)
    c. OEM/ Hardware vendor
    d. Not an Energy-Related Company

4. *Which type of buildings do you handle?*
    a. Education facility
    b. Factory
    c. Health centre
    d. Hospital
    e. Hotel

f. Housing
g. Industrial warehouse
h. Leisure facility
i. Library
j. Museum
k. Office building
l. Parking
m. Restaurant
n. Retail store
o. Small office
p. Sports facility
q. Supermarket
r. University

As our literature research has shown (Moss and Cubed, 2008) and as our partner Dexma confirmed, there are three key factors to be considered that affect a facility manager's work with his or her respective customers. The first factor is **the decision-making pathway**[9] in the respective facility that needs to be undertaken when making decisions regarding energy savings (e.g. switching to LED lamps in one of his/her managed hotels). In this regard there are two familiar approaches 1) the top-down decision-making approach and 2) the bottom-up decision-making approach. The latter implies that decision-making needs to be supported by the employees, which implies a longer decision-making pathway, while the top-down approach allows for a quicker implementation as the absolute savings are the most relevant factor for the directors of the facility. Hence, if the decision pathway is long, the energy saving action cannot be implemented rapidly (Moss and Cubed, 2008).

The second factor is **access to finance**. The monetary factor is to be taken into account as well, if eco-bot wants to give tailor-made advice. Studies have shown that measures related to climate change mitigation do not have a priority for many low-income families owning a business. At the same time small companies are potentially less able to purchase new and energy efficient appliances (Moss and Cubed, 2008). Hence, this economic factor needs to be considered in order to help the energy manager to give the most pertinent advice on energy saving measures to his or her clients.

Finally, knowing **a company's communication values and the marketing strategy** will help to determine the motivation of a company to engage in energy efficiency measures and to know to which type of energy saving measure the customer is more likely to be inclined to. The purchasing sensibilities of many customers have changed over the last years and environmental concerns have a growing impact. So-called green-marketing for

[9] From the point, where the energy manager receives advice from eco-bot, to the point where the suggested energy saving measure is implemented.

sustainable branding is trending (Ottman, 2011). If a company follows a green-marketing strategy and might even be interested in certain labels or certifications[10] this has a great impact on their decision-making process.

Based on the above-mentioned explanations additional questions could be useful for eco-bot to ask in order for it to further characterize the energy manager and his / her ability to enact change. This set of questions relates to the buildings the energy manager handles and includes:

1. **Decision pathways**
   a. *How long does it take to adopt a small scope energy saving measure such as changing all light bulbs to LED bulbs in one of the buildings that you handle?*
      i. Less than one week
      ii. Between one and four weeks
      iii. Between one month and 5 months
      iv. More than 6 months
      v. Don't know
      vi. Other _____

   b. *How long does it take to adopt a medium scope energy saving measure such as replacing one type of moving appliances (such HVAC, boiler, refrigerator, machinery, and lighting) in one of the buildings that you handle?*
      i. Less than one month
      ii. Between one and two months
      iii. Between two month and 5 months
      iv. More than six months
      v. Don't know
      vi. Other _____

   c. *How long does it take to adopt a large scope energy saving measure (such as full insulation) in one of the buildings that you handle?*
      i. Less than six months
      ii. Between six and twelve months
      iii. Between one year and two years
      iv. More than two years
      v. Don't know
      vi. Other _____

2. **Access to financing**
   a. *Which of the following energy saving measures could your organization easily afford an investment in?*
      i. Replacing all light bulbs with LED bulbs

[10] For instance EU Ecolabel or other national environmental labels (like Blue Angel), EMAS or ISO 14001 certifications, or the Nordic Ecolabel

ii. Replacing all windows
iii. Retrofit the building envelope
iv. All of the above
v. None of the above

b. *Have you ever considered applying for a subsidy through a support programme of your commune or the federal government?*
   i. Yes
   ii. No
   iii. I don't know of any support programmes

3. **PR values and marketing strategy**
   a. (If applicable) What is at the core of your marketing strategy?
   b. Do you practise green-marketing?
   c. Is green-marketing something that you would be interested in to build customer loyalty?
   d. Are you interested in getting energy efficiency certificates?

In order to further elaborate on the questions to feed the eco-bot software, we suggest taking a closer look at lighting and cooling. Studies have shown that cooling and lighting have the highest energy consumption of all appliances especially in food retailing (Atzberger et al., 2016, p 6.). Therefore, it might be worthwhile to develop questions relating to the highest and lowest energy consumption of certain appliances of each type of building (by distinguishing between food and non-food buildings).

5. Mapping the segments to Triandis' models

The outcome of D2.2 (Taxonomy of energy efficiency models) shows that the model by Triandis is the most appropriate model to implement the goals of the eco-bot project (see D2.2, p.172). In this Chapter, the previously defined segments for the residential consumers and the business consumers (see Chapters 4.1 and 4.3) are mapped to the factors of Triandis' model.

The strength of the model is that it takes into account the complexity of energy-saving behaviours and aims at a deeper understanding of the user that goes beyond socio-economic and/or demographic factors. Consequently, it is also the most compatible model when it comes to our market segmentation pursuing the goal of understanding motivation and ability to make energy-consumption related change happen in one's home.

The following mapping focuses on **attitude** (composed of beliefs about outcomes of certain behaviour and the evaluation thereof), **social factors** (composed of norms, roles and self-concept), **affect** (emotions) and **past behaviour**. The mapping is derived from Frankel et al. (2013) specification of the segments (as illustrated in Chapter 4). We argue that the sub segments[11] that we created do not need to be further distinguished in this mapping, as the common root is the motivation, which is more pertinent for Triandis' model than the factors influencing the ability to enact change (notably ownership and income).

For mapping the three types of energy managers, the interpretation of each factor of the Triandis' model had to be adapted. Since the energy managers are professionals, their personal views are less important. Hence, the focus lies on their role as an energy manager. Accordingly, the attitude and their beliefs about the outcomes were interpreted as their beliefs or requirements for information from eco-bot and the evaluation thereof. When it comes to the social factors, solely the role (as the understanding of the own professional role) was considered. We came up with three labels, summing up this role (see table below). The third factor *affect* was interpreted more in terms of closeness and contact to the specific customer and reliability. Lastly, the factor *past behaviour* allows a deeper insight into the three types and what they actually do. The information was extracted from the input by Dexma on the user requirements of their consumer base.

[11] See Chapter 4.1 page 14.

Factors	Residential Segments					Business User Types		
	Green-advocate energy savers (S1-S6)	**Traditionalist cost-focused energy savers (S7-S12)**	**Home-focused selective energy savers (S13-S18)**	**Non-green selective energy savers (S19-S24)**	**Disengaged energy wasters (S25-S30)**	**Energy/Facility Manager with small portfolio (Type 1)**	**Energy/Facility Manager with large portfolio (Type 2)**	**Executive with large portfolio (Type 3)**
Attitude (Beliefs about outcomes, evaluation of outcomes)	Reducing energy consumption -> saving the environment Very important, responsibility for further generations	Reducing energy consumption → reducing cost -> increasing quality of life Important for oneself	Reducing energy consumption → improving the home and reducing bills Important to set the dwelling up for the future	Reducing energy consumption when convenient Moderately important, a person does not make that big of a difference	Reducing energy consumption is not necessary	The more information, the better Exploring a maximum of energy-saving potentials will lead to the best outcomes Tailored service is crucial to ensure customer satisfaction	Less specific information is better to keep the overview and work efficiently, by filtering relevant solutions Providing a global strategy that can easily be applied and followed through is key	Only the most relevant information should be outlined to ensure the best and most intuitive overview, which will generate the best results
Social factors (Norms, Roles, Self-concept)	Give an example, be part of a movement and convince others of the importance to save	Energy saving is everyone's own choice	Energy saving is everyone's own choice, interest in exchange with other likeminded homeowners	Everyone's own choice	Everyone's own choice, there should not be any rules around energy consumption. Motto: If I can afford it,	Personalized assistant	Road mapper	Supervisor

	energy		(giving and receiving advice)		I earned it and it is nobody else's business how I spent my money			
Affect (Emotions)	Strong affect: The environment is the source of all life	Little affect concerning the environment more pragmatic. Affect concerning the ability to make a good living.	Little affect concerning the environment more pragmatic. Affect concerning the ability to build or maintain something that will last and is of good quality.	No affect	No affect	Frequent contact with the clients, direct communication, certain familiarity. Knowledge about the users of the building	More distant, rarely direct contact with customers, less affect. Overview of the behaviour of the building users	No direct contact with costumers Ambitions and reliability more oriented towards the stakeholders. No interest in energy.
Past behaviour	Most extensive energy-saving behaviours of the five segments (including more inconvenient ones)	Extensive energy-saving behaviours, usually the most common behaviours are performed to keep bills low (switching the lights off etc.)	Energy-saving behaviours are not necessarily routinized. But investments have been made regularly.	No routinized energy-saving behaviours, set-and-forget solutions at work	No routinized energy-saving behaviours, energy is consumed without second thought, whenever it is convenient	**Very engaged in a specific facilities energy-saving effort** (reduce electricity bills, detect inefficiencies, decide what to implement and where, execute	**Focused on creating a road map for the managed buildings** (reduce electricity bills, detect inefficiencies, decide what to implement and	**Focused on keeping an overview** (sharing information among stakeholders, report energy efficiency metrics, execute

					and/or fun	energy efficiency projects, track energy efficiency projects, achieve annual targets, assist to meetings and provide relevant metrics, be legislation compliant (Carbon, ISO 5001, NZEB etc.)	where, execute energy efficiency projects, track energy efficiency projects, achieve annual targets, assist to meetings and provide relevant metrics, be legislation compliant (Carbon, ISO 5001, NZEB etc.)	company objectives)

Table 7: Mapping the identified segments to Triandis' model

6. Mapping the segments to the user requirements of the pilots

In this section we map the identified segments onto the defined user requirements of Estabanell, Senercon and Dexma.[12] This deeper insight in the preferences and needs of the segments will help eco-bot to communicate more efficiently and effectively with the users.

To determine the relevance for our segments (S1-S30) for each of the user requirements listed by Senercon and Estabanell, we relied on the more detailed description of the five main categories according to Frankel et al. (2013) (Chapter 4, p. 11-14). Besides motivation, Frankel et al. specifies the interest in technology (Table 8). While **Green-advocate energy savers** are very tech-savvy and interested in different features and more detailed information, **Traditional-cost focused energy savers** and **Non-green selective energy savers** have less interest in technology and do not want to be overburdened with information or features and options to choose from. Non-green selective energy-savers are looking for convenience and therefore prefer "set-and-forget" settings. **Home-focused energy savers** are interested in technology but focused on their home (in terms of home improvements, better control/security) and not so much on feedback of environmental impact. **Disengaged energy savers** do not show any interest in technology related to energy saving measures nor are they motivated to in this regard.

[12] A preliminary listing of the user requirements was developed in D2.1. The list of user requirements of all use cases has been further prioritized and classified in a workshop during the plenary meeting in Athens on May 3rd, were they were discussed and further refined with all project partners from both a user perspective and a technical perspective.

	Green-advocate energy savers (S1-S6)	Traditionalist cost-focused energy savers (S7-S12)	Home-focused selective energy savers (S13-S18)	Non-green selective energy savers (S19-S24)	Disengaged energy savers (S25-S30)
Main motivation	Saving the environment	Cost-saving	Home improvement (value), better control/security	None	None
Other motivations	Cost-saving	None	Cost-saving	Cost-saving and environmental gain as long as it is easy	None
Interest in technology	High interest in new technologies and different features	Limited, only when it allows cost-savings and does not require much skill and/or time	High interest in technologies that allow improving the home and feeling more in control (monitoring)	Limited – set-and-forget interventions	None (at least linked to energy saving measures)

Table 8: Overview of the five main segments and their motivation and interest in technology, based on Frankel et al. (2013)

The following tables (Tables 9-12) provide detailed insight into the mapping of each user requirement, i.e. what the user needs eco-bot to do. The four tables address four different topics respectively**: 1) easy relationship with the electricity supplier(s) or platform provider (iESA[13])**; **2) deep knowledge from inside the household**; **3) reliable and easy source of information**; and **4) characteristics of the bot**.

All four tables are structured as follows:

- **In the first column** of each table the topic is divided into further categories,
- **The second column** specifies the priority level, meaning whether this is of relevance exclusively for Estabanell or Senercon or for both,
- **The third column** lists the requirement[14],
- **The fourth column** maps the segments to the requirement and gives a brief explanation of the mapping following the above explained method.

[13] Interactive Energy Savings Account
[14] It is crucial to mention that the list of user requirements listed is more of a "wish list", than a list of requirements that can and will eventually be implemented in eco-bot. Before implementation some of these requirements might need further refinement, while others might to not be feasible to be implemented at all due to technical and/or resource-related constraints.

For each of the subsequent tables, we decomposed each requirement along the lines of: **a) potential gains (environmental and/or monetary and/or home improvement and/or control/security, and/ or home improvement)** to map it onto the motivation of the respective segment(s), and **b) extent of underlying technological skill/interest** to compare it with the technological affinity of the segments. Some requirements, especially in the personalization category appear to be universal. We assume that every user wants eco-bot to communicate in a way that can be easily understood and only provide info that is relevant for a specific case.

To **fine-tune** our mapping, we then differentiated whether the requirement **is more pertinent for home owners or tenants and for a certain income level**. When a requirement was identified as particularly important to a specific group of a segment we pointed that out as well. The intention here is to provide helpful guidelines to privilege certain information/advice when eco-bot communicates with the respective segments.

The first table (Table 9) deals with the **first topic: easy relationship with the electricity supplier(s) or platform provider (iESA)**. It is divided into six categories, namely contracted power, tariff simulation, company communication, user support, special services and platform interaction.

Easy relationship with the electricity supplier(s) or platform provider (iESA[15])			
Category	**Priority level**	**User Requirement**	**Mapped segments**
Contracted power	**Priority Estabanell & Senercon**	As a titleholder of my meter, I want to know if I have the adequate contracted power, so that I can reduce it if possible.	**Environmental gain** • **Green-advocate energy savers (S1-S6)** **Monetary gain** • **Especially: Traditionalist cost-focused energy savers (S7-S12)** • **Home-focused selective energy savers (S13-S18)** • **Non-green selective energy savers (S19-S24)**
Tariff simulation	**Priority Estabanell & Senercon**	As an energy consumer, I want to be able to know the cost of my energy between any two dates, so I can split that bill with another person that stayed in my house at a certain time while I was away or know the cost of my consumption between two given dates.	**Environmental gain** • **Green-advocate energy savers (S1-S6)** **Monetary gain** • **Especially: Traditionalist cost-focused energy savers (S7-S12)** Possible fine tuning: higher relevance for low-income tenants **S12,** who might sublet when going away e.g. • **Non-green selective energy savers (S19-S24)** Possible fine tuning: higher relevance for low-

[15] Interactive Energy savings Account

Tariff simulation			income owners and tenants (**S21** and **S24**) who sublet, e.g. when on vacation **Control/Security** • **Home-focused selective energy savers (S13-S18)**
	Priority Senercon & Estabanell	As an energy consumer, I want to know which tariff best fits my consumption, so that I can reduce my bill.	**Monetary gain** • **Especially: Traditionalist cost-focused energy savers (S7-S12)** Possible fine-tuning: most relevant for owners and tenants of low and middle income (**S8** and **S9**, **S11** and **S12**) • **Home-focused selective energy savers (S13-S18)** • **Green-advocate energy savers (S1-S6)**

Category	Priority level	User Requirement	Mapped segments
Company communication	**No priority level**[16]	As an energy consumer, I want to know what my electricity company offers, so that I know if there is anything of interest.	**Environmental gain (e.g. the company offers a mix with a higher ratio of green energy/renewables)** • **Green-advocate energy savers (S1-S6)** **Monetary gain (since most often the offers of the electricity company are different plans that imply different costs)** • **Especially: Traditionalist cost-focused energy savers (S7-S12)** Possible fine-tuning: most relevant for tenants of low and middle income **S11** and **S12** • **Home-focused selective energy savers (S13-S18)**[17]
	Priority Estabanell	As an energy consumer, I want to be informed on the steps to change my contracted power, meter title holder, and address, so I can know what to do.	**Environmental gain** • **Green-advocate energy savers (S1-S6)** **Monetary gain**

[16] This means that the requirement is not considered as (high) priority for neither Estabanell nor Senercon, but rather as "nice to have" but not required.

[17] Segments S19-S24 and segments S25-S30 are not mapped here, because it is necessary to be interested in spending time to learn about the different options. This interest is not given for the segment of Non-green selective energy savers (S19-S24), who are not interested in spending time and cognitive effort on it (set-and-forget); once a plan is running and electricity is flowing it allows them to go about their business and they are satisfied. This is equally not the case for the segment of *Disengaged Energy wasters* (S25-S30), who are also not interested in more information from the company.

			• **Especially: Traditionalist cost-focused energy savers (S7-S12)** While S1-S18 all benefit from being walked through the process by eco-bot this is likely to be even more relevant for the two following less tech savvy segments: • **Home-focused selective energy savers (S13-S18)** • **Non-green selective energy savers (S19-S24)**
User support	**Priority Senercon**	In case of an error in my iESA account, I would like to contact the support helpdesk or being notified by the bot of a false data entry.	**All segments S1-S30**, although it is possible that *disengaged energy wasters* will not care about this. **Especially: Home-focused selective energy savers (S13-S18)** (Control and security)

Category	Priority level	User Requirement	Mapped segments
Special services	**No priority level**	I would like to use special services of the platform like the energy analysis out of consumption and the correction of the contracted power for district heating.	**Environmental gain** • **Green-advocate energy savers (S1-S6)** **Monetary gain** • **Especially: Traditionalist cost-focused energy savers (S7-S12)** • **Home-focused selective energy savers (S13-S18)**[18] Possible fine-tuning (middle and low-income tenants **S11 and S12**, **S17 and S18**)
Platform interaction	**Priority Senercon**	I would like to notify the bot to enter new energy saving events which I have performed in the iESA data base including time stamp. So I can later on evaluate their impact.	**Environmental gain** • **Especially: Green-advocate energy savers (S1-S6)** **Monetary gain** • **Traditionalist cost-focused energy savers (S7-S12)**

[18] Note: In case of energy analysis of the contracted power for district heating, this concerns only the respective home owners of the segments mentioned above. For other energy analysis (e.g. electricity consumption) this is relevant for all of the above.

			Control/Security • **Home-focused selective energy savers (S13-S18)**

Table 9: User requirements with regard to relationship with electricity provider or platform provider (iESA)

The following table (Table 10) focuses on the **second topic: deep knowledge from inside the household** and consists of four categories (knowing what's going on at home; consumer habits; comparison with other similar users; comparison of time periods, especially after energy efficiency improvements (investments and behavioural changes)). These requirements specifically involve having control over the home, understanding the consumption patterns present and allowing making comparisons in order to gain a better understanding of what the former mean. Such comparison can help the users to evaluate their consumption levels and see whether their efforts to save energy were successful.

Deep knowledge from inside the household			
Category	**Priority level**	**User Requirement**	**Mapped segments**
Knowing what's going on at home	**Priority Estabanell & Senercon**	As an energy consumer, I want to understand the consumption of my appliances, so that I am aware of my usage and I can use them better. I would also like to know how much single household activities cost me, and which devices consume the most.	**Environmental gain**[19] • **Green-advocate energy savers (S1-S6)** **Monetary gain & Control/security** • **Home-focused selective energy savers (S13-S18)** Possible fine-tuning: most relevant for low-income segments of the above mentioned (**S3, S6**, **S15, S18**) **Extent of underlying technological skill/interest**[20]

[19] Optimizing energy consumption
[20] Great interest required in consumption patterns and technology. Even though there are potential cost savings, Traditionalist cost-focused energy savers are unlikely to be very interested, as their interest in technology is quite limited.

Knowing what's going on at home	**Priority Estabanell**	As a home owner, I want to know if anything is being used while I am away or asleep, so I am more in control of my house, kids, and their security.	**Environmental gain[21]** • **Green-advocate energy savers (S1-S3)** **Monetary gain and Control/security** • **Home-focused selective energy savers (S13-S15)** **Extent of underlying technological skill/interest[22]**
	Priority Estabanell & Senercon	When a high bill arrives, I want to know what happened in the last month, so I understand why I paid so much.	**Environmental gain[23]** • **Green-advocate energy savers (S1-S6)** **Monetary gain** • **Especially: Traditionalist cost-focused energy savers (S7-S12)** **Control/Security** • **Home-focused selective energy savers (S13-S18)** **Extent of underlying technological skill/interest[24]**

[21] Monitor behaviour of other members of the household (e.g. teenagers who might be disengaged energy wasters, leaving devices in stand-by etc. and address this to optimize the overall energy consumption and hence have an environmental gain.
[22] Interest in receiving notification (constant feedback) from the app is unlikely to be present in Traditionalist cost-focused energy savers.
[23] Optimizing energy consumption
[24] Interest in digging into the past months behaviour required. Possible fine-tuning: most relevant for low-income segments of the above mentioned (**S3, S6, S9, S12, S15, S18**)

Knowing what's going on at home	**Priority Estabanell & Senercon**	When an appliance is left on for longer than usual, I want to be notified, so I can check what is happening.	**Environmental gain**[25] • **Green-advocate energy savers (S1-S6)** **Control/Security** • **Especially: Home-focused selective energy savers (S13-S18)** **Extent of underlying technological interest**[26]
	No priority level	When I have a power cut, I want to know why, to figure out what I can do.	**All segments S1-S30**
	Priority Estabanell & Senercon	When I am having a particularly high consumption day/week/ month, I want to be notified, so that I am aware of it.	**Environmental gain**[27] • **Green-advocate energy savers (S1-S6)** **Control/Security** • **Home-focused selective energy savers (S13-S18)** **Extent of underlying technological skill/interest**[28]

[25] Optimizing energy consumption
[26] Interest in receiving regular notifications (hence, a constant feedback) from the app might be unlikely to be present in *Traditionalist cost-focused energy savers*. Hence, we believe this segment not to be relevant.
[27] See footnote 24
[28] See footnote 25

Category	Priority level	User Requirement	Mapped segments
Consumer habits	**Priority Estabanell & Senercon**	As an energy consumer, I want to know how I can improve my consumption habits, so that I can reduce my consumption and contracted power.	**Environmental gain**[29] • **Green-advocate energy savers (S1-S6)** **Monetary gain** • **Traditionalist cost-focused energy savers (S7-S12)** Possible fine-tuning: most relevant for low-income segments of the above mentioned (**S3, S6**, **S9, S12**)
	Priority Estabanell & Senercon	I would also like to receive suggestions for improvements tailored to my home.	**Relevant for home owners** **Environmental gain**[30] • **Green-advocate energy savers (S1-S3)** **Monetary gain** • **Traditionalist cost-focused energy savers (S7-S9)** **Home improvement** • **Especially: Home-focused selective energy**

[29] Optimizing energy consumption
[30] See footnote 28

Consumer habits			savers (S13-S15)
	No priority level	When the weather can affect my energy consumption, I want to be notified, so that I can act accordingly.	**Environmental gain**[31] • **Green-advocate energy savers (S1-S6)** **Control/Security + monetary gain** • **Home-focused selective energy savers (S13-S18)** **Extent of underlying technological skill/interest**[32]

[31] See footnote 28
[32] Interest in receiving regular notifications (hence, a constant feedback) from the app might be unlikely to be present in *Traditionalist cost-focused energy savers*. Hence, we believe this segment not to be relevant.

Consumer habits	**Priority Estabanell & Senercon**	As a consumer, I want to know about any easy steps that can reduce my environmental impact and consumption, so that I can make changes without a lot of effort or investment.	**Environmental gain**[33] • **Green-advocate energy savers (S1-S6)** **Monetary gain** • **Traditionalist cost-focused energy savers (S7-S12)** • **Especially, Non-green selective energy savers (S19-S24)**[34] **Control/Security** • **Home-focused selective energy savers (S13-S18)**
	Priority Senercon	As a home owner with a central heating system I want to know if my circulation pump is up to date as old pumps waste a lot of money.	**Relevant for home owners** **Environmental gain** • **Green-advocate energy savers (S1-S3)** **Monetary gain** • **Traditionalist cost-focused energy savers (S7-S9)** • **Non-green selective energy savers (S19-**

[33] Optimizing energy consumption
[34] Set-and-forget preference

Consumer habits			**S21)** **Home improvement** • **Home-focused selective energy savers (S13-S15)** **Extent of underlying technological skill/interest**[35]
	Priority Senercon	As a home owner with a central heating system I want to know if my circulation pump has the correct setting.	**Relevant for home owners** **Environmental gain**[36] • **Green-advocate energy savers (S1-S3)** **Monetary gain** • **Traditionalist cost-focused energy savers (S7-S9)** • **Home-focused selective energy savers (S13-S15)** • **Non-green selective energy savers (S19-S21)**[37]

[35] Possible fine tuning: higher relevance for middle and high-income segments (**S1, S2, S7, S8, S13, S14** and **S19, S 20**) as a new pump might be too much of an investment for low-income segments (especially since the old one is still working). Note: More significant for German residential clients. As heating systems constitute a bigger part of the consumption in Germany, and a significant number of the heating systems in Spain (especially in the pilot area) are gas heating systems, which is not monitored by eco-bot.

[36] Optimizing energy consumption

[37] Extent of underlying technological skill/interest: Some interest is required. Non-green selective energy savers included since it is a set-and-forget intervention that can lead to cost-savings.

Consumer habits	**Priority Senercon**	As a consumer, I want to know the share of my Standby power consumption.	**Environmental gain**[38] • **Green-advocate energy savers (S1-S6)** **Monetary gain** • **Traditionalist cost-focused energy savers (S7-S12)** • **Home-focused selective energy savers (S13-S18)**
	Priority Senercon	As a consumer I want to know if my fridge is up to date as old fridges waste a lot of money.	**Environmental gain**[39] • **Green-advocate energy savers (S1-S6)** **Monetary gain** • **Traditionalist cost-focused energy savers (S7-S12)** • **Non-green selective energy savers (S19-S24)**[40] Possible fine tuning: higher relevance for middle & high-income segments (**S1, S2**, **S4, S5**, **S7, S8, S11, S10** and **S19, S20, 22, S 23**) as a new fridge can be too expensive for low-income segments.

[38] Limiting energy consumption
[39] Limit energy consumption
[40] Set-and-forget intervention

Consumer habits	**Priority Senercon**	When should I schedule the different household activities, like starting the washing machine?	**Environmental gain**[41] • **Green-advocate energy savers (S1-S6)** **Monetary gain**[42] (use energy, when it is cheap) • **Traditionalist cost-focused energy savers (S7-S12)**
	Priority Senercon	Will my advanced payments for electricity cover my electricity bill by the end of the current billing?	**All segments S1-S30**[43]
	No priority level	By how much would my consumption increase by getting an additional device "xy" (e.g. Sauna)?	**Environmental gain**[44] • **Green-advocate energy savers (S1-S6)** **Monetary gain** (limit additional spending)[45] • **Especially: Traditionalist cost-focused energy savers (S7-S12)**

[41] Use of green/renewable energy when available
[42] Use of energy, when it is cheap
[43] Note: only applicable in Germany
[44] Understanding one's environmental impact and making decisions accordingly
[45] The segment *Home-focused selective energy savers* is not included here. They are focused on the home and concern about the environment. Cost comes second in this case. If a home owner thinks a new sauna would improve the home in terms of comfort or value, he/she will go ahead. Likewise, for a home-focused energy saver who is a tenant and considers getting new home entertainment equipment, the person will undertake this.

Category	Priority level	User Requirement	Mapped segments
Comparison with other similar users	**Priority Estabanell**	When I am using more energy than usual for my household characteristics, I want to be notified, so that I can investigate why.	**Environmental gain**[46] • **Green-advocate energy savers (S1-S6)** **Monetary gain and Control/Security** • **Especially: Home-focused selective energy savers (S13-S18)** **Extent of underlying technological skill/interest**[47]
	n/a	Displaying benchmarks of individual energy consumption with other members of the user group segment and text message or chat	**Environmental gain**[48] • **Green-advocate energy savers (S1-S6)** **Control** • **Especially: Home-focused selective energy savers (S13-S18)** **Extent of underlying technological skill/interest**[49]

[46] Optimizing energy consumption
[47] Interest in receiving notification (constant feedback) from the app is unlikely to be present in the segment *Traditionalist cost-focused energy savers*. Furthermore exploring the feedback through an investigation requires looking into more data and consequently technological skill.
[48] See footnote 43
[49] Great interest in consumption patterns (also of others) required, as well as engaging with interactive features of the app (message/chat). This is unlikely to be of interest for those segments with limited technology interest and or limited interested in such deeper knowledge (*Traditionalist cost-focused energy savers, Non-green selective energy savers, Disengaged energy wasters*)

Comparison of time periods, especially after energy efficiency improvements (investments and behavioural changes)	**Priority Senercon**	When I have performed any energy efficiency improvements, I would like to compare my new energy consumption with the consumption before	**Environmental gain**[50] • **Green-advocate energy savers (S1-S6)** **Monetary gain** • **Especially: Traditionalist cost-focused energy savers (S7-S12)**[51] • **Home-focused selective energy savers (S13-S18)**
	n/a	I have applied an energy saving measure eco-bot suggested and now I would like to see if it was worth doing.	**All segments S1-S30**
	n/a	When I change my behaviour positively, I want to see how much money I save.	**All segments S1-S30** • **Especially: Traditionalist cost-focused energy savers (S7-S12)**

Table 10: User requirements with regard to deep knowledge from inside the household

[50] Optimizing energy consumption
[51] The limited interest in technology of this segment might narrow the interest in such comparison, though understanding monetary savings is important.

The third table (Table 11) is about having a **reliable and easy source of information**. It is crucial for users to know that any advice or information from eco-bot is reliable. This will underline eco-bot's strength as an educative and empowering consumer tool. Users will no longer have to engage in tedious long research and dealing with (sometimes) contradictory information that they find. Since such detailed research requires a high level of motivation, there is also a risk that false information is believed and acted upon. This is of course highly counterproductive to achieving energy savings. The categories, which are addressed here are legal info, understand "energy related topics", environmental impact and new systems and appliances.

Reliable and easy source of Information			
Category	**Priority level**	**User Requirement**	**Mapped segments**
Legal information	**Priority Estabanell**	As an energy consumer, I want to better understand the sector and the legislation that concerns me, so that I am aware of my rights and options.	**Environmental gain** • **Green-advocate energy savers (S1-S6)** **Monetary gain** • **Traditionalist cost-focused energy savers (S7-S12)** **Home improvement** • **Home-focused selective energy savers (S13-S18)** **Extent of underlying technological skill/interest**[52]

[52] No interest in technology or technological skills required, but an interest in understanding legislations in the energy sector.

Legal information		When a new energy law is issued, I want to know how it affects me, so I can act accordingly.	**Environmental gain** • **Green-advocate energy savers (S1-S6)** **Monetary gain** • **Traditionalist cost-focused energy savers (S7-S12)** **Home improvement** • **Home-focused selective energy savers (S13-S18)** **Extent of underlying technological skill/interest**[53]
		When I am eligible for some energy grant or project, I want to be aware, so that I can apply if I want to.	**Environmental gain** • **Green-advocate energy savers (S1-S6)** **Monetary gain** • **Traditionalist cost-focused energy savers (S7-S12)** **Home improvement** • **Home-focused selective energy savers (S13-S18)**

[53] See footnote 51

			Extent of underlying technological skill/interest[54]
Understanding "energy-related topics"	**Priority Estabanell & Senercon**	As an energy consumer, I want to understand my electricity bill, so that I know what I am paying.	**Environmental gain** • **Green-advocate energy savers (S1-S6)** **Monetary gain** • **Traditionalist cost-focused energy savers (S7-S12)** **Control/Security** • **Home-focused selective energy savers (S13-S18)**
	Priority Estabanell	As an energy consumer, I want to know what the best practices of using my appliances are, so I can use them better.	**Environmental gain** • **Green-advocate energy savers (S1-S6)** **Monetary gain** • **Traditionalist cost-focused energy savers (S7-S12)** • **Home-focused selective energy savers (S13-S18)**
	No priority level	When I receive the report of an electrician, I want to understand what it means, so I know the implications.	**All segments S1-S30**

[54] No interest in technology or technological skills required, but an interest in understanding economic support programs and potentially taking the time to applying to them.

	No priority level	When I see energy news on TV or the internet, I want to inquire more about it, to know how it affects me or the environment.	**Extent of underlying technological skill/interest:** A great interest in energy and the environment plus the desire to deepen that knowledge. This is exclusively the case for **Green-advocate energy savers (S1-S6)**
Category	**Priority level**	**User Requirement**	**Mapped segments**
Environmental Impact	**Priority Estabanell & Senercon**	As an energy consumer and/or a parent, I want to know how my consumption is affecting the environment and public health, so I can improve it to lower my impact and provide a better future for my kids.	**Environmental gain**[55] **Green-advocate energy savers (S1-S6)** **Extent of underlying technological skill/interest**[56]
	No priority level	As a consumer I want to know how much co2 I can save if I switch to green electricity.	**Environmental gain**[57] • **Green-advocate energy savers (S1-S6)**
New systems and appliances	**Priority Senercon & Estabanell**	When an appliance starts consuming more than usual, I want to be notified, so I can check if it needs replacing.	**Environmental gain**[58] • **Green-advocate energy savers (S1-S6)** **Control/Security + monetary gain** • **Home-focused selective energy savers (S13-S18)** **Extent of underlying technological skill/interest**[59]

[55] Ensuring the quality of life for future generations by taking responsibilities now
[56] Great interest in energy and the environment plus the desire to deepen that knowledge, is exclusively the case for **Green-advocate energy savers (S1-S6)**
[57] Understanding and reducing one's carbon footprint
[58] Optimizing energy consumption
[59] Interest in receiving notification (constant feedback) from the app is unlikely to be present in Traditionalist cost-focused energy savers.

New systems and appliances	**Priority Senercon & Estabanell**	When I need to buy a new appliance, I want to receive suggestions/advice on the best appliance(s) to buy, so that I don't have to look for the best choice myself.(e.g. EcoTopTen)	**All segments S1-S30**
	Priority Estabanell & Senercon	As a home owner, I want to know if a PV installation is a good idea for my house, so that I can inquire more on the issue.	**Relevant for homeowners** **Environmental gain**[60] • **Especially: Green-advocate energy savers (S1-S3)** **Monetary gain**[61] • **Traditionalist cost-focused energy savers (S7-S9)** **Home improvement** • **Especially: Home-focused selective energy savers (S13-S15)** *possible fine tuning: higher relevance for middle and high-income segments* (**S1,S2, S7, S8, S13, S14**) *as a PV installation is a bigger investment*

[60] Using and producing green energy
[61] Saving on energy bills

	No priority level	When does a new fridge or pump pay off (amortization)? How much money do I save by replacing the device?	**Environmental gain**[62] • **Green-advocate energy savers (S1-S6)** **Monetary gain** • **Especially: Traditionalist cost-focused energy savers (S7-S12)** • **Non-green selective energy savers (S19-S24)** **Home improvement** • **Home-focused selective energy savers (S13-S18)** **Extent of underlying technological skill/interest**[63]

Table 11: User requirements with regard to reliable and easy source of information

[62] Optimizing energy consumption
[63] Only limited interest required, since there is no need to go through a multitude of suggestions. Knowing when a new device is paid off and how much money can be saved should be of interest to all segments apart from disengaged energy wasters.

The fourth table (Table 12) is concerned with the **practical part of eco-bot**, hence the direct communication with the user. Understandable language, personalization, effective communication and features (e.g. feedback mechanisms, possibility to invite friends etc.) are the four categories in this case. The fulfilment of these requirements often concerns all segments, as explained earlier. Thus, its fulfilment will make eco-bot the innovative user-friendly tool that it is meant to be. Engaging consumers through individualized strategies and providing them with the information they require in precise, comprehensive and motivating way, is the overall goal of the project.

Characteristics of the Bot			
Category	**Priority level**	**User Requirement**	**Mapped segments**
Understandable language	**No priority level**	As an energy consumer, I want to be spoken to in a familiar vocabulary, so that I am able to best understand the advice.	**All Segments (S1-S30)**
Personalization	**Priority Estabanell & Senercon**	As an energy consumer, I want to control what notifications I get and when, so that I am not bothered by a stream of messages or uninteresting information.	**All Segments (S1-S30)**
	Priority Estabanell	As an energy consumer, I want the bot to correctly identify my profile, so that it interacts with me in the most engaging and understandable way.	**All Segments (S1-S30)**
Effective communication	**Priority Estabanell**	When my chat-bot cannot solve my problem, I want to be given the contact of the right person/place, so I can solve my problem there.	**All Segments (S1-S30)**
	Priority Estabanell & Senercon	As a consumer, I want to complement my messages with photos when possible, so that I save time typing.	**All Segments (S1-S30)**

	Priority Estabanell & Senercon	As an energy consumer, I want to view information graphically when possible, so that I can understand/draw conclusions more quickly.	**All Segments (S1-S30)**
Category	**Priority level**	**User Requirement**	**Mapped segments**
Features	**No priority level**	When I successfully lower my impact on the environment, I want to share it with my friends, so that they can see my progress.	While there are no gains (environmental/home improvement/ cost-saving) this is more peer group related, the peers of the following segments are likely to be interested: • **Especially: Green-advocate energy savers (S1-S6)** • **Traditionalist cost-focused energy savers (S7-S11)** • **Home-focused selective energy savers (S13-S18)**
	Priority Estabanell & Senercon	When I change my behaviour positively, I want to be congratulated, so that I remain motivated.	**All Segments (S1-S30)**
	Priority Estabanell & Senercon	As a consumer, I want to invite my friends to the app, so they can also enjoy the benefits.	While there are no gains (environmental/home improvement/ cost-saving) this is more peer group related, the peers of the following segments are likely to take interest: • **Especially: Green-advocate energy savers (S1-S6)** • **Traditionalist cost-focused energy**

			savers (S7-S11) • Home-focused selective energy savers (S13-S18)
Features	**Priority Estabanell**	As a consumer, I want to be able to set saving goals (money, energy, trees, emissions…), and be engaged as I am approaching my goal, so that I am better able to meet it.	**Environmental gain (energy, trees, emissions)** • **Especially: Green-advocate energy savers (S1-S6)** **Monetary gain** • **Traditionalist cost-focused energy savers (S7-S11)** **Home improvement** • **Home-focused selective energy savers (S13-S18)**

Table 12: User requirements with regard to the characteristics of eco-bot

In the following table (Table 13), the requirements for facility/energy managers are presented and mapped onto the three user types. In order to determine the relevance for the three user types for each of the user requirements, we relied on the expertise of our partner Dexma, and developed the mapping accordingly.

The mapping was done according to the needs of information, considering the available time of the respective facility/energy manager. Therefore, most requirements apply mainly to user type 1, a manager with a small portfolio, as this type of manager has an interest in detailed information. User type 2, a manager with a large portfolio, is listed in brackets (if applicable), as he or she is not per se interested in this but still might occasionally want this type of information and request it. User type 3, an executive with large portfolio, has very little time on his or her hands for detailed information and only requires a yearly overview.

Characteristics of the Bot		
Category	**User Requirement**	**Mapped facility/energy manager user types**
Decision making/ Problem solving support	**When** I arrive at my office every morning, **I want to** know the top-10 priority tasks for today regarding the inefficiencies detected, **So, I can** plan how to solve it.	**Type 1, (Type 2)**
	When I know about the top-10 priority tasks. **I want to** learn about the details (how much energy we've lost, money, repeated times in last month, etc.)**,** **So, I can** make better decisions.	**Type 1, (Type 2)**
	When I am preparing the monthly/quarterly metrics meeting **I want to** know about my site metrics (report configured in DEXCell)**,** **So, I can** make better decisions.	**Type 1, (Type 2)**
	When I am preparing the year to date metrics meeting **I want to** know about my site metrics (report configured in DEXCell), **So, I can** make better decisions.	**Type 3 (Type 1 and 2)**
	When I am around the buildings **I want to** know about the savings produced by my ongoing projects (especially the worst ones), **So, I can** check what is happening and solve it.	**Type 1, (Type 2)**
	When some of my hardware is not sending data **I want to** know about it, **so, I can** act in consequence**.**	**Type 1, (Type 2)**
	When I want to do a job from User Type 1 **I want to** select which hierarchy level or locations to analyse **So, I can** focus my actions on a specific part of my portfolio.	**Type 2**

Record keeping/ Basis for analysis and trends	**When** I am asking for the weekly/monthly/quarterly report **I want to** be able to view the report in pdf **So, I can** analyse the consumption and trends.	**Type 1, (Type 2)**
Record keeping/ Basis for analysis and trends	**When** I am asking for the Year to date report **I want to** be able to view the report in pdf **So, I can** analyse the consumption and trends.	**Type 3**
	When I want to know about consumptions / demands / temperatures **I want to** get a chart of it **So, I can** see the trend for the date range.	**Type 1, (Type 2)**
	When I am in a current month **I want to** know about the energy forecast for this month **So, I can** check it against our budget.	**Type 1, (Type 2)**
	When it is the first labour day of a month **I want to** know if we did ok and we are on target **So, I can** know if I am doing my job well.	**Type 1 (Type 2)**
	When I want to know about my energy consumption in a date range **I want to** ask to get a site / HVAC / Lighting consumption for a specific building and date range **So, I can** know how much we've consumed.	**Type 1, (Type 2)**
Support for efficient communication with colleagues, clients and stakeholder	**When** I am preparing the weekly metrics meeting **I want to** know about my site weekly metrics (report configured in DEXCell) **So, I can** answer the questions in the meeting.	**Type 1, (Type 2)**
	When I am asking for the weekly/monthly/quarterly report **I want to** be able to send the report by e-mail **So, I can** send the information to any stakeholder.	**Type 1**
	When I am asking for the year to date report **I want to** be able to send the report by e-mail **So, I can** send the information to any stakeholder.	**Type 3 (Type 1 and 2)**

Support for efficient communication with colleagues, clients and stakeholder	**When** I am getting a complaint about being too hot / cold in an office **I want to** get the temperature values **So,** I can understand if my colleague is right or not.	**Type 1, (Type 2)**
Information on changes and novelties to save energy	**When** a new legislation is applicable to my sites **I want to** know about it and how to implement it **So, I can** be legislation compliant.	**Type 1, (Type 2)**
	When I am installing a new hardware **I want to** know if everything is being installed properly and I am getting data **So, I can** ensure that my job is being done properly and I can do another thing.	**Type 1, (Type 2)**
	When a new potential retrofit is detected **I want to** know about it (financial metrics, type of retrofit, potential partners to execute it) **So, I can** keep reducing my energy consumption.	**Type 1, (Type 2)**
	When the system has detected an improvement **I want to** be proactively recommended **So, I can** decide if execute it or not and keep reducing my bill.	**Type 1, (Type 2)**
	When an energy contract (electricity, gas, water, etc.) is 3 months to expiration **I want to** receive a reminder **So, I can** start looking for some new prices/offers.	**Type 1, (Type 2)**

Table 13: User requirements (facility/energy managers) with regard to the characteristics of eco-bot

Conclusion

This deliverable proposed market segmentation for private households and energy managers. The identified segments share similar needs and shall serve as a basis for eco-bot to ensure efficient and effective communication with the respective users, once the user is allocated to a segment.

In the case of **private households (Chapter 4.1)**, the segments allow a deeper understanding of the user's motivation and ability to enact change. This way, eco-bot can filter the information that the user needs and wants. It can then frame it accordingly to the users' motivation, creating powerful engagement strategies. The deliverable identified relevant questions that help eco-bot allocate the users to the identified segments. Special attention has been paid to keep those questions limited and ensure that the user will not get bored or feel that his or her time is being wasted.

Additionally, this report gave insights into **household energy consumption (Chapter 4.1.1)** and the spectrum of energy saving measures (energy saving behaviours and investments). **Country and region-specific information (Chapter 4.1.2)** was shared as well in order to point out further development paths for eco-bot that will allow an even more tailored service.

In the case of the **energy managers (Chapter 4.2)** the segmentation focused primarily on the need of information that each of the three types of managers has. Furthermore, three key factors that will enable or inhibit a company to enact change were outlined as an important input for eco-bot to support the energy manager in maximizing the energy savings of different facilities.

In **Chapter 5**, the identified **segments** of private households and facility managers were **mapped to** the taxonomy of the multi-factorial model, **Triandis' Model**, as recommended in deliverable D2.2. Lastly, the **segments** were also **mapped on the list of user requirements** provided by Senercon, Estabanell and Dexma in order to allow eco-bot to identify the most suited recommendations and to emphasize on those categories where the respective segments have a strong stance.

The segmentation illustrated in this deliverable serves as a basis for further tasks of the eco-bot project, while it allows for flexibility, i.e. adaptation and / or enlargement of segments. In particular, this segmentation will be relevant for the further development of (sub-) clusters once the demo cases have started and smart meter data is available, while the identified segments will be used as the founding first step. Furthermore, the segmentation will be exploited in WP4, where the back-end knowledge platform and personalized recommendations will be produced. To conclude, the segmentation feeds into WP7, where the future of eco-bot will be analysed in three business case workshops of each pilot setting.

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ANNEX A: Key findings from the literature on clustering and segmentation approaches

It is important to note that the market segmentation proposed was derived from literature research without smart meter data from the pilot settings handy at that stage. The literature research built the foundation for the further development of the deliverable and required input by the respective partners regarding their user groups.

According to the DoW, market segmentation and clustering were to be developed based only on secondary analysis, in order to be used as input to the next phases of eco-bot. Since according to our findings from this analysis, clustering can only be undertaken with prior data-collection, further enhancement and clustering can and will be performed after the demo cases have started and smart meter data from the pilots is available.

There certainly is abundance of data-driven clustering and cluster analysis in the literature. For instance, in the field of energy efficiency, many studies have sought to develop models that allow the pertinent clustering of energy consumer profiles (e.g. Appen et al. 2014; Giraudet et al. 2012; Kang and Lee 2015; Piao and Ryu 2016 and Swan and Ugursal 2009). Nevertheless, this knowledge cannot be applied without data at hand. Patching together the separate findings from different empirical studies would not only be scientifically incorrect but it would also cause a multitude of inconsistencies regarding the segmentation. Furthermore, proliferation of possible segments would be the result and therefore no pertinence for any application as we explain in this Annex.

Turning to already identified clusters of energy usage patterns by other authors (e.g. Beckel et al., 2014; Borg und Kelly 2011; Kavousian et al. 2013 and Viegas et al., 2016) bears other problems. Here, smart meter data regarding the consumer's energy consumption is used to generate daily energy profiles. These profiles are then clustered into distinct shapes of energy load profiles accounting for different lifestyles (Kwac et al., 2016). It is important to know that such shapes stand merely for the same kind of energy usage pattern (often referred to as lifestyles). Accordingly, the same user can be found to have different lifestyles (e.g. have different patterns during the weekend or some seasons or even just for a couple of days when staying home from work etc.). In conclusion such energy load profile-based clustering approaches do not by themselves provide sufficient confidence regarding the identification of distinct consumer groups.

Gouveia and Seixas (2016) try to bring together the information on the household and dwelling characteristics as well as the energy consumption pattern. The problem is that this data his highly context-specific and relates to the prevalent climate and culture of the sample, in this case Portugal. In addition, the sample is not chosen according to criteria that

would allow drawing conclusions on the general population[64]. Furthermore, the appliances that are considered do not appear consistently throughout the clustering by Gouveia and Seixas. In other words, while one identified cluster refers to air conditioning another one leaves out this information.

The project team also engaged in specific research on the three countries of the use cases. While there are interesting clustering approaches to be found (e.g. McLoughlin et al. 2015, Sánchez et al., 2009) these are not comparable to each other, as they focus on different influencing factors. McLoughlin distinguishes between 17 specific household appliances ranging from electric water heating to game consoles. In case of Sánchez et al. 2009 appliances were considered in percentages according to three classes of appliances, which allows no information on individual appliances. The three classes relate to their prevalence meaning the category high would stand for appliances that most households have, while medium stands for those that many have and low for those that few have. This does not allow for differentiation of the appliance equipment of different household types.

The literature findings on clustering and segmentation approaches that were outlined here show how the market segmentation approach that we propose, will serve eco-bot better. Because it focuses on the potential for action and can be paired up with highly specific data from smart meters, once it becomes available.

Complexity of energy consumption and adoption of energy saving measures in households

The project team considered segmenting along the lines of energy consumption levels, socio-economic/demographic and dwelling related criteria. This corresponds to a more narrow interpretation of consumer needs, considering the needs basically as the need of energy at a certain point in time. We abandoned this approach, because it is very limited and does not offer more insight other than the later available smart meter data on the user would provide anyhow. Furthermore, pursuing such an approach poses a number of difficulties and can be less beneficial for the development of eco-bot, as we elaborate in the following:

Most of the studies we examined studied socio-economic and/or dwelling related criteria separately. These findings cannot simply be patched together.

Segmenting the market according to energy used in each household and considering socio-demographic and socio-economic variables (age, gender, education, income) along with dwelling related criteria (e.g. location, size and building age) and household equipment related variables (e.g. the number and type of appliances etc.) is not feasible. Our literature

[64] Representativeness is an issue in many of the studies on clustering or classifying energy consumers: Most data stems from selected customers of a specific energy provider in a town or region (e.g. Beckel et al. 2014;Kwac et al. 2016; Viegas et al. 2016).

review revealed that studies look at these criteria separately and assess the impact of each one on energy consumption. The separate findings of these studies cannot just be patched together. For example, if a study finds that the presence of teenagers increases the energy consumption of a household, and another study finds that dwellings with air conditioning have a particularly high consumption, it cannot be derived that there is a segment of consumer households with teenagers and air conditioning. Another example would be to conclude that there must be a segment of high energy consumption levels consisting of unemployed single parents living in large detached houses on the country-side, sleeping on waterbeds, having a sauna, a pool, a terrarium and aquarium since all of these elements were found to be drivers of high energy consumption.

1. **Complexity layer number one: Infinite possible combinations**

Further it becomes clear that the various combination possibilities of all these criteria (and appliances) would lead to an infinite number of segments, which would not help structuring the market as we demonstrated below in a graph (Fig. 6). For the purpose of visualizing the problem we limited the selection of criteria and options, namely income, household composition (presence of teenagers), dwelling location (urban or rural) and a single appliance (air conditioning). All the while being very reductionist, this already leads to 24 possible combinations. When we consider that household composition by itself could have far more manifestations than just the presence of teenagers and that the number of people living in the household should definitely be accounted for when it comes to the energy consumption of the household, we start to understand the complexity of the issue. There are far more criteria to consider when it comes to the dwelling than just the location of it, the size being for instance a crucial information. When it comes to appliances the statistical office of the European Union takes at least six groups of appliances into consideration: "At least six major energy end-uses are distinguished for the energy consumption in households space cooling, water heating, cooking, lighting and electrical appliances and other use; the category identified as 'other use' can be used to consider any other energy consumption in households such as use of energy for the outdoor and any other activities not included into the five major energy end-uses mentioned above (e.g. lawn mowers, swimming pool heating, outdoor heaters, outdoor barbeques, saunas, etc.)." (Eurostat, 2013). This still leaves out the number of each appliance and the type (e.g. energy efficiency rating of the gadget).

2. **Complexity layer number two: The same energy consumption levels do not correspond to homogenous groups**

In addition, the myriad of combination possibilities cannot be grouped into comprehensive segments of the same energy usage. In Figure 6 we intend to demonstrate that by giving each option a rating. In other words, when some manifestation of a criterion was associated with high energy consumption in the literature, two points were added; when some manifestation of a criterion was associated with low energy consumption zero points were added. Accordingly, high income corresponds to two points, low income to zero points and

middle income to one point; the presence of teenagers to two points and their absence to zero points etc. The very bottom of the graph shows the total scores and thus the energy use – a low score corresponding to low energy consumption and vice versa a high score corresponding to high energy consumption. It would not make sense to group the different paths together according to their total score since that would mean that in the group of moderate energy consumption (score 4) we would find households from all different income groups, with teenagers or not, living in urban or rural areas and using air conditioning or not – or simply we would have one candidate of every single one of these combinations present.

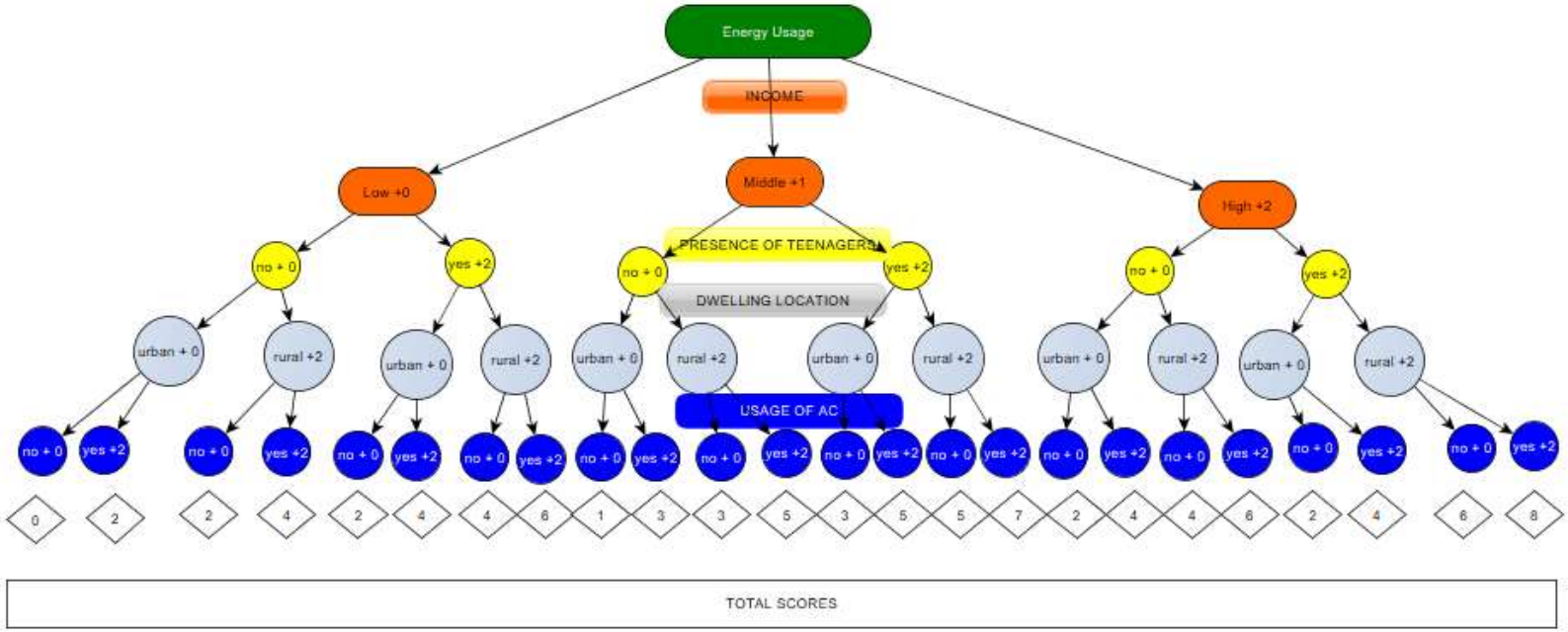

Figure 6: Illustration of prolific paths development and similar energy usage among completely distinct consumer groups

Such grouping would not allow drawing any conclusion on how eco-bot should communicate with the group nor would it suggest what kind of recommendations should be given. Applying the criteria of successful market segmentation, we quickly see that such segmentation is set up for failure:

Criteria for a successful market segmentation	Fulfilment of the approach to segment according to energy usage levels
1) Identifiability *Can we see clear differences between segments?*	**NO** Myriad of possible combinations of socio-demographic and dwelling related characteristics as well as heterogeneity in household equipment for each segment, largely overlapping with other segments.
2) Substantiality *Are the segments large enough to warrant separate marketing targeting?*	**Questionable** Large segments arise, but they do however not allow separate marketing.
3) Accessibility *Can we reach our customers?*	**Questionable** The segmentation does not give any tools to know how to address and reach customers of each segment.
4) Stability *Are our segments stable over a certain period of time?*	**Questionable** The fluctuation of energy use pattern (entropy) will not be homogenous among each segment. It cannot be concluded that there will be stability. Furthermore, since the energy usage is THE only common feature of the segments a shift in energy usage would signify a shift in the segmentation as a whole.
5) Responsiveness *Is the response to our marketing effort segment specific?*	**NO** The response will be specific to the motivation of the consumer and the ability to change behaviour or invest in order to save energy.
6) Action ability *Does the segmentation provide direction for marketing efforts?*	**NO** There is no information on the consumers attitude, values, motivation or ability to enact change and save more energy in his or her home.

Table 14: Checklist criteria for successful market segmentation

3. **Complexity layer number three: Missing data when it comes to household equipment and energy consumption of the main appliances**

Information on the set of appliances that are to be found in different types of households is scarce. There are no extensive data sets available. The assumption of homogenous groups of households regarding the equipment with appliances and certain socio-demographic criteria is farfetched (Frondel et al. 2015). As Almeida et al. (2011) note, even information on the energy consumption of the most common household appliances is missing: "In most Western European countries the consumption of the main domestic appliances, namely the load curve, and the peak power, is roughly known. Conventional "main domestic appliances" include cold appliances, washing machines, dryers and lighting."

It is certainly possible to find a few studies that did a clustering of energy consumption patterns (in their respective sample of energy users) and tried to identify which type of households, type of dwellings and equipment correspond to the patterns (e.g. Gouveia and Seixas, 2016). However, these studies are (as mentioned above) data-driven and use modelling procedures to produce plausible clusters. By the way that the households and dwellings are matched to the energy consumption profiles it becomes clear once again, that there are no homogenous groups: Gouveia and Seixas (2016) present their clusters using percentages, e.g. "59% aged between 18 and 49 years old; 100% of the adult members have at least the secondary level of education; 50% of the members either have full time jobs (50%) or are students (38%); 50% of the households have an income level above $2500 per month" etc. This means that there will be overlaps in the clusters. Such clustering would not allow targeting each cluster specifically with tailored energy advice (see table 12 points 1 and 6). It is also important to know that such studies are not done extensively over the EU countries and the findings cannot be taken out of their geographical and cultural context.

4. **Complexity layer number four: Energy consumption is more influenced by the usage of the appliance than its mere possession**

Lastly even if we knew about the appliance equipment in different households, homogenous groups of energy consumers could still not be identified, the possession of an appliance alone does not determine the amount of energy that will be consumed. It is crucial to know how and with which frequency the appliance is used. Alborzi et al. (2017) exemplify this by showing the numerous different behaviours around doing laundry. Moreover, the authors demonstrate that one behaviour or action will not necessarily be more energy efficient than the other since it is the sequence and thus the combination of such actions that account for the total energy consumption. For example, while cold washing might be more energy efficient, the total energy consumption due to washing will be higher if a person does frequent small loads and subsequently tumble dries and irons than if the washing machine is loaded to its maximum capacity the laundry is washed hot and hung up to dry. Taking behaviour and the combination of different behaviours into

account clearly adds another layer of complexity. Also one has to keep in mind, that within a single household members can have different behaviours with opposing effects on energy consumption (Palmer and Cooper, 2012). Hence, market segmentation through literature review taking all of these criteria into account is neither realistic nor does it bring about advantages for the development of eco-bot.

ANNEX B: Application of market segmentation to the use cases

The presented market segmentation can also be used to illustrate potential benefits that result from a smart meter use, depending on the interest level of the consumers. Table 15 shows potential benefits that result from 1) targeting all of the segments, 2) targeting the most interested segments and 3) targeting the least interested segments.

Objective	Approach	Potential benefit
Complete portrait of energy saving behaviours across the segments (representative)	1. Targeting all of the segments (S1 -S30)	Insight in the energy related behaviours of all segments to deepen the understanding of such groups and identifying patterns. This will be invaluable for further personalization of the energy saving suggestions. Further understanding of the energy saving potential that can be realized throughout the project.
Maximize the energy saving potential through the intervention	2. Targeting the most interested segments This corresponds to segments manifesting an interest in changing their energy behaviour, in new technologies (smart meters) and with the most power to enact change on a larger scale. Home owners (S1-S3, S7-S9, S13-S15) Tenants (S4-S6, S10-S12, S16-S18)	Achieving the most energy savings, while working together with consumers willing to dedicate the time to converse with eco-bot and thereby provide information necessary for the back-end data base.

Getting more users on board	**3. Targeting the least interested segments** **(S25-S27 and S28- S30 followed by S19-S21 and S22-S24 followed by S13-S15 and S16-S18).**	**When thinking that the very engaged segments (S1-S12) will be on board for technologies like eco-bot anyways, it is important to gain more insight into the other, less interested and motivated consumer segments (S13 – S30) and find out how to get them on board. This way a much broader application of eco-bot throughout the consumer groups can be ensured in the future. The more users eco-bot will have in the future, the more energy savings will be achieved in the long-run.**

Table 15: Potential benefits of smart meter use depending on the interest level of the consumers

ANNEX C: Findings on energy consumption levels and relation to socio-demographic/economic criteria and dwelling characteristics

The table below showcases the findings in the literature on energy consumption levels and how they are related to socio-demographic/economic criteria and dwelling characteristics. In the first column it is specified whether the study provided information on the overall energy consumption or concerning a specific appliance. This information is matched with the aforementioned criteria. Red colouring and pluses identify the drivers of high energy consumption, green colouring and pluses the drivers of lower consumption and black colouring indicates that it was not found to be a significant factor in the respective study.

It becomes clear that information on how socio-demographic/economic and dwelling characteristics influence energy consumption is predominant. And vice-versa studies show that pairing up the possession and/or usage of specific appliances with such criteria is more scattered.

	Source	Geo.		Socio-dem.							Dwelling					
		Country	Region	No. of inhabitants	Household composition	Age	Gender	Employment status	Income	Education	Urban/ Rural	Type	Age	Floor area	No. of bedrooms	No. of rooms
Overall energy-use (undifferentiated)	Kavousian, Amir; Rajagopal, Ram; Fischer, Martin (2013)[65]	US			pets +	55plus or 19-35 -			0		Rural +++	detached houses +++	not significant[66]	increase in dwelling size correlated with an increase in electricity consumption		

[65] Kavousian, Amir; Rajagopal, Ram; Fischer, Martin (2013): Determinants of residential electricity consumption. Using smart meter data to examine the effect of climate, building characteristics, appliance stock, and occupants' behaviour. In: Energy 55, S. 184–194. DOI: 10.1016/j.energy.2013.03.086.

[66] However, the results suggested US houses built before 1975 on average consumed less energy than those built between 1993 and 2003 (increased penetration of air conditioning and other high consumption appliances in newer house)

	Yohanis YG, Mondol JD, Wright A, Norton B.[67]	Ireland	Northern Ireland	4 or more +++		50-65 + >50 or 65plus		working full time+++ (home being unoccupied during the day)	Households with large incomes use 2.5 times more electricity on average in the evenings			detached +++ Terraced		Monthly energy consumption normalized by floor area indicates similar variation in average consumption for each type of house (between 2,5 and 5.0 KWh m-2)	very significant +++	

[67] Yohanis YG, Mondol JD, Wright A, Norton B. Real-life energy use in the UK: how occupancy and dwelling characteristics affect domestic electricity use. Energy Build 2008;40(6):1053–9.

	McLoughlin, Fintan; Duffy, Aidan; Conlon, Michael (2015).[68]	Ireland		fewer ---		younger (18 - 35) vs. Older (36-55 and 56 plus)				0					Most significant +++	
	McLoughlin F, Duffy A, Conlon M.[69]	Ireland													more rooms +++ each additional room increases the total electricity consumptio	

[68] McLoughlin, Fintan; Duffy, Aidan; Conlon, Michael (2015): A clustering approach to domestic electricity load profile characterisation using smart metering data. In: Applied Energy 141, S. 190–199. DOI: 10.1016/j.apenergy.2014.12.039

[69] McLoughlin F, Duffy A, Conlon M. Characterising domestic electricity consumption patterns by dwelling and occupant socio-economic variables: an Irish case study. Energy Build 2012;48:240–8.

															n on average by 15,4 % over a 6 months period	
	STATISTIK AUSTRIA	Austria		per person +		Older +++		unemployement +++		0	Rural		Houses build after 1990	steady increase with size		
	Gram-Hanssen K, Kofod C, Petersen KN.[70]	Denmark		strongest explanation +++	teenagers (13 -19) +++ small children (0-9) --		female occupied household		high +++	primary education only households use on average 200kWh pa-1 more than households with higher				steady increase with size		

[70] Gram-Hanssen K, Kofod C, Petersen KN. Different everyday lives: different patterns of electricity use. In: Proceedings of the ACEEE 2004 Summer Study, American Council for Energy Efficient Economy; 2004. 7:74–85.

										education						
	Schaffrin, André; Reibling, Nadine (2015)[71]	Austria, Denmark, UK							Greater number of devices			Detached +++ Semi-Detached ++ Terraced		big +++		
	Brounen D, Kok N, Quigley JM. (2012)[72]	Netherlands		per additional person -> 21% electricity consumption increase	families with children 1/5th more electricity consumption than families without children. Especially strong when older children	elderly --- (2-4% less energy consumption than middle-			1% increase of disposable income -> 11% increase of household electricity			Corner buildings ++ Detached++ vs. Apartment and duplex homes	1970-1980 cohort uses 53% more energy and 1980-1990 26% more energ	increase in dwelling size correlated with an increase in electricity consumption		more rooms --- (an additional room decreases the electricity consumption by 0,5 %)

[71] Schaffrin, André; Reibling, Nadine (2015): Household energy and climate mitigation policies. Investigating energy practices in the housing sector. In: *Energy Policy* 77, S. 1–10. DOI: 10.1016/j.enpol.2014.12.002.
[72] Brounen D, Kok N, Quigley JM. Residential energy use and conservation: economics and demographics. Eur Econ Rev 2012;56(5):931–45.

					present +++ they watch TV, use Computers etc. "Nintendo Effect"	aged married couples) Retired people spend more time at home but have fewer appliances)			usage				y than the post-2000 buildings			
	Wiesmann D, Lima Azevedo I, Ferrão P, Fernández JE.(2011)	Portugal		more people =higher total energy consumption but lower per capita	families with older children				high income +++				newer homes ---	increase in dwelling size correlated with		not significant

	[73]			consumption										an increase in electricity consumption		
	Bartiaux F, Gram-Hanssen K.(2005) [74]	Belgium, Denmark		more people =higher total energy consumption but lower per capita consumption	teenagers (13-19) +++ small children (0-9) -- in DK				high income +++			electricity use of detached houses is on average twice as high as in apartments. Note: Number of inhabitants				

[73] Wiesmann D, Lima Azevedo I, Ferrão P, Fernández JE. Residential electricity consumption in Portugal: findings from top-down and bottom-up models. Energy Policy 2011;39(5):2772–9.

[74] Bartiaux F, Gram-Hanssen K. Socio-political factors influencing household electricity consumption: a comparison between Denmark and Belgium. In: Proceedings of the ECEEE 2005 Summer Study, European Council for an Energy Efficient Economy; 2005. 1313–1325.

												does not affect electricity total electricity consumption in apartments in Belgium				
	Zhou S, Teng F. (2013)[75]	China		more people =higher total energy consumption but lower per capita consumption		Household responsible person 50 + approx. 3% more			high income +++	higher education than primary school				1% increase in dwelling size - 0,1 % increase in electricity consumption		

[75] Zhou S, Teng F. Estimation of urban residential electricity demand in China using household survey data. Energy Policy 2013;61:394–402.

						energy use										
	Leahy E, Lyons S. (2010)[76]	Ireland			single parent (+ 10,4 %)vs. Two parent household	45-64+ ++ 64+ yrs. and 35-44 -- -			increase of disposable household income by one unit increase electricity use by 4% per week	households with only primary education use 6,4% less electricity per week than those who completed the secondary school Leaving Certificate (18yrs)		semi-detached and terrace houses - 6,9% electricity than in detached houses; apartments - 10.7% electricity consumption per	built before 1918 + 6,1 % more electricity per week than those built between 1918-1960 (due to insulation and electric heatin			1-2 rooms use significantly less energy than 5 rooms houses

[76] Leahy E, Lyons S. Energy use and appliance ownership in Ireland. Energy Policy 2010;38(8):4265–79.

												week than detached houses	g, power showers instead of gas central heating) built in 2000 and after---			
	Wyatt P. (2013)[77]	Portugal							electricity consumption of highest income group in the UK (more than 75,000 per annum)			detached houses +++ purpose-built flats --- mid-terrace houses ---	newer homes---(due to more wealthy occupants - more energy	increase in dwelling size correlated with an increase in electricity consumption		

[77] Wyatt P. A dwelling-level investigation into the physical and socio-economic drivers of domestic energy consumption in England. Energy Policy 2013;60:540–9.

									was 1.9 times higher than the lowest income group (less than (10,000 per annum) .			(least amount of electricity) , semi-detached, end-of terrace houses use similar amounts of electricity	efficient gadgets in the house)			
	Hamilton IG, Steadman PJ, Bruhns H, Summerfield AJ, Lowe R. (2013)[78]	UK										detached houses +++	not significant		more rooms +++ (electricity demand increases linearly from	

[78] Hamilton IG, Steadman PJ, Bruhns H, Summerfield AJ, Lowe R. Energy efficiency in the British housing stock: energy demand and the Homes Energy Efficiency Database. Energy Policy 2013;60:462–80.

															1-4 rooms, than the increase from 4 to 5 rooms is 12%)	
	Santamouris M, Kapsis K, Korres D, Livada I, Pavlou C, Assimakopoulos MN. (2007)[79]	Greece							an almost linear relationship between annual expenditure on electricity and family income. BUT the lower the							

[79] Santamouris M, Kapsis K, Korres D, Livada I, Pavlou C, Assimakopoulos MN. On the relation between the energy and social characteristics of the residential sector. Energy Build 2007;39(8):893–905.

									income the higher the electricity consumption per m2 and person (67% more).							
	Tso GKF, Yau KKW. (2007)[80]	China		additional person -> increased electricity consumption					not significant				not significant	increase in dwelling size correlated with an increase in electricity consumption		

[80] Tso GKF, Yau KKW. Predicting electricity energy consumption: a comparison of regression analysis, decision tree and neural networks. Energy 2007;32 (9):1761–8.

	Firth SK, Lomas KJ, Wright AJ. (2010)[81]	UK										Bungalows --- (mainly occupied by elderly)				
	Nielsen L. (1993)[82]	Denmark		additional person -> increased electricity consumption	presence of older children ++	over 65 +++								1% increase in size -> 0,61% increase in electricity consumption		
	Parker DS. (2003)[83]	USA											older buildings +++ (poor insulation)	larger homes - greater energy consumption		more rooms +++

[81] Firth SK, Lomas KJ, Wright AJ. Targeting household energy-efficiency measures using sensitivity analysis. Build Res Inf 2010;38(1):25–41.
[82] Nielsen L. How to get the birds in the bush into your hand: results from a Danish research project on electricity savings. Energy Policy 1993;21 (11):1133–44.

[83] Parker DS. Research highlights from a large scale residential monitoring study in a hot climate. Energy Build 2003;35(9):863–76.

														(space heating and cooling)		

	Source	Geographical		Socio-dem.							Dwelling					
		Countries	Regions	No. of inhabitants	Household composition	Age	Gender	Employment status	Income	Education	Urban/ Rural	Type	Age	Floor area	No. of bedrooms	No. of rooms
Appliances																
Heating	Schaffrin, André; Reibling, Nadine (2015)[84]	Austria, Denmark, UK						working full time ---	higher comfort levels +++			House vs. Apartment		big +++		4-6 rooms +++
Non-electrical boiler	Parker DS. (2003)[85]	USA														
Electrical heating	Bartusch C, Odlare M, Wallin F, Wester L. (2012)[86]	Sweden			teenagers (13-19) +++								newer homes--- (due to more wealthy occup	increase in dwelling size correlated with an increase in electricity		

[84] Schaffrin, André; Reibling, Nadine (2015): Household energy and climate mitigation policies. Investigating energy practices in the housing sector. In: *Energy Policy* 77, S. 1–10. DOI: 10.1016/j.enpol.2014.12.002.
[85] Parker DS. Research highlights from a large scale residential monitoring study in a hot climate. Energy Build 2003;35(9):863–76.
[86] Bartusch C, Odlare M, Wallin F, Wester L. Exploring variance in residential electricity consumption: household features and building properties. Appl Energy 2012;92:637–43.

													ants - more energy efficient gadgets in the house)	consumption		
Lighting	Bedir M, Hasselaar E, Itard L. (2013)[87]	Netherlands		significant +	Presence of children or elderly 0				higher income +++	not significant				0	significant +	more rooms +++ especially with the number of study/hobby rooms

[87] Bedir M, Hasselaar E, Itard L. Determinants of electricity consumption in Dutch dwellings. Energy Build 2013; 58:194–207.

Lightning and small appliances	Genjo K, Tanabe S, Matsumoto S, Hasegawa K, Yoshino H. (2005)[88]	Japan		increase of 230 kWh per add. Person					electricity consumption increases linearly with annual income (350kWh per 27.000 $ increase)				newer homes--- (due to more wealthy occupants - more energy efficient gadgets in the house)	increase in dwelling size correlated with an increase in electricity consumption		
Air Conditioning	Baker KJ, Rylatt RM. (2008)[89]	UK											newer homes+++ > more air conditioning			

[88] Genjo K, Tanabe S, Matsumoto S, Hasegawa K, Yoshino H. Relationship between possession of electric appliances and electricity for lighting and others in Japanese households. Energy Build 2005;37(3):259–72.

[89] Baker KJ, Rylatt RM. Improving the prediction of UK domestic energy-demand using annual consumption-data. Energy 2008;85(6):475–82.

	Chong H. (2012)[90]	USA											newer homes+++ > more air conditioning			
	Tso GKF, Yau KKW. (2007)[91].	China												increase size - increase consumption (significant in the summer)		
TV	Sanquist TF, Orr H, Shui B, Bittner AC. (2012)[92]	USA		more TVs in larger house holds and longer time in use												

[90] Chong H. Building vintage and electricity use: old homes use less electricity in hot weather. Eur Econ Rev 2012; 56(5):906–30.
[91] Tso GKF, Yau KKW. Predicting electricity energy consumption: a comparison of regression analysis, decision tree and neural networks. Energy 2007; 32 (9):1761–8.
[92] Sanquist TF, Orr H, Shui B, Bittner AC. Lifestyle factors in U.S. residential electricity consumption. Energy Policy 2012;42: 354–64.

IT Appliances	Sanquist TF, Orr H, Shui B, Bittner AC. (2012)[93]	USA							more IT appliances and more use in households with higher income							
Washing machines	Sanquist TF, Orr H, Shui B, Bittner AC. (2012)[94]	USA		more washing machines and/or more frequent use												

Table 16: Findings on overall energy use and relation to socio-demographic/economic criteria and dwelling characteristics

[93] See footnote 47.

[94] See footnote 47.