The SIT4Energy project has received funding from the German Federal Ministry of Education and Research (BMBF) and the Greek General Secretariat for Research and Technology (GSRT) in the context of the Greek-German Call for Proposals on Bilateral Research and Innovation Cooperation, 2016

SIT4Energy

Project Acronym: SIT4Energy

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Project Duration: 36 months (01/03/2018 – 28/02/2021)

DELIVERABLE 1.2.1
Demand Analysis & User Taxonomy

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Executive Summary

This deliverable D1.2.1 “Demand Analysis and User Taxonomy” provides the first results on the identification of user information needs to inform the design of the SIT4Energy applications. The derivation of the model comprises an analysis of literature to inform the understanding of the end users and the application context from related work. Furthermore, user workshops in form of focus groups were performed to support the identification of user information needs from the specific application context focused on the actual SIT4Energy pilots and their target groups.

The deliverable is structured as follows:

Section 2 presents the further analysis of the raw data obtained from the SIT4Energy Market Research Survey undertaken in T1.1 in order to provide a classification of the SIT4Energy target users based on the German data for target group 1 and the Greek data for target group 3.

Section 3 shows the analysis of energy demand for the pilot specific target groups on the basis of historical consumption data, that will be collected, processed and analysed due to the objects of the project.

Section 4 collaborates the SIT4Energy users, their needs and the specific energy demand in a summarizing view. It is split to the pilot countries and the analysis is based on social and energy relevant factors. Whereupon the energy demand analysis was started but could not be finished yet. The results will be presented in the next version of this deliverable (M24).

Section 5 presents the conclusions of the deliverable.

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List of Acronyms and Abbreviations

Term	Description
EE	Energy Efficiency
EMS	Energy Management Service
EU	European Union
DNAS	'Drivers - Needs - Actions - Systems'
GDPR	General Data Protection Regulation
HUA	Harokopio University of Athens
ICT	Information and Communication Technology
RES	Renewable Energy Source
ToE	Tonne of oil equivalent

1. Introduction

The goal of the SIT4Energy project is to demonstrate how integrated energy management for prosumers can be realised through smart IT solutions supporting the identification of efficiency potentials in local energy production and consumption. The project includes the development of a Smart Energy Dashboard for helping prosumers and utilities to optimize energy production and consumption and an intelligent mobile recommendation service for energy saving in university settings.

The development of SIT4Energy applications addresses different target groups. This deliverable classifies the end-users according to socio-demografic, personality traits, attitudes and the energy demand. The classification is determined in an overall user taxonomy and the energy demand analysis, performed based on available historical consumption data for different user classes.

1.1 Scope and objectives of the deliverable

Within this deliverable D1.2 *"Demand Analysis and User Taxonomy"* the taxonomy of SIT4Energy users is determined and the energy demand analysis is performed, based on available historical consumption data for different user classes and pilot cases. The start for this analysis was made by an evaluation of the survey data from *T1.1 "Market Research Design"* respectively *D1.1 "Market Research Survey Tool",* available consumption/production data of the partner countries and the project partner utilities in Greece and Germany.

The objective of the first procedure is to classify users based on:

- Socio-demographic factors
- personality traits
- attitudes
- energy demand

1.2 Structure of the deliverable

This deliverable is structured in 5 sections. Section 1 introduces this deliverable. Section 2 classifies end-users based on survey finding of Task 1.1. Section 3 analyses the energy demand of the identified end-users. In section 4 the overall SIT4Energy user taxonomy is described. Section 5 presents the conclusions of this deliverable

1.3 Relation to other tasks and deliverables

- T1.1 "Market Research Design" respectively D1.1 "Market Research Survey Tool".
- T1.3 "User Information Model" and D1.3 "User Information Model"
- T1.4 "Energy Behaviour Change Modelling" and D1.4 "Analysis of Factors Influencing Consumer Choices"

2. Classification of SIT4Energy target users based on socio-demographics, attitudes and personality traits

In this chapter, the raw data obtained from the SIT4Energy Market Research Survey undertaken in T1.1 will be further analysed in order to provide a classification of the SIT4Energy target users. A complete overview of the survey results and a preliminary analysis of this data has been already provided in *D1.1. Market Research Survey Tool* (Akarmazyan & Bravos, 2018). This will now be extended in order to provide an overview of the socio-demographic characteristics, personality traits and attitudes towards energy efficiency that are prevalent amongst the SIT4Energy end-users in this sample. The analysis will be based on the German data for TG1, which are the household users, especially prosumer households. For Greece, the data from TG3 will be analysed, which are Greek energy consumers in households and workplaces.

2.1 Classification of German End-user types (consumers/prosumers)

In the following section, the German data will be analysed along the lines of socio-demographic factors, personality traits and attitudes. Not all questions used in the survey will be analysed here but only the ones relating to those factors. Questions 16[1], 17[2], 18[3], 24[4] and 28[5] of the survey are excluded here since they provide insights into recommendations and their respective micro-moments, which will be relevant in WP3. Questions 26[6] and 27[7] are discussed in Deliverable *D.1.4.1. Analysis of factors influencing consumer choices* (Allemand, Akarmazyan, Chouliara, & Schneider, 2019).

2.1.1 *Socio-demographic factors*

A general overview of the socio-demographic characteristics of the obtained sample has already been reported in *D.1.1. Market Research Survey Tool* (Akarmazyan & Bravos, 2018). As a recapitulation, a shortened version of the table will be repeated here:

Socio-demographic variables	Percent (%)
Gender	
Male	84.8
Female	15.2
Age	
18-25	-
25-35	30.3
35-45	15.2
Over 45	54.5
Highest degree of education?	
Middle school[8]	18.2
High school	9.1
Bachelor	12.1
Master[9]	39.3
Doctorate	21.2
Other	-
Occupation	

[1] What kind of tips would you be interested to receive?
[2] When would you like to receive notifications on your smartphone with tips for optimizing your energy use?
[3] How often would you like to receive notifications on your smartphone with tips for optimizing your energy use?
[4] Are you happy with your thermal comfort at your living space?
[5] What kind of energy management services would you like to buy?
[6] How important is for you to pay for efficient energy management services and thus automatically minimize your energy consumption?
[7] How important is for you to pay for efficient energy management services and thus automatically maximise your energy production?
[8] This category includes the German ‚Hauptschulabschluss' (High school diploma) and ‚Realschulabschluss' (Secondary school certificate).
[9] This category includes degrees from a university and the German ‚Fachhochschule' (Polytechnic degree).

Socio-demographic variables	Percent (%)
Unemployed	-
Employee in public sector	51.5
Employee in private sector	30.3
Self-employed	12.1
Student	3
Pensioner	3
Household average yearly income is	
Under 20K	3.2
20K-30K	-
30K-40K	16.1
Over 40K	80.6

Table 1: Socio-demographic variables (as reported in D.1.1)

Around 85% of the respondents in the sample are male and over half of the respondents are older than 45 years of age. The sample only includes people older than 25 years. One third of the respondents is between 25-35 years old. So, this is a relatively male-dominated sample reflecting only people in their early and later middle ages. Over half of the sample have a Master's degree or higher, with 72.7% in total holding a University degree. This sample represents therefore a very educated sub-section of society. More than half of the respondents are public service employees; one third is employed in the private sector. Self-employed workers make up 12.1%. The sample does not include people who are unemployed. This suggests that the majority of the respondents work in reasonably stable and secure employment. The sample is also heavily skewed towards well-earning households, with approx. 80% of respondents living in households with incomes higher than 40.000€ a year.

Overall, it could be argued that this sample reflects mainly members of the German middle classes. This is not surprising but in line with current research, since socio-demographic variables like high incomes and home ownership enable people to become prosumers in the first place. Given this, prosumers are more likely to be members of the middle classes. As such, this sample represents an accurate reflection of the prosumer sub-section of society.

However, the small sample size of n = 33 poses some restrictions for the analysis.

Given these particular characteristics of the sample, the following three socio-demographic variables have been chosen as key features to base the further analysis on:

- Age: divided into the age groups '25 - 35 years old', '35 - 45 years old' and those 'older than 45 years'
- Gender: divided into 'male' and 'female' respondents
- Income[10] divided into two income groups[11]: those living in households earning '30.000 - 40.000 € per year' and respondents living in households earning 'more than 40.000 € per year'.

Age, gender and income are commonly used variables of analysis that help describe groups of populations in more detail. In market research, they are often used as indicators for the definition of different target groups. In this analysis, they will be used as dividers across the sample in order to get a clearer image of the characteristics of SIT4Energy end-users.

2.1.1.1 *Socio-demographics by age*

[10] Given the relatively small sample size, the sub-samples in the education category were too small to use for a meaningful analys. For this reason, income was chosen instead.

[11] One respondent who indicated that he was earning less than 20.000€ a year has been excluded from the income groups.

Looking at the other main socio-demographic variables broken down by age, the following picture emerges:

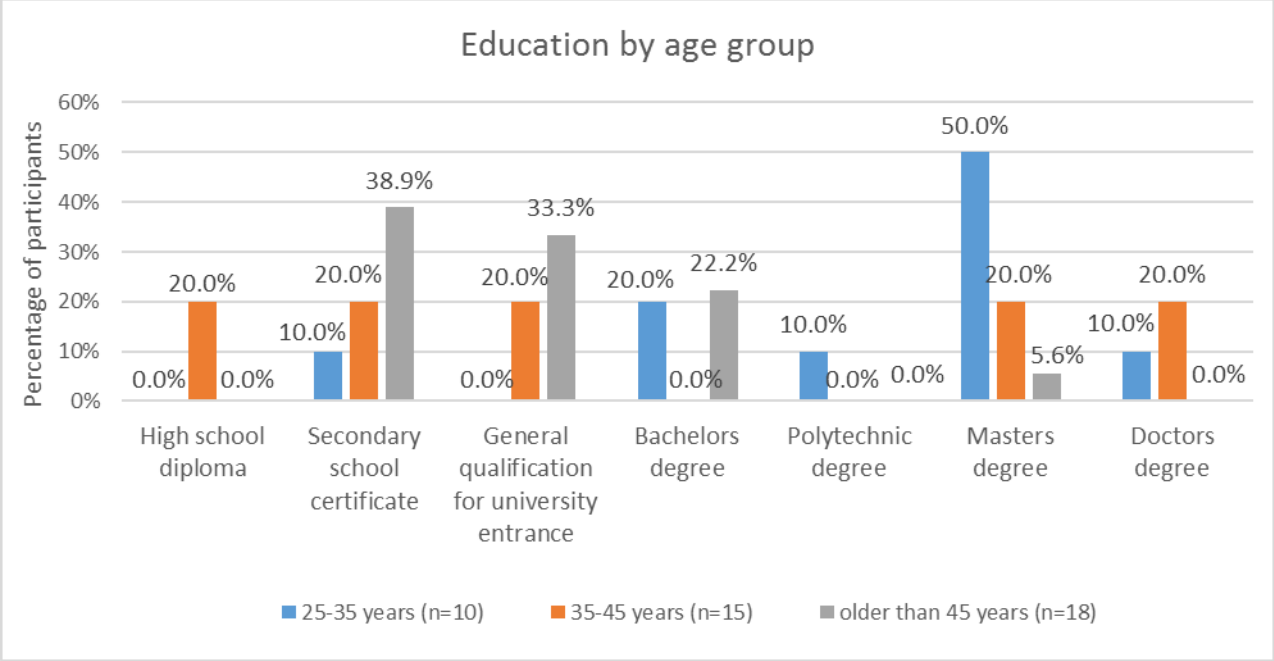
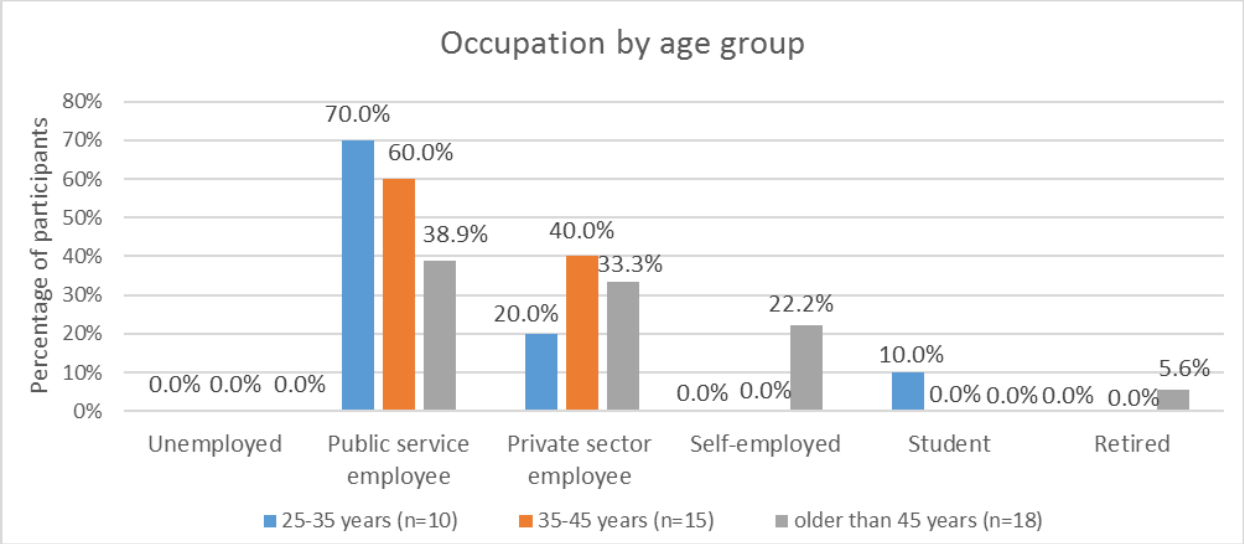


Figure 1. Education by age group.

The sample reflects common trends in German society, showing that younger people tend to have higher levels of education. While the distribution is evenly spread across all levels of education for the 35-45 year olds, nearly three thirds of those over 45 years of age have finished their school education but have not proceeded further to university studies. In comparison, 60% of the respondents in the youngest age group have obtained a Master's degree or higher.

Figure 2. Occupation by age group



As shown in Figure 2, 70% of the young professionals in the sample also work in the public service sector, which provides reasonably stable career paths, 20% are employed in the private sector. In the middle aged group of the 35-45 year olds, 60% work in the public service sector and 40% are employees in the private sector, suggesting again rather stable career choices. Interestingly, the group of the over 45 year olds presents a different and more varied image. Roughly two fifth work as public and private sector employees, while one fifth is self-employed.

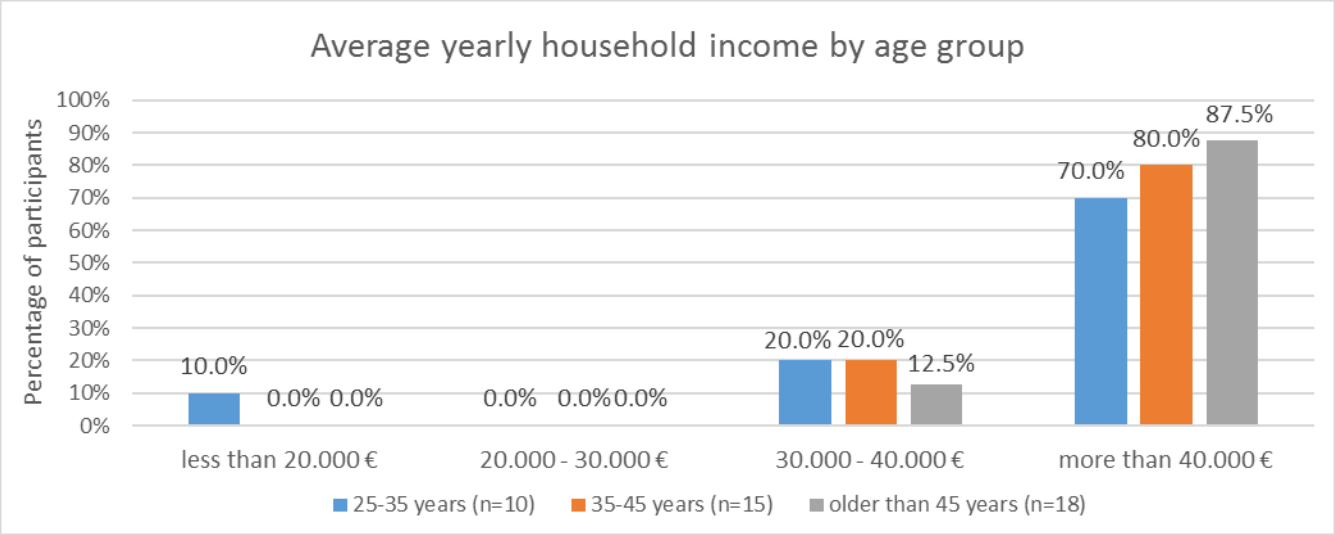


Figure 3. Average yearly household income by age group.

Figure 3 shows that even though they are the least formally educated respondents in the sample, the over 45 years old are the largest group earning the highest yearly household incomes. Again, this reflects larger societal trends, since income tends to increase with age when measured over a lifespan and remains relatively stable after 45 years of age until retirement (PMSG, 2017). Since the beginning of the 1990s, it has become common-place for young middle class Germans to obtain university degrees. Before then, this was not the case. Today, a master's degree is a good predictor for an above average income (PMSG, 2017), as can also be seen in Figure 3: 70% of the youngest respondents are already living in households earning above 40,000€ a year.

Based on these findings, a rough first categorisation of the target users can be suggested:

- The youngest age group consists of well-educated and well-earning young professionals in stable employment.
- Respondents in the middle aged group have the most varied educational backgrounds, but the group consists mainly of well-earning public and private sector employees.
- The oldest age group consists of the least formally educated respondents, who are nonetheless mostly living in the highest-earning households. They are mainly either public and private sector employees or self-employed.

2.1.1.2 *Socio-demographics by gender*

Including gender as a variable of analysis will further sharpen the emerging picture of our target users:

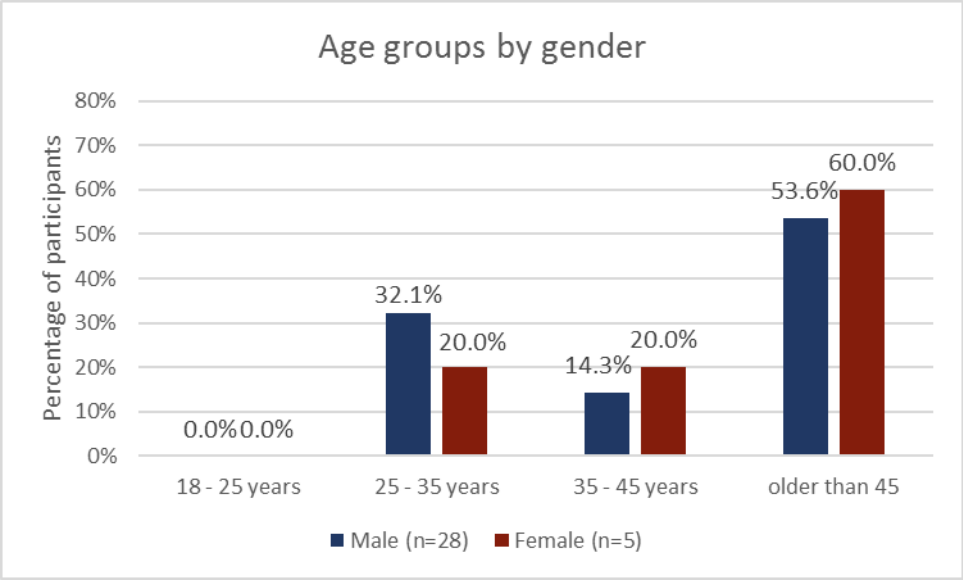


Figure 4. Age groups by gender.

Figure 4 shows that the age distribution in both gender groups is relatively even. The male respondents tend to be slightly younger than the female respondents, especially in the lower age groups. The largest difference is in the youngest age group, to which roughly one third of the men in the sample belong and one fifth of the women. The relatively similar age distribution in the two gender groups makes for an easier comparison when looking at other variables, such as education, occupation and income.

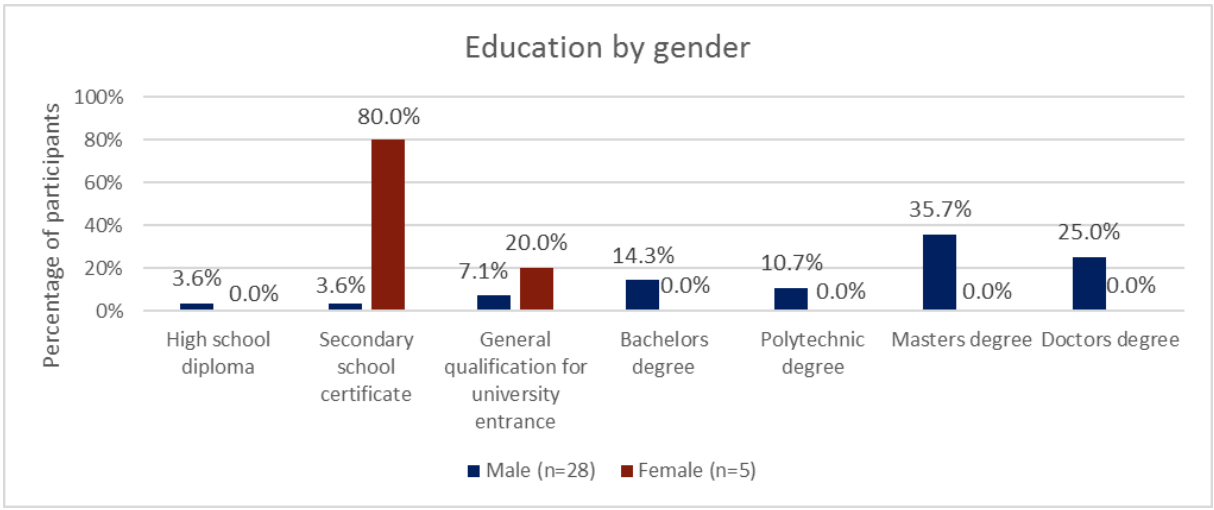


Figure 5. Education by gender.

As shown in Figure 5, the distinction by gender reveals a large educational gap between the men and the women in the sample. 80% of the women have finished their middle school education. None of the women in the sample have obtained university degrees. On the male side, this looks rather different: 85,7% of the males hold a university degree. Given the fact, that the majority of the women in the sample are aged over 45 years, this can also be explained by a generational difference. In the 1970s when these women were young, middle schooling was in some families still often seen as sufficient for a girl. These attitudes have been changing since then but its remnants might still be reflected in the sample here.

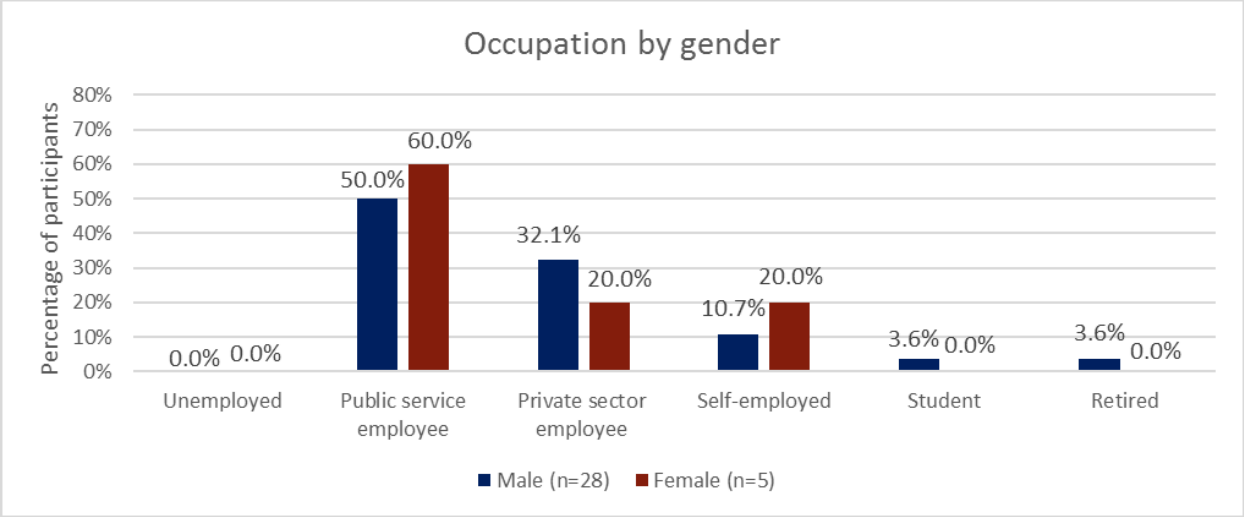


Figure 6. Occupation by gender.

Figure 6 does not reveal large differences in occupation between the gender groups. Roughly 80% of the men and women in the sample work as private or public sector employees, while the percentage of women working in the public sector is slightly higher compared to the men. Interestingly, one fifth of the women in the sample are self-employed, which is a higher percentage than amongst the men. Yet due to the small sample size, this might be an over-representation.

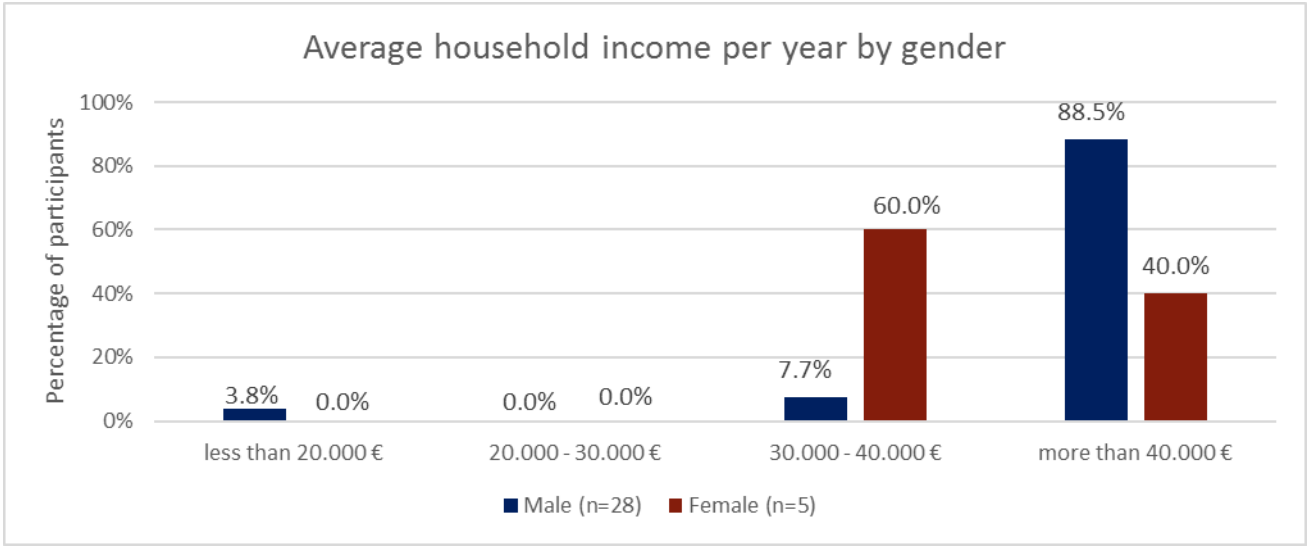


Figure 7. Average household income by year by gender.

Figure 7 reflects the fact that women still tend to earn less than men. Here, this effect might be aggravated by the fact that the women in this sample are also formally less educated than the male respondents.

When looking at the highest earning group (n=27) more closely, it shows the following gender and age distribution:

Income:	Male (n=25)	Female (n=2)
More than 40.000 €	92.6%	7.4%

Table 2. Gender distribution in the highest group of income.

Age:	More than 40.000 € (n=27)
25 - 35 years	25.9%
35 - 45 years	14.8%
older than 45	59.3%

Table 3. Age distribution in the highest group of income

The highest income earners in this sample are predominantly male and over 45 years of age (60%) or younger than 35 years (25%).

In summary, we can refine our user groups as follows:

- The youngest age group consists of well-educated and well-earning young professionals in stable employment who also tend to be male.
- The oldest age group consists of the least formally educated, but best-earning respondents, who are also predominantly male. They have the most varied professional backgrounds of the age groups, including self-employment.
- The women in the sample tend to be older than 35 years of age, live in households that earn between 35.000-45.000€ per year and have no university education. They predominantly work as employees in the public sector. A smaller fraction is self-employed or employed in the private sector.
- The highest income earners in this sample are predominantly male and over 45 years of age (60%) or younger than 35 years (25%).

2.1.2 *Personality traits*

Having gained some insights into the socio-demographic make-up of this sample, it is time to see how these variables interact with the sampled energy-related personality traits. The psychological term 'personality' is a vast one and a thorough discussion would exceed the limitation and the scope of this deliverable. As a short-handle, the analysis will use one of the most established tried and tested models of personality, the so-called 'Big Five Model' or OCEAN Model developed by Lewis Goldberg (Goldberg, 1990, 1993; John, Naumann, & Soto, 2008; Wiggins, 1996).

The OCEAN Model distinguishes five primary factors of personality that can broadly be summarised like this:

- **Openness to experience** describes an appreciation for a variety of experiences. This includes the openness to try new things and the ability to think outside the box.
- **Agreeableness** means being kind, sympathetic and happy to help. Individuals with high levels of agreeableness tend to value social harmony, which makes them compassionate, compliant and cooperative.
- **Conscientiousness** describes the tendency to plan ahead rather than being spontaneous and to act in an organized or thoughtful way.
- **Extraversion** is a person's tendency to seek stimulation in the company of others. It means being sociable, energetic and talkative.
- **Neuroticism** refers to an individual's emotional stability and general temper. Low self-confidence and an inclination to worry, be vulnerable or temperamental are characteristics of individual's who score highly in this category.

Extraversion and neuroticism will not be further included in the analysis, since they are not relevant for the context of the SIT4Energy project. Extraversion – introversion is a personality trait which is related to human interaction, not human – technology interaction. Neuroticism is not relevant to the projects' interest in personality traits that influence energy-related behaviour.

2.1.2.1 *Openness to experience*

In the context of the SIT4Energy project, 'openness to experience' was operationalised as the general awareness of smart energy services and the current use of such services in order to optimize one's energy production and consumption. The answers to these tree questions will now be analysed across the identified age, gender and income groups mentioned above.

By age

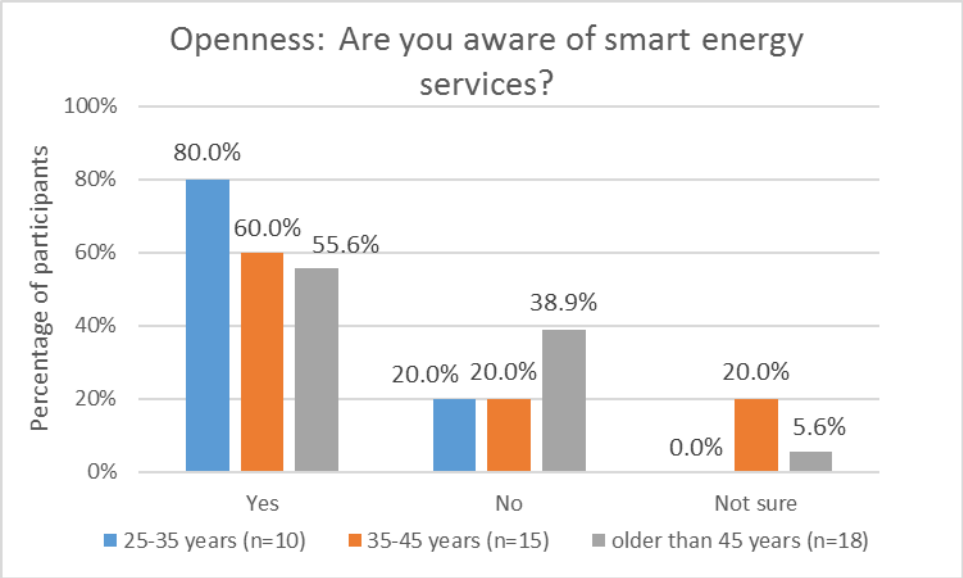


Figure 8. Awareness of smart energy services by age.

Figure 8 shows that the younger age groups are generally more aware of smart energy services, with the youngest age group also being the most aware and the oldest age group being the least aware. 80% of the respondents in the youngest age group indicated that they were aware of such services. In the oldest age group, 56% indicated such awareness.

The 25-35 year olds in this sample belong to the generation born between 1984 and 1994. Especially its younger members are sometimes labelled as 'digital natives' because they grew up in times of the rising internet and the ensuing digitalisation of the private and public sphere. Due to this, it is often assumed that they tend to be more open to the technological advances of their time, perceiving them as normal, while members of the older generations have spent larger portions of their lives in 'analogue times', which might make them less familiar with and less open towards the use of new technologies and smart services.

However, while Figure 8 gives some credit to these types of considerations, this is not the entire picture. Figure 9 below shows that the over 45 year olds are also the largest group in the sample who are already using smart services to optimise their energy production. In comparison, only 10% of the youngest age group and none of the middle aged group members are currently using these services. This suggests that there is a sub-section in the older age group, which is technology- affine and open to the use of smart energy services in order to optimize their energy production. They are most likely already prosumers.

The lower usage of smart energy production services amongst the younger age groups could be related to the fact that they might not be prosumers yet, since they might not have settled into stable lives yet,

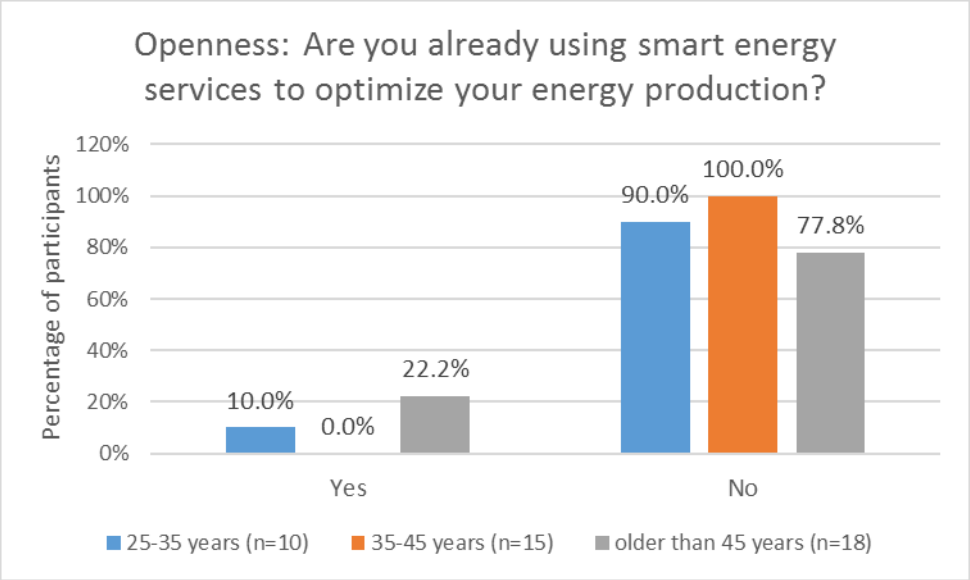


Figure 9: Use of smart energy services for optimization of energy production by age.

have not bought their own homes yet or have not built up enough financial reserves yet to finance an investment into costly prosumer technology. However, given their general awareness and openness towards smart technological solutions and their middle-class backgrounds, members of the youngest age group could be the SIT4Energy service users of tomorrow.

Figure 10 shows that the use of energy services aiming to optimize energy consumption is slightly more prevalent amongst the respondents in this sample. Interestingly, the youngest and oldest age groups are reaching almost similar levels of use, with one fifth in the youngest and nearly one quarter in the oldest age group. This difference to the distribution shown might be attributed to the fact that the younger generations are more acutely aware of the need to act in environmentally friendly ways by saving energy, and might be more open to use smart services to achieve such aims, but they have not become prosumers yet.

In summary:

- The youngest respondents are the most aware of smart energy services and are open to their use, especially for the optimisation of their energy consumption. They might not have developed a need for production-related smart energy services yet.
- Despite their relatively high awareness of smart energy services, the middle aged groups are the least open to using them.
- Despite having the lowest general awareness of smart energy services of the three age groups,

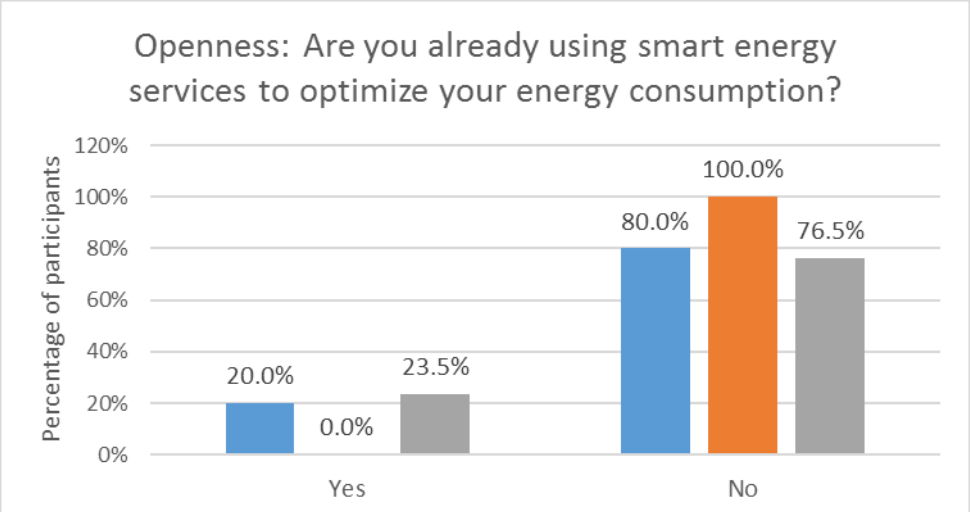


Figure 10: Use of smart energy services for optimization of energy consumption by age.

the oldest respondents are also the largest group currently using smart energy services for production and consumption optimization. This suggests the presence of a technology-affine subsection of prosumer pioneers in this age group.

By gender

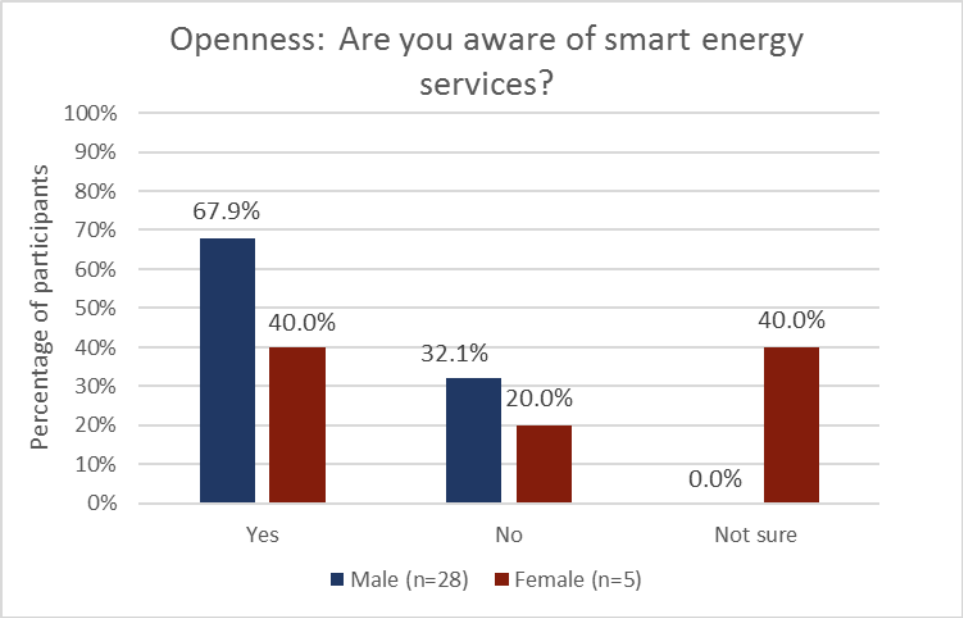


Figure 11. Awareness of smart energy services by gender.

Figure 11 shows that less women than men are aware of smart energy services in this sample.
This could be the expression of the different socialisation of men and women in the realm of technology. For the most part of the last century, technology has been seen and treated as an exclusively male domain, from which women were first explicitly and later implicitly excluded. While these attitudes are slowly shifting, they might still have an influence on women's openness and confidence to engage with new technologies today.

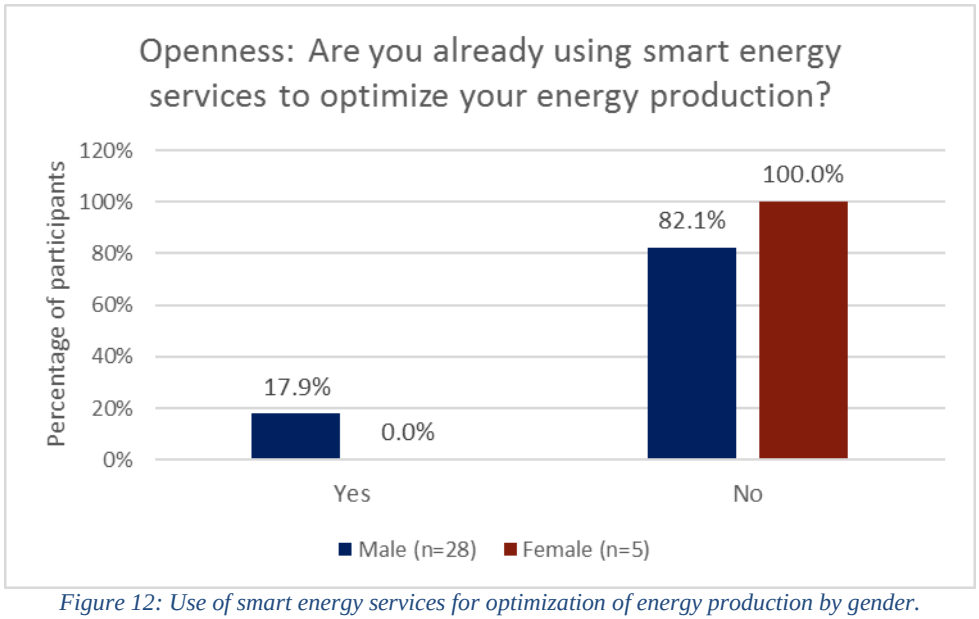


Figure 12: Use of smart energy services for optimization of energy production by gender.

Figure 12**Error! Reference source not found.** seem to confirm this assumption since none of the omen in this sample are currently using smart energy services. However, given the small number of women in this sample, these findings need to be interpreted with caution.

In summary:

- The female respondents are less aware of smart energy services and at lot less open to their use than the males. None of the female respondents are currently using smart energy services.

By income

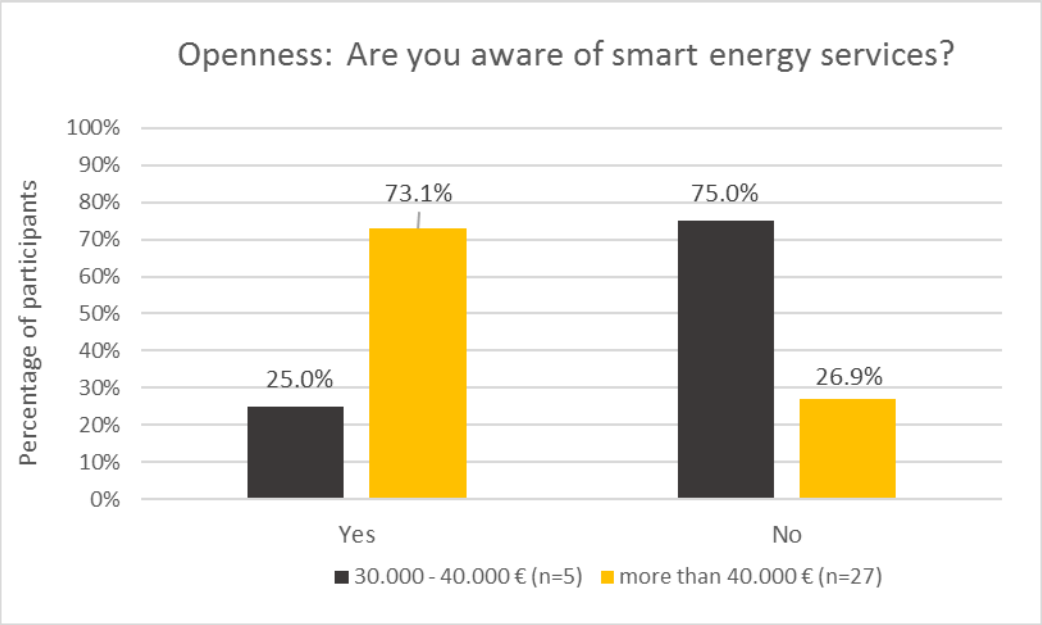


Figure 13. Awareness of smart energy services by income.

Figure 13 shows that it is predominantly the well-earning respondents in the sample who are also aware of smart energy services. Figure 14 and Figure 15 show that it is also only the highest-earning income group, which is currently using such services. This is in line with previous theorising on the importance of financial security for becoming a prosumer, since it requires being able and willing to invest into expensive energy-management products and services. The fact that 60% of the respondents in the lower income group are also female might also be reason for this striking difference.

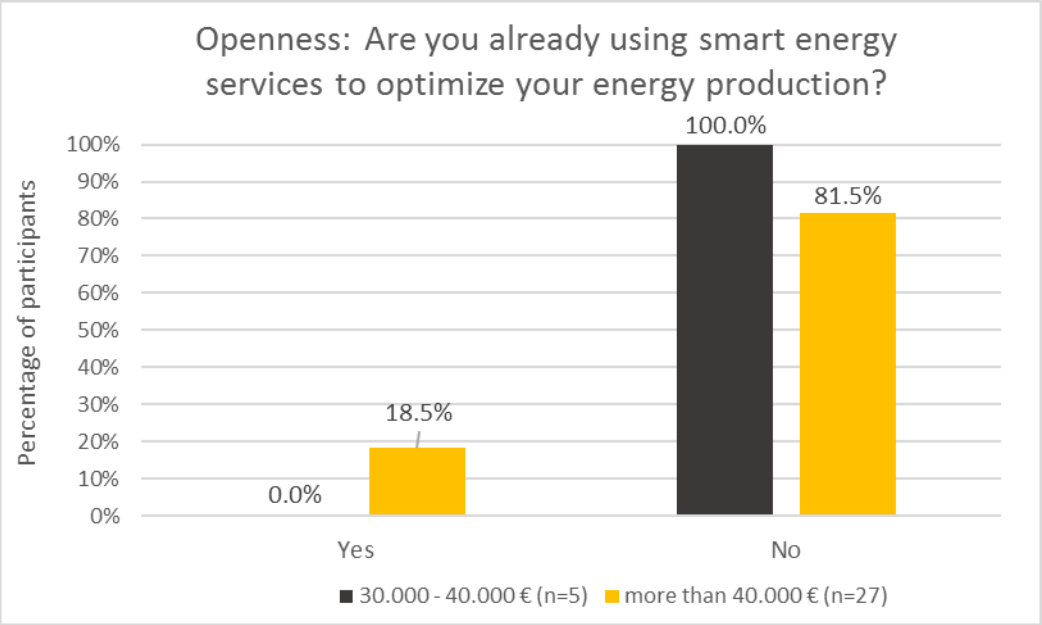


Figure 14. Use of smart energy services for optimization of energy production by income.

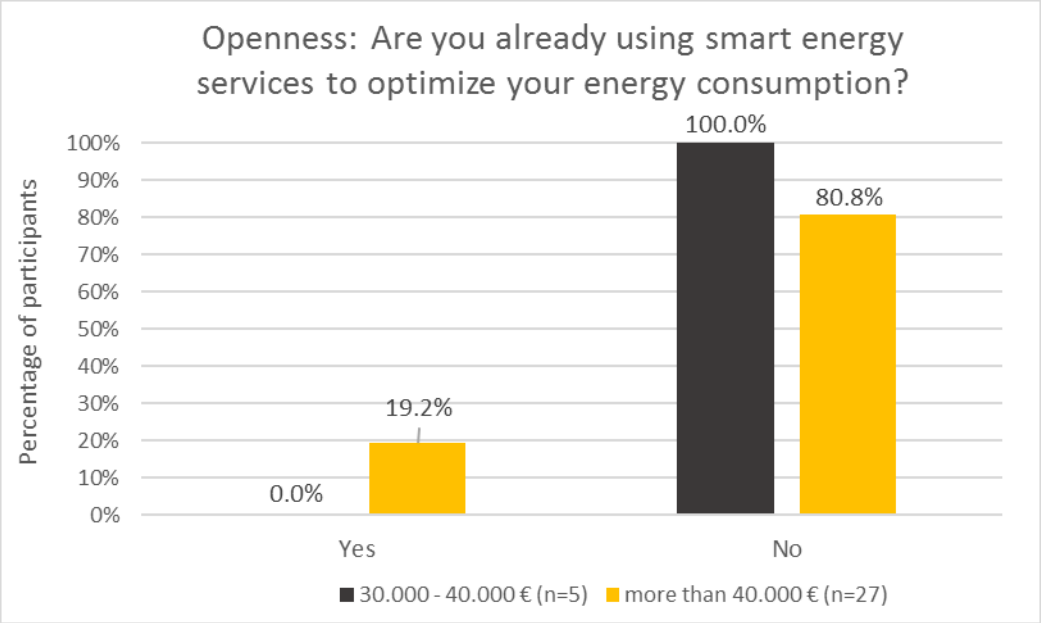


Figure 15. Use of smart energy services for optimization of energy consumption by income.

In summary:

- The highest income respondents are also the ones who are the most aware of smart energy services and the most open to their use. None of the respondents in the lower income group is currently using smart energy services.

2.1.2.2 *Agreeableness*

The personality trait of 'agreeableness' in relation to energy-efficient behaviour has been operationalised as the question 'Would you be willing to switch off appliances during peak hours?'.

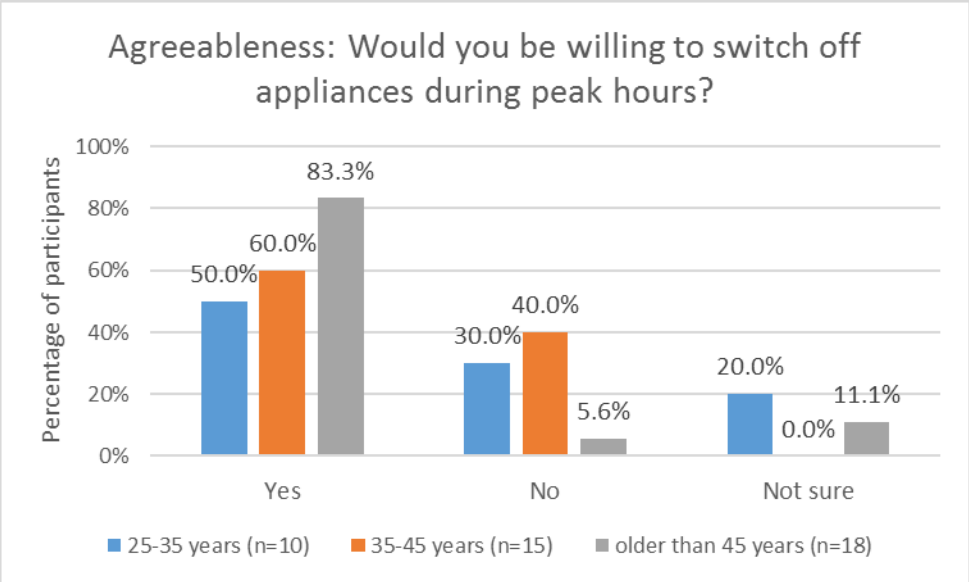


Figure 16. Agreeableness by age.

Figure 16 shows the distribution in the sample broken down by age. Interestingly, it is the oldest age group, which is the most often willing to forego personal comfort and convenience in order to maximise grid efficiency: nearly 85% of the oldest respondents answered this question positively. In comparison: Only half of the youngest respondents answered this question with 'yes' and roughly one third answered with 'no'. The middle aged group is the most reluctant to actively align their behaviour with the demands of grid-efficiency: 40% answered this question with 'no'.

This distribution could be explained with the increasing individualisation of the German society and the high-standard of living enjoyed by those born in the last few decades. Since the post-war period, Germany's affluence has given rise to a 'consumerist' society, in which consumption is used to construct individualised identities. At the same time, post-materialist values of 'self-realization' have started to replace traditional, collective ways of life.

For the younger respondents it is more likely than for the older respondents that they have been socialised to value consumption for its own sake and to use it as an expression of their individuality and their social identities. The older respondents in the sample are more likely to have been taught less consumption- and more community-oriented values and behaviours. The distribution in this sample might also be an expression of this general value-shift.

It is a well-established fact that women tend to be more likely to exhibit cooperative social behaviour than men, here termed 'agreeableness'. Figure 17 confirms that this is also true for the sample here: 80% of the women in the sample indicated agreeableness, compared to ca. 68% of the males. None of the female respondents openly refused to switch off appliances during peak hours, instead one fifth said that they were 'not sure' about this. In comparison roughly one fifth of the males answered this question with 'no'.

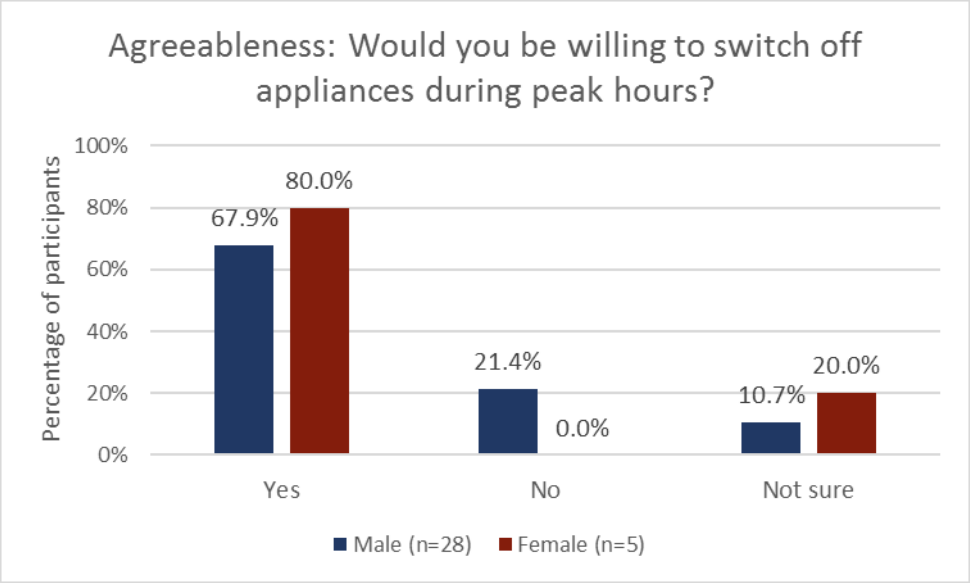


Figure 17. Agreeableness by gender.

Figure 18 below does not show big differences in agreeableness between the two income groups. It is the highest earning group that also show the highest agreeableness, but overall the differences are negligible.

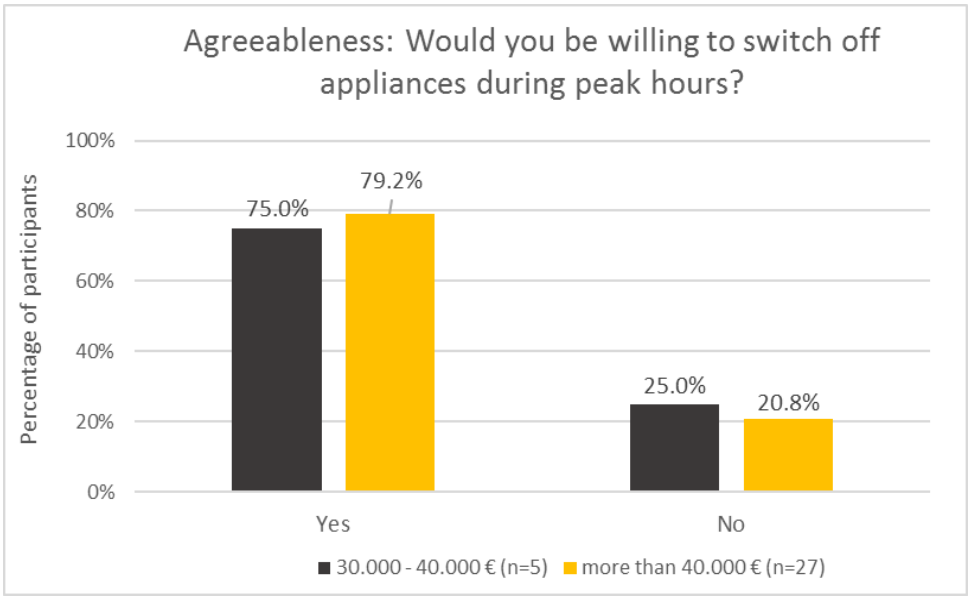


Figure 18. Agreeableness by income.

In summary:

- Female respondents and respondents over the age of 45 are the most likely to agree with and actively conform to grid-efficient curtailment behaviour.
- The youngest age group is the least likely to actively exhibit 'agreeable' grid-efficient behaviour. Only half of the respondents indicated they would turn off appliances to support grid efficiency. One third refused to do so.
- In the middle aged group 60% of the respondents agreed to grid-efficient curtailment behaviour. 40% however did not. They are therefore the most reluctant age group to subject themselves to the behavioural constraints of grid-efficiency.

2.1.2.3 *Conscientiousness*

The last personality category analysed here refers to 'conscientiousness', which is measured as the desire to be able to control one's energy production and consumption and the desire to receive real-time feedback in order to stay informed. The question was: 'How important is it to you to control your electricity production/consumption and to get real-time feedback onto your smartphone?'

By age

To facilitate the comparison, an overview of the desired production/consumption control and feedback indicated by the different age groups is provided in Table 4.
Overall, it is a relatively even distribution across the age groups. The most striking result is that 60% of the middle aged respondents feel neutral towards the possibility of controlling their energy production and consumption. They are the least conscientious age group, with only 20% of the respondents finding it important to control and be informed about their energy production/consumption. Over the course of this analysis, this age group is emerging as the one with the lowest levels of openness to experience, agreeableness and conscientiousness of the three. To facilitate the comparison further, the aggregated percentages are presented in Table 5.

Table 4: Conscientiousness: Production/consumption control and feedback by age.

Conscientiousness: Consumption	**How important is it to you to control your electricity consumption and to get real-time feedback onto your smartphone?**		
	25-35 years (n=10)	**35-45 years (n=15)**	**older than 45 years (n=18)**
Very unimportant	20.0%	20.0%	16.7%
Unimportant	10.0%	0.0%	16.7%
Neutral	30.0%	60.0%	27.8%
Important	30.0%	20.0%	27.8%
Very important	10.0%	0.0%	11.1%
Conscientiousness: Production	**How important is it to you to control your electricity production and to get real-time feedback onto your smartphone?**		
	25-35 years (n=10)	**35-45 years (n=15)**	**older than 45 years (n=18)**
Very unimportant	30.0%	20.0%	27.8%
Unimportant	10.0%	0.0%	16.7%
Neutral	20.0%	60.0%	22.2%
Important	30.0%	20.0%	22.2%
Very important	10.0%	0.0%	11.1%

Table 5: Conscientiousness: Production/consumption control and feedback by age (Aggregated percentages).

Conscientiousness: Consumption	**How important is it to you to control your electricity consumption and to get real-time feedback onto your smartphone?**		
	25-35 years (n=10)	**35-45 years (n=15)**	**older than 45 years (n=18)**
Unimportant to very unimportant	30.0%	20.0%	33.3%
Neutral	30.0%	60.0%	27.8%
Important to very important	40.0%	20.0%	38.9%
Conscientiousness: Production	**How important is it to you to control your electricity production and to get real-time feedback onto your smartphone?**		

	25-35 years (n=10)	35-45 years (n=15)	older than 45 years (n=18)
Unimportant to very unimportant	40.0%	20.0%	44.4%
Neutral	20.0%	60.0%	22.2%
Important to very important	40.0%	20.0%	33.3%

The youngest age group is the most evenly divided. 40% find consumption/production control and feedback 'important' to 'very important'. 40% find production control 'unimportant' to 'very unimportant'. Slightly fewer respondents (30%) find consumption control 'unimportant' to 'very unimportant'. This ties in with earlier findings that younger respondents might not be prosumers yet and have therefore less interest in and need for production management services. Overall, this age group is the one with the most respondents showing high levels of conscientiousness.

Interestingly, the oldest and the youngest age groups show relatively similar distributions across the table, suggesting similar levels of conscientiousness within these two groups. For example, like the youngest respondents, nearly 40% of the over 45 year olds also find consumption/production control and feedback 'important' to 'very important'. One third of the over 45 years olds find production control and feedback 'important' to 'very important', suggesting the presence of many prosumers in this group. This is likely, given the fact that this is also the age group with the most well-earning respondents. Overall, having control and feedback over one's energy consumption seems to be slightly more important across all three groups than controlling and receiving information about one's energy production. This makes sense, given the fact that not all respondents in the sample are currently prosumers. But they surely are all consuming energy.

In summary:

- The youngest and oldest age groups show similar distributions of conscientiousness across their groups. Both groups have a relatively even split of roughly 30/30/40 between those that find consumption control and feedback (very) unimportant, neutral and (very) important. Both groups also tend to find production control and feedback slightly less important than consumption control and feedback.
- Overall, the youngest age group has the most respondents showing high levels of conscientiousness, which might be related to their general openness towards technological innovations and solutions.
- The fact that the oldest age group shows similar levels of conscientiousness to the youngest group might in their case be related to their financial prowess, which makes it more likely for them to be already prosumers.
- The middle aged group gives the least importance to controlling their energy consumption/production and to receiving information about it. The majority in this group has a 'neutral' stance towards this possibility. Over the course of this analysis, this age group is emerging as the one with the lowest levels of openness to experience, agreeableness and conscientiousness of the three.

By gender

Table 6: Conscientiousness: Production/consumption control and feedback by gender.

Conscientiousness: Consumption	How important is it to you to control your electricity consumption and to get real-time feedback onto your smartphone?	
	Male (n=28)	Female (n=5)
Very unimportant	21.4%	0.0%

Unimportant	10.7%	20.0%
Neutral	28.6%	60.0%
Important	28.6%	20.0%
Very important	10.7%	0.0%
Conscientiousness: Production	**How important is it to you to control your electricity production and to get real-time feedback onto your smartphone?**	
	Male (n=28)	**Female (n=5)**
Very unimportant	28.6%	20.0%
Unimportant	7.1%	40.0%
Neutral	28.6%	20.0%
Important	25.0%	20.0%
Very important	10.7%	0.0%

Table 7: Conscientiousness: Production/consumption control and feedback by gender

Conscientiousness: Consumption	**How important is it to you to control your electricity consumption and to get real-time feedback onto your smartphone?**	
	Male (n=28)	**Female (n=5)**
Unimportant to very unimportant	32.1%	20.0%
Neutral	28.6%	60.0%
Important to very important	39.3%	20.0%
Conscientiousness: Production	**How important is it to you to control your electricity production and to get real-time feedback onto your smartphone?**	
	Male (n=28)	**Female (n=5)**
Unimportant to very unimportant	35.7%	60.0%
Neutral	28.6%	20.0%
Important to very important	35.7%	20.0%

Table 6and Table 7 show the distribution of conscientiousness in the male and female groups in percentages and in aggregated percentages. Overall, women tend to ascribe little importance to consumption/production control and feedback: only 20% found it important. In comparison nearly 40% of the male respondents found consumption control and feedback (very) important and 35% thought this way about production control and feedback.

While 60% of the women feel 'neutral' towards the possibility to control their consumption, 20% found it unimportant. This distribution is reversed for the production control and feedback: a clear majority of 60% found this possibility (very) unimportant, 20% felt 'neutral' about it. The males did not show such big differences of interest between consumption and production control: they also have a slight preference for consumption over production control and feedback, but the distribution in both categories tends to be relatively equal, clustering around a rough 35/30/35 distribution of (very) unimportant/neutral/(very) important.

A possible interpretation of this finding could be that women are less often prosumers than men. It is possible that the female sample includes very few to none. This would not be surprising, since the women in this sample also tended to be less open towards technological solutions and innovations than the men.

In summary:

- Women have considerably lower levels of conscientiousness in regards to energy consumption/production control and feedback than their male counterparts. Their lack of interest is especially pronounced in the area of production control and feedback. As already seen above, they are also a group with very little openness towards smart energy management tools and technologies. At the same time, they are a group with many 'agreeable' personalities, which makes them a dormant but potentially interesting target group if activated to become prosumers.

By income

Table 8: Conscientiousness: Production/consumption control and feedback by income.

Conscientiousness: Consumption	**How important is it to you to control your electricity consumption and to get real-time feedback onto your smartphone?**	
	30.000 - 40.000 € (n=5)	**more than 40.000 € (n=27)**
Very unimportant	40.0%	14.8%
Unimportant	0.0%	14.8%
Neutral	40.0%	33.3%
Important	20.0%	29.6%
Very important	0.0%	7.4%
Conscientiousness: Production	**How important is it to you to control your electricity production and to get real-time feedback onto your smartphone?**	
	30.000 - 40.000 € (n=5)	**more than 40.000 € (n=27)**
Very unimportant	40.0%	25.9%
Unimportant	20.0%	11.1%
Neutral	20.0%	29.6%
Important	20.0%	25.9%
Very important	0.0%	7.4%

Table 9: Conscientiousness: Production/consumption control and feedback by income

Conscientiousness: Consumption	**How important is it to you to control your electricity consumption and to get real-time feedback onto your smartphone?**	
	30.000 - 40.000 € (n=5)	**more than 40.000 € (n=27)**
Unimportant to very unimportant	40.0%	29.6%
Neutral	40.0%	33.3%
Important to very important	20.0%	37.0%
Conscientiousness: Production	**How important is it to you to control your electricity production and to get real-time feedback onto your smartphone?**	
	30.000 - 40.000 € (n=5)	**more than 40.000 € (n=27)**
Unimportant to very unimportant	60.0%	37.0%
Neutral	20.0%	29.6%

Important to very important	20.0%	33.3%

Table 8and Table 9 show the distribution of conscientiousness in the two income groups in percentages and in aggregated percentages. The highest income earners also portray higher levels of conscientiousness, which is not surprising, since the majority of the over 45 year olds discussed before are also part of this group. Nearly two fifth of the high income earners find it (very) important to control their consumption and receive feedback about it. In regards to production, the proportion remains with one third relatively high. This is not surprising, since it is likely that many respondents in this group are already prosumers, given their stable financial situation. In comparison, only 20% of the respondents living in the lower income households rated it (very) important to have control and feedback regarding their energy production and consumption. This is also fitting, since the respondents in this income group are less financially secure and are also mostly female. Like the gender and age groups, both groups also tend to find consumption control and feedback more important than production control and feedback.

In summary:

- The highest income earners in the sample also have high levels of conscientiousness in regards to energy consumption and production control and feedback. Many of them are most likely already prosumers.
- The lower income earners have a lot lower levels of conscientiousness in regards to energy consumption and production control and feedback, which might also be related to the presence of many women in this group.

2.1.3 *Attitudes*

Having shed a bit of light on the personality traits that characterise the respondents in this sample and also inform their energy-related behaviour, the following section will focus on the specific attitudes[12] that respondents hold towards energy-efficiency, which might influence their interest in and interaction with the SIT4Energy products and services. These attitudes include their general inclination and motivation to save energy, their willingness to learn about efficient energy production and consumption, their actionability or interest to act towards energy efficiency in their homes, and their willingness to share resources by joining a prosumer community. In the following, these central attitudes will be analysed across the defined age, gender and income groups.

2.1.3.1 *Inclination to save energy*

The inclination to save energy has been operationalised as the question: 'What is your general attitude to energy saving?' Figure 19 shows that none of the respondents indicated a (very) negative attitude towards energy saving per se. This is not surprising g given the fact that saving energy is environmentally friendly and therefore a socially desired behaviour. Nonetheless, interesting differences exist between the age groups. It is again the middle aged group of respondents that has the highest percentage of respondents feeling 'neutral' towards saving energy (20%). In the other two age groups, this percentage is only half as high. It is again the oldest and the youngest age groups that show similar distributions and a high to very high inclination to save energy.

Figure 20 shows that the women in the sample are generally more inclined to save energy than the men. None of the women felt 'neutral' towards this question and all of them report a positive to very positive attitude towards energy saving. The answers are more varied in the male sample, but the men have more respondents that indicate a 'very positive' attitude towards energy saving than in the female group: 43% of men compared to 20% of women. This suggests that less men might be inclined to save energy but if they are, they have a higher inclination to do so than most of the women.

[12] For a more detailed theoretical discussion of the concept of ‚attitudes' refer to D1.4.1.

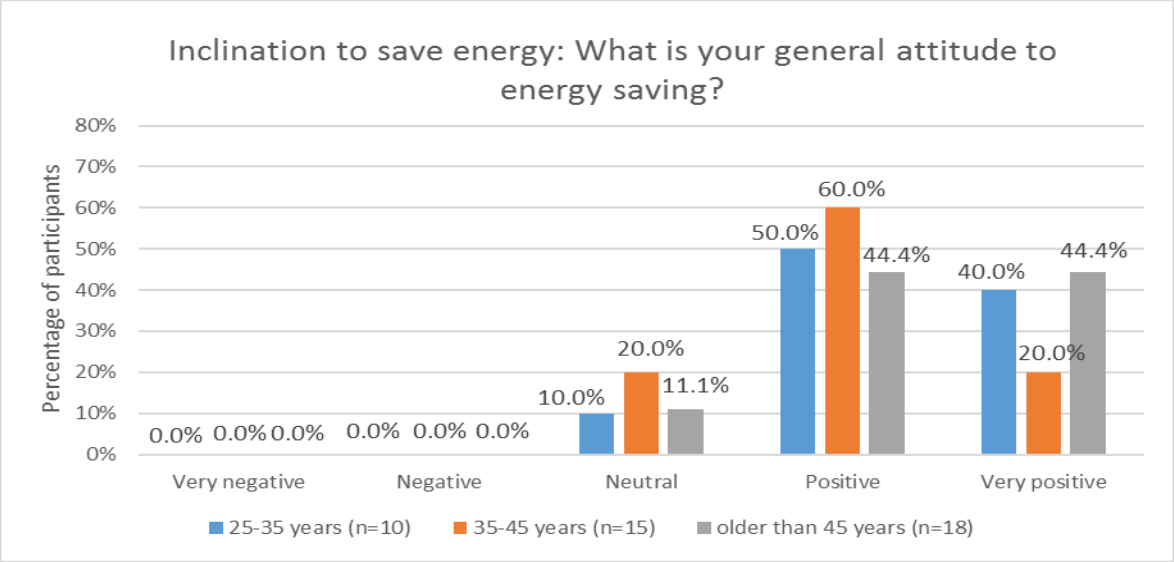


Figure 19: Inclination to save energy by age

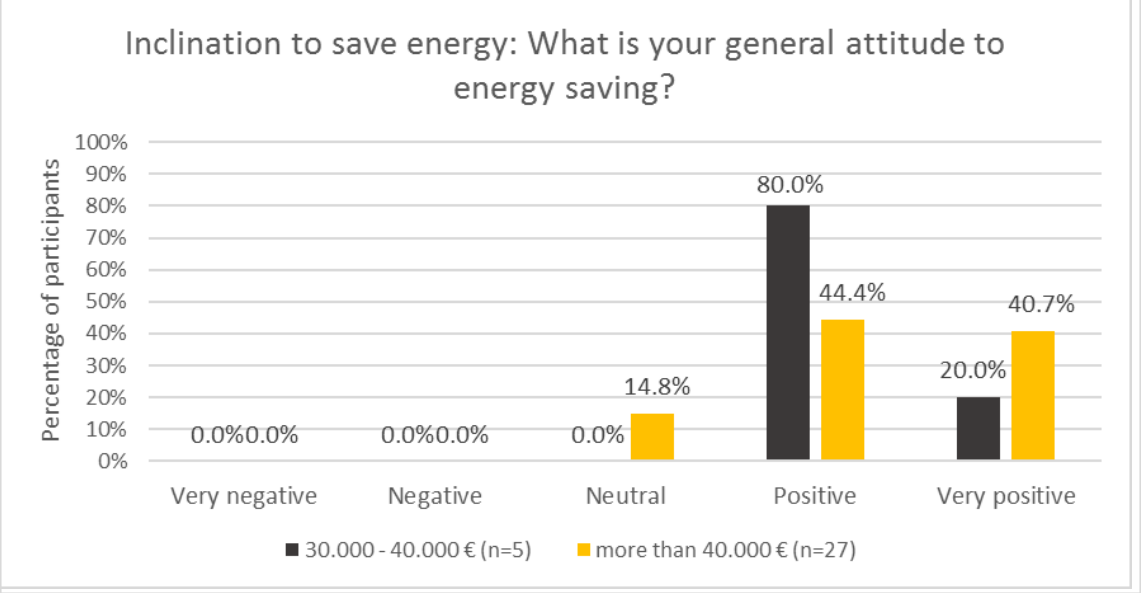


Figure 20: Inclination to save energy by gender.

In summary:

- The inclination to save energy is high across the whole sample. Especially the youngest and the oldest age groups have similar high to very high inclinations to save energy, while the middle aged group is more neutral and less inclined towards it.
- The women in the sample are generally more inclined to save energy than the men. But the men who do feel inclined to save energy have a higher inclination to do so than most of the women.

- Similar to the inclination by gender, it is also the higher income group that has more respondents with a 'very high' inclination to save energy than the lower income group, while the lower income group is more inclined to save energy in general.

2.1.3.2 *Motivation to save energy*

Respondents' motivation to save energy was measured as a multiple-choice question with the possibility to give multiple answers, phrased like this: 'What would motivate you to improve your energy saving behaviour? (Tick as many as are relevant to you)'. Respondents who selected 'other' were prompted to give an open-ended answer in a subsequent question.

By age

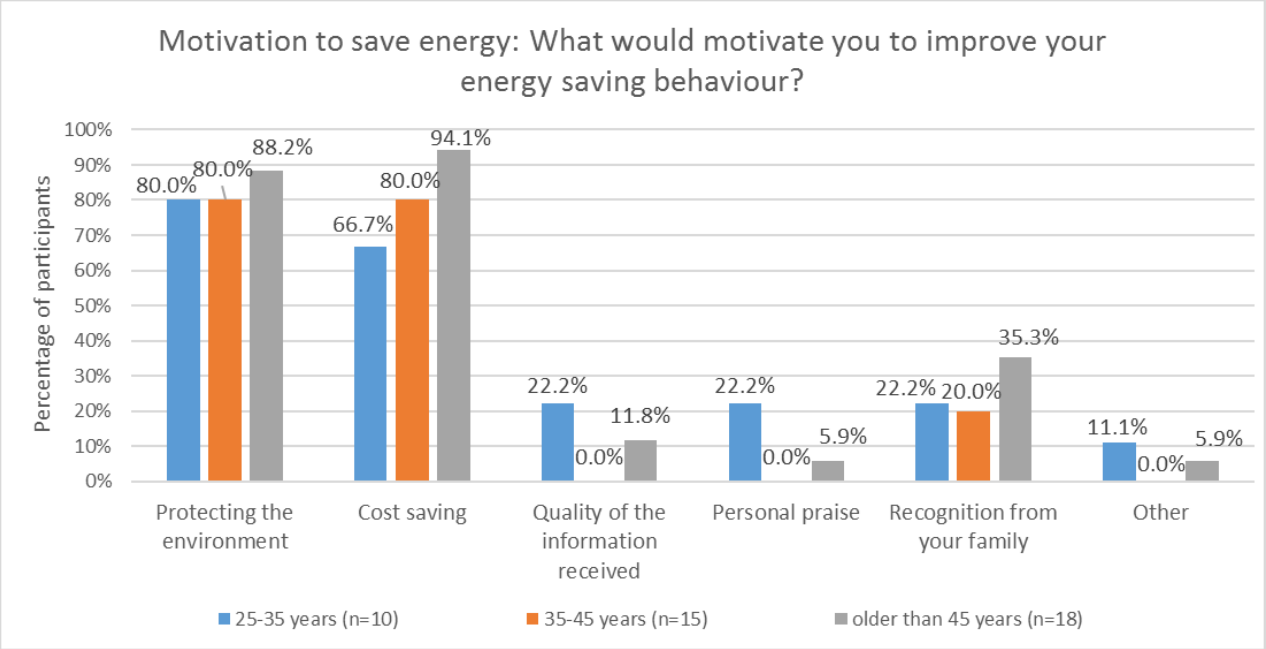


Figure 22. Motivation to save energy by age.

Figure 22 shows that across all age groups, the main two motivators to improve one's energy saving behaviour are the protection of the environment and saving costs. But there are differences as well. The oldest respondents in the sample are also the ones that are the most motivated by cost saving (ca. 95%), while this reason become less relevant in the middle aged (80%) and youngest group (ca. 67%). The oldest age group also finds 'recognition form your family' a lot more important than the other two groups. Over a third of the respondents chose this answer, compared to roughly a fifth of the respondents in the middle aged and younger age groups.

The middle aged group is evenly motivated by financial and environmental concerns alike, and like the oldest respondents, receiving recognition from their family is the third important reason for these respondents to improve their energy saving.

In comparison, the youngest respondents are more often motivated by environmental concerns than by financial reasons. Unlike the other two groups where none or only a few of the respondents chose these options, one fifth also indicated that 'personal praise' and the 'quality of the received information' would be motivators for them to save energy.

This finding is clearly related to the 'value shift' discussed earlier, which is marked by a decline of traditional, collective value-orientations and the move towards an individualised, pluralistic society of free-floating individuals making ego-centric lifestyle-choices. Amongst the youngest respondents, we find a decline of the purely materialistic concerns, which had marked the older generations afflicted by

post-war scarcity and the ensuing 'Miracle on the Rhine'[13] in the mid-1950s. They have been replaced by more post-modern concerns of status (personal praise) and individual preference (quality of information received) but also environmental concerns.

'Innovative thinking', 'competition', 'comparison with others' and 'game' were also named as 'other' reasons in the open-ended answering category.

By gender

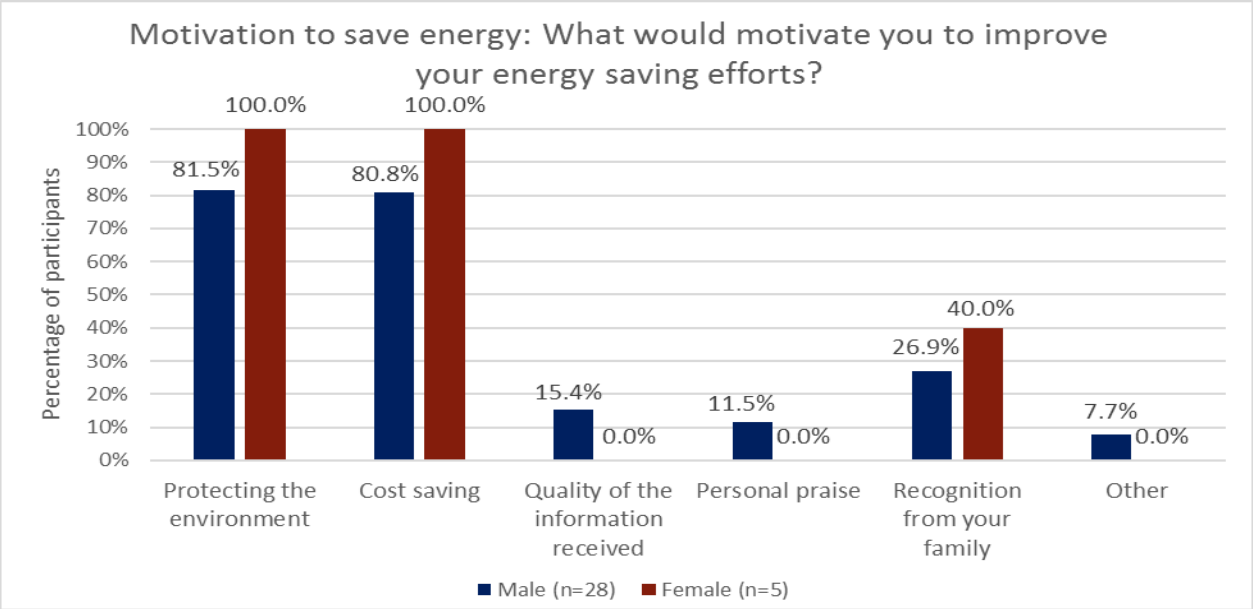


Figure 23. Motivation to save energy by gender.

Figure 23 shows that women are equally motivated by environmental and financial concerns. All women in the sample have selected both answers. For 40% of the women 'recognition from your family' was the third important reason to save energy, compared to 27% of the men. Overall, the men in the sample gave more varied answers than the women. They also found the environment, financial reasons and family recognition the three most important reasons to save energy. For them, the quality of the received information (~15%) and personal praise (~12%) were also important, while none of the women had selected these answers.

The findings show that the women are more often motivated by environmental and financial reasons than the men. They are also more family-oriented than their male counterparts. This makes sense given the fact, that many of them belong to the lower income earners of the sample and many of them have been socialised at times when being a mother and caring for one's family were seen as central aspects of a female identity.

[13] In German, the economic boom after World War II is called ‚Wirtschaftswunder' or ‚economic miracle'.

By income

Figure 24 shows that the lower income earners are all motivated by financial reasons first, followed by environmental concerns. The higher income earners are slightly more often motivated by environmental concerns (~85%) than by financial considerations (~80%). For approximately one quarter of the higher income earners, the third reason is 'recognition from your family' (24%), while the lower income earners feel equally motivated by 'quality of the information received', 'personal praise' and 'recognition from your family' (40% respectively). One fifth also stated that 'other' motivators were important to them. In comparison, only 4% of the higher income earners felt motivated by the 'quality of the information received'. None of them selected 'personal praise' or 'other' reasons. This shows that being more restricted in terms of financial possibilities might make a person not only more aware of the costs of certain behaviours, but also more dependent on other factors to derive meaning and self-esteem from. Since this analysis does not examine the direction of causalities any further, it could also be argued that individuals with family-orientated or individualistic value-orientations are less likely to choose high-paying and (by implication) more demanding jobs than individuals with a more materialistic motivation, who can later afford to worry less about financial cost considerations.

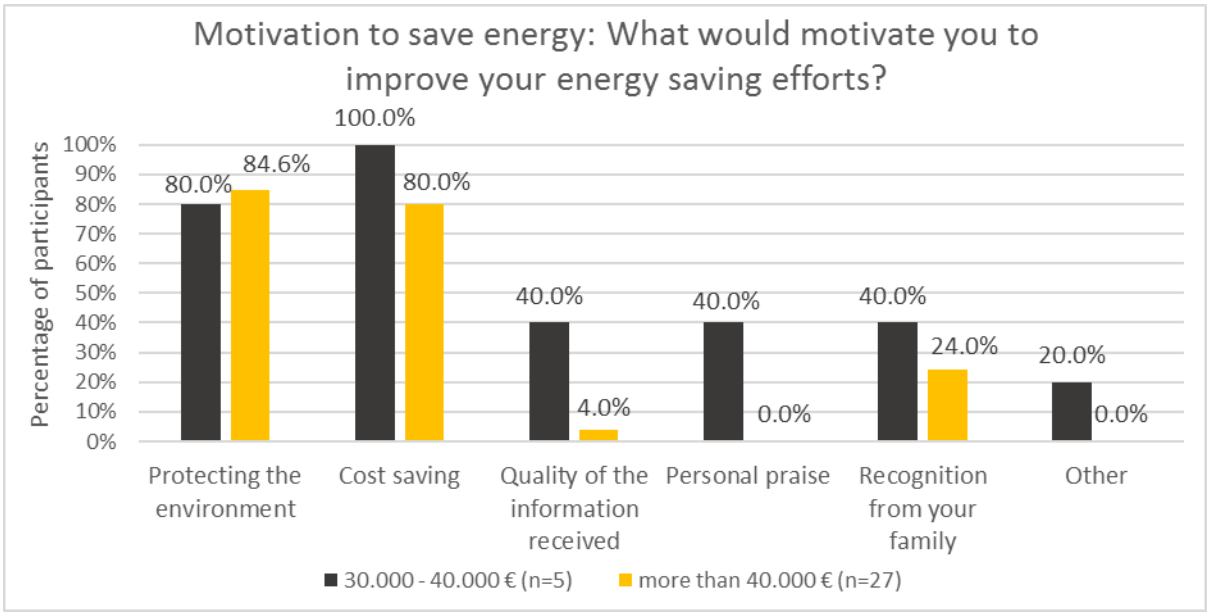


Figure 24. Motivation to save energy by income.

In summary:

- All respondents feel strongly motivated by environmental and financial reasons to save energy, with different emphasis and weighting across the groups. The third reason is most often 'recognition from your family', which emphasises the influence of significant others on individuals' energy behaviour (see D.1.4.1 for further discussion).
- The youngest respondents, males and the lower-income earners are also motivated by 'personal praise' and the 'quality of the received information'.
- The oldest respondents and the low income earners are most often motivated by financial reasons, followed by environmental concerns.
- All women equally valued the environment and cost saving, followed by 'recognition by your family'.

2.1.3.3 *Willingness to learn about saving energy/ efficient energy production*

The questions 'How important is to you to receive tips about efficient energy production?' and 'How important is to you to receive tips about efficient energy consumption?' were formulated to measure respondents' willingness to learn about efficient energy production and about energy saving.

By age

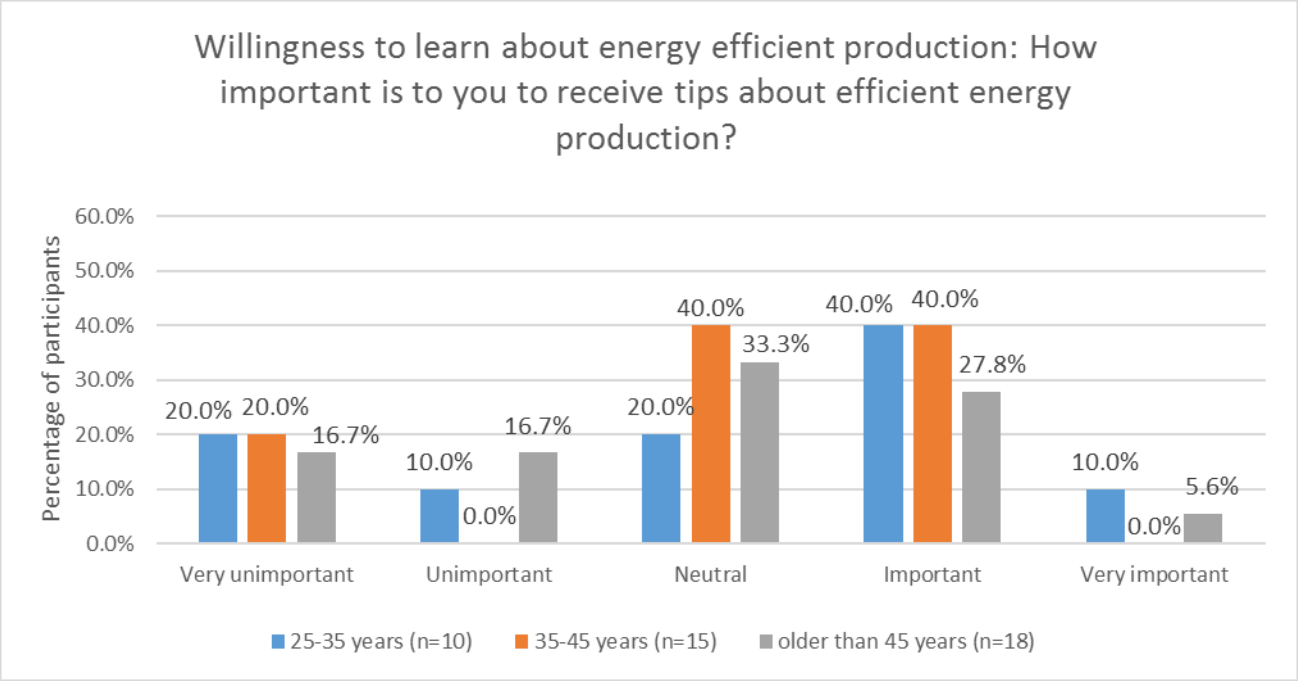


Figure 26: Willingness to learn about energy efficient production by age.

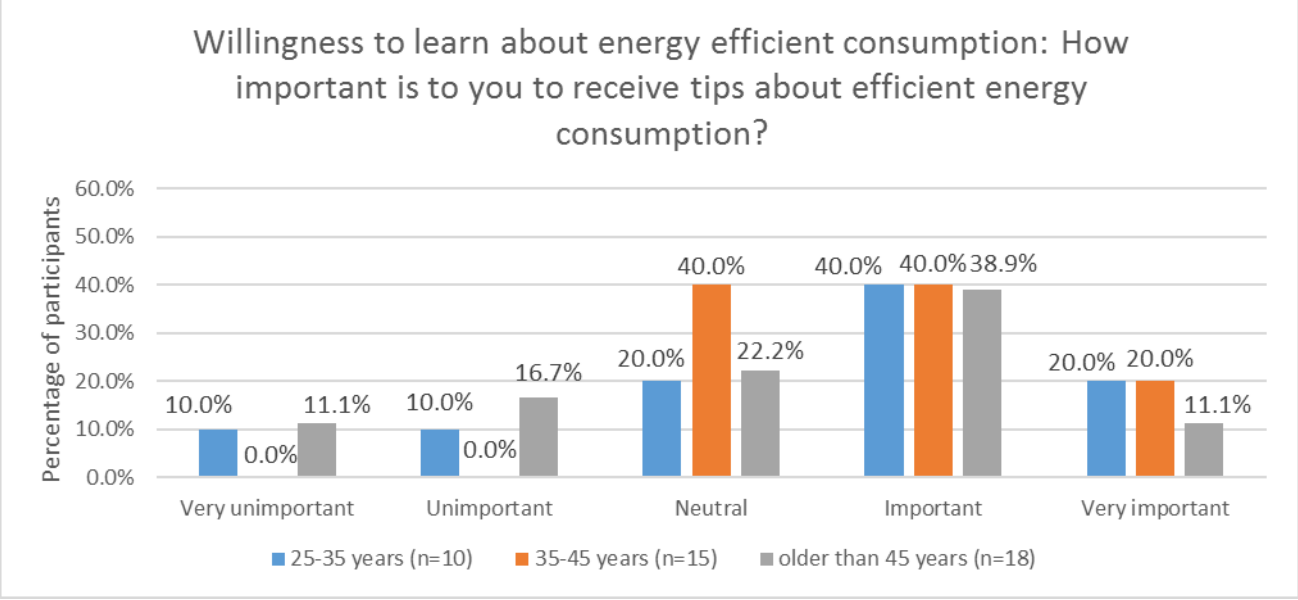


Figure 25: Willingness to learn about energy efficient consumption by age.

Figure 26 shows that it is the youngest age group that is the most willing to learn about energy efficient production, with 50% finding it 'important' to 'very important'. This willingness shows that even though they might not be prosumers yet, some young respondents might wish to become prosumers in the future. It is also possible that the recent public discussion of Germany's energy transition towards

renewable energy sources has ignited an interest in energy efficient production. Or it could simply be the expression of a general interest for technological advances, given this age groups' openness to technology.

The middle aged group is evenly divided into a 20/40/40 distribution of those who find it '(very) unimportant', feel 'neutral' or find it 'important' to learn about energy efficient production. The oldest age group is the least willing to learn about energy efficient production. Their group is split into thirds: one third of respondents find it '(very) unimportant', one third feels 'neutral' and one third finds it '(very) important' to learn about energy efficient production. This shows that the willingness to learn new information or to change one's way of doing things is declining with age. Even though the oldest age group is most likely also the one with most current prosumers and consists of a lot of 'conscientious' personalities, these respondents are not fundamentally interested in learning profoundly new ways of producing their energy. It is more likely that they are more interested in small 'tweaks' rather than big adjustments.

Figure 25 shows that across all age groups, learning about energy efficient consumption is seen as generally more important, which is similar to the previous discussion of 'conscientiousness'. It is again the two younger age groups that have the highest willingness to learn about energy efficient consumption (60% respectively) and the oldest age group, which finds it the least important (27,8%). The middle aged group has the highest percentage of 'neutral' respondents to that question.

By gender

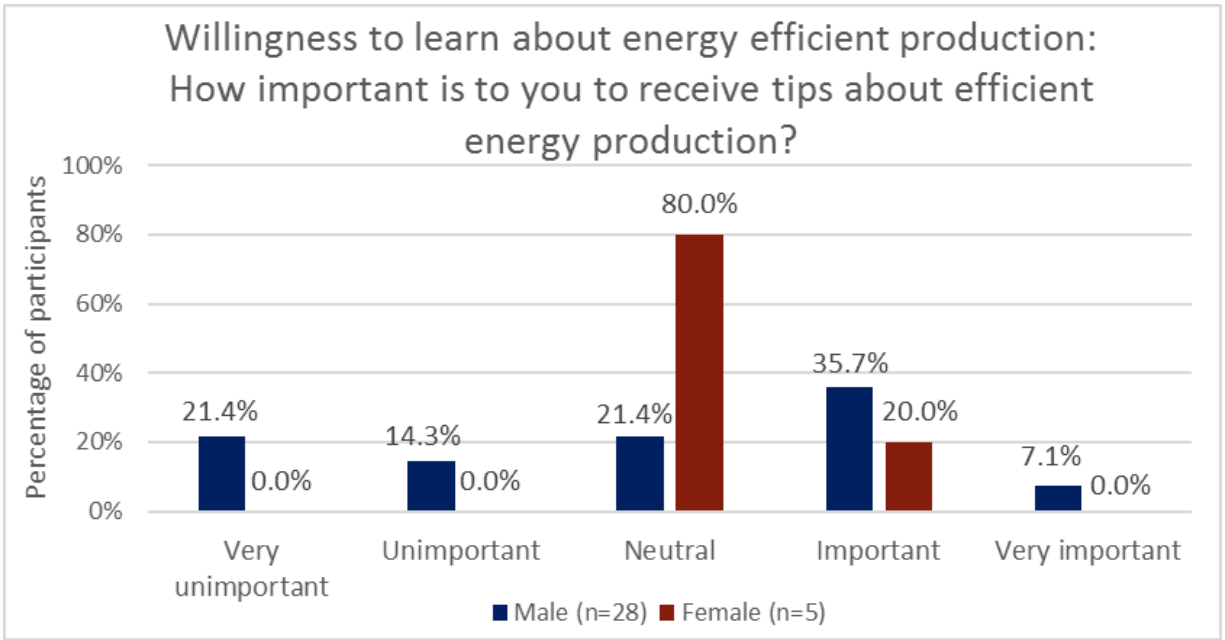


Figure 27. Willingness to learn about energy efficient production by gender.

Figure 27 shows striking gender differences in this question. While most of the women feel 'neutral' about the possibility to learn about energy efficient production and only one fifth finds it 'important', the men give a lot more varied answers to this question. Over two fifth of the male respondents find it '(very) important', roughly a fifth feel 'neutral' towards it and little more than a third find it '(very) unimportant'. This ties in with earlier findings about women showing less interest in and openness towards technological solutions, which makes them also less likely to be prosumers. They are less overt about their disinterest than the men.

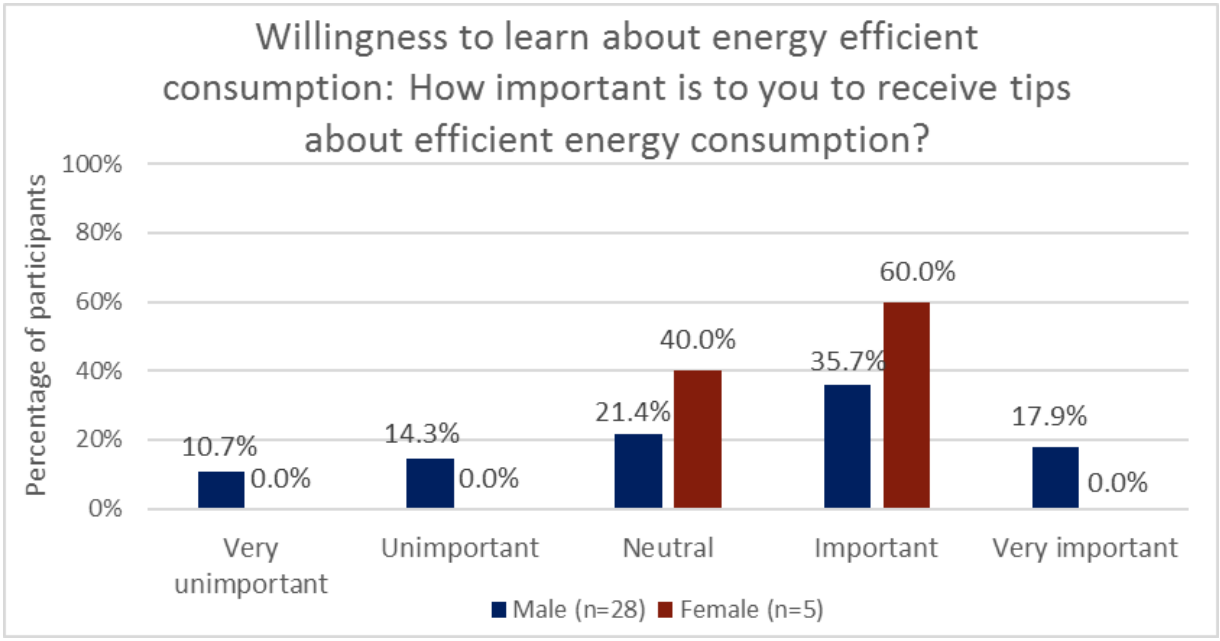


Figure 28. Willingness to learn about energy efficient consumption by gender

Figure 28 shows that the majority of the women (60%) are willing to learn about energy efficient consumption, compared to 53,4% of the men, but they are less strongly motivated to do so. 17,9% of the men find learning about energy efficient consumption 'very important', while none of the women ascribed such high levels of importance. Overall, the men gave more varied answers than the women, who either found it 'important' or gave a 'neutral' answer to the question.

By income

Figure 29 shows that it is mostly the well-earning respondents who are interested in learning about energy efficient production, which makes sense, since we have already established that they are also the most likely respondents in the sample to be prosumers.

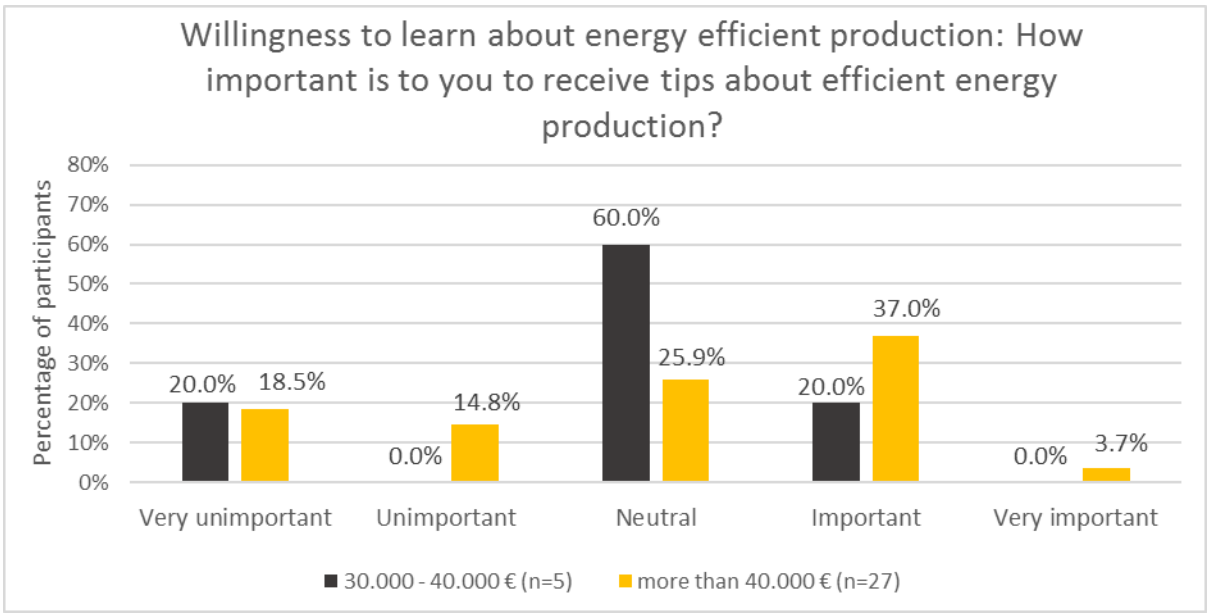


Figure 29. Willingness to learn about energy efficient production by income.

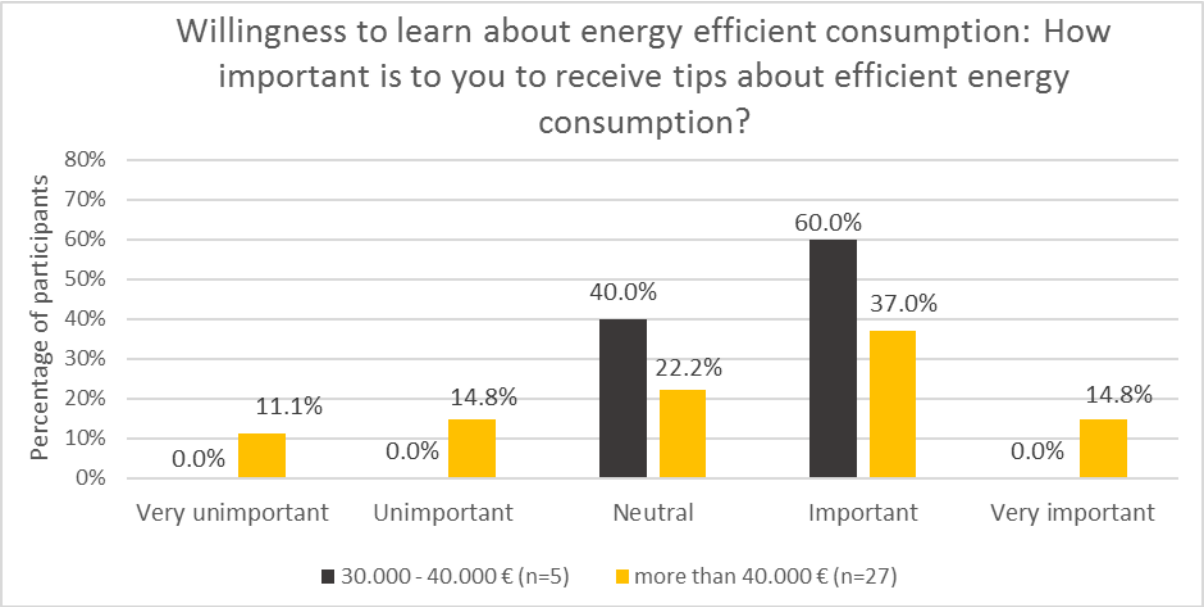


Figure 30. Willingness to learn about energy efficient consumption by income.

Figure 30 highlights the fact that learning about energy efficient consumption is of more interest to all respondents, regardless of their status as prosumers. This is logical, since the respondents with lower incomes have an interest in keeping energy bills low as well.

In summary:

- All respondents in the sample are generally more interested in learning about energy-efficient consumption than production, since not all of the them are currently prosumers, but consumers of energy.
- When looking at willingness to learn about energy efficient production and consumption by age, it is the youngest and middle aged groups that are the most willing to learn about it, even though they might not be prosumers yet. This shows that willingness to learn decreases with age and it can also be interpreted as a wish of the younger respondents to become prosumers later on.
- Women are generally more willing to learn about energy-efficient consumption than about energy-efficient production, which ties in with their lower incomes and openness towards technology in general, making them less likely to be prosumers.
- High-income earners are more interested in learning about energy efficient production, which makes sense, since they are most likely to also be prosumers. Lower income earners have a stronger interest in keeping energy bills low, which makes them more motivated to learn about energy-efficient consumption behaviours.

2.1.3.4 *Actionability*

In the questionnaire 'actionability' or the importance one ascribes to one's ability to act has been measured as the degree to which respondents agreed with the following statement: 'Being able to perform actions that improve my building's impact on the environment is important to me.'

Figure 31 shows that the differences between the youngest and oldest age groups on the one side and the middle aged group on the other continue to persist. While roughly one fifth of the respondents in each group either agreed 'fully' with this statement or felt 'neutral' towards it, considerable differences exist in the percentages concerning the answer category 'agree' and 'fully disagree'. While roughly 60% of the youngest and oldest respondents agreed to the statement, only 20% of the middle aged respondents did. At the same time 40% of the middle aged respondents indicated that they 'fully

disagreed' with the statement, making them the respondents with the most negative stance towards actionability in the sample.

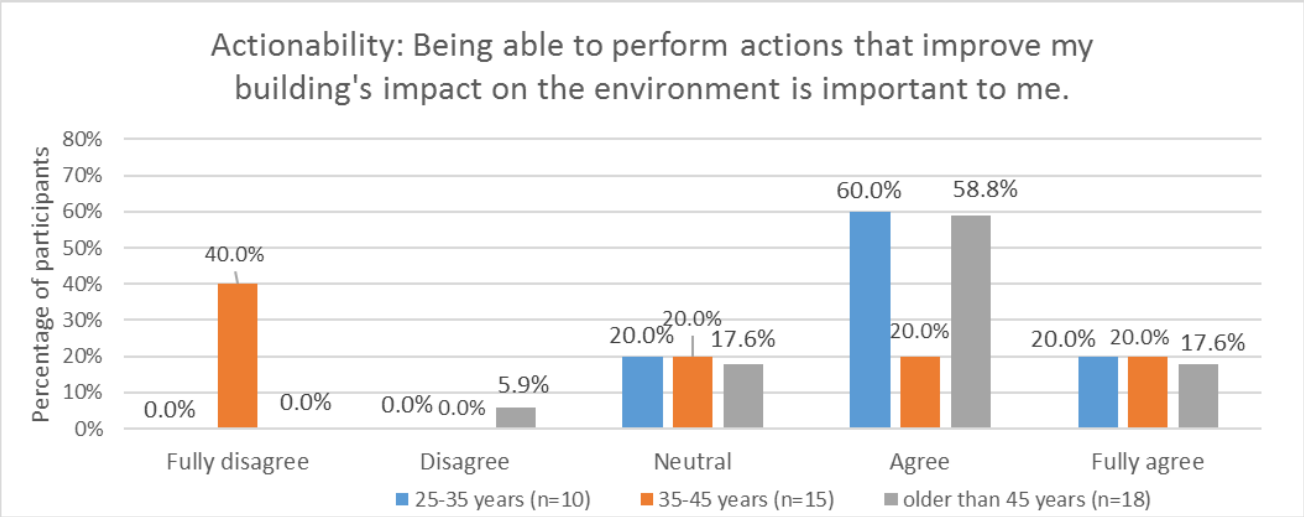


Figure 31. Actionability by age.

It is again the youngest age group, which shows the most actionability, closely followed by the oldest respondents. This could either be interpreted as a wish expressed by the young respondents to become prosumers later on or as the 'can do' attitude expressed by the older respondents who are capable to undertake and finance energy efficient measures to improve their homes.

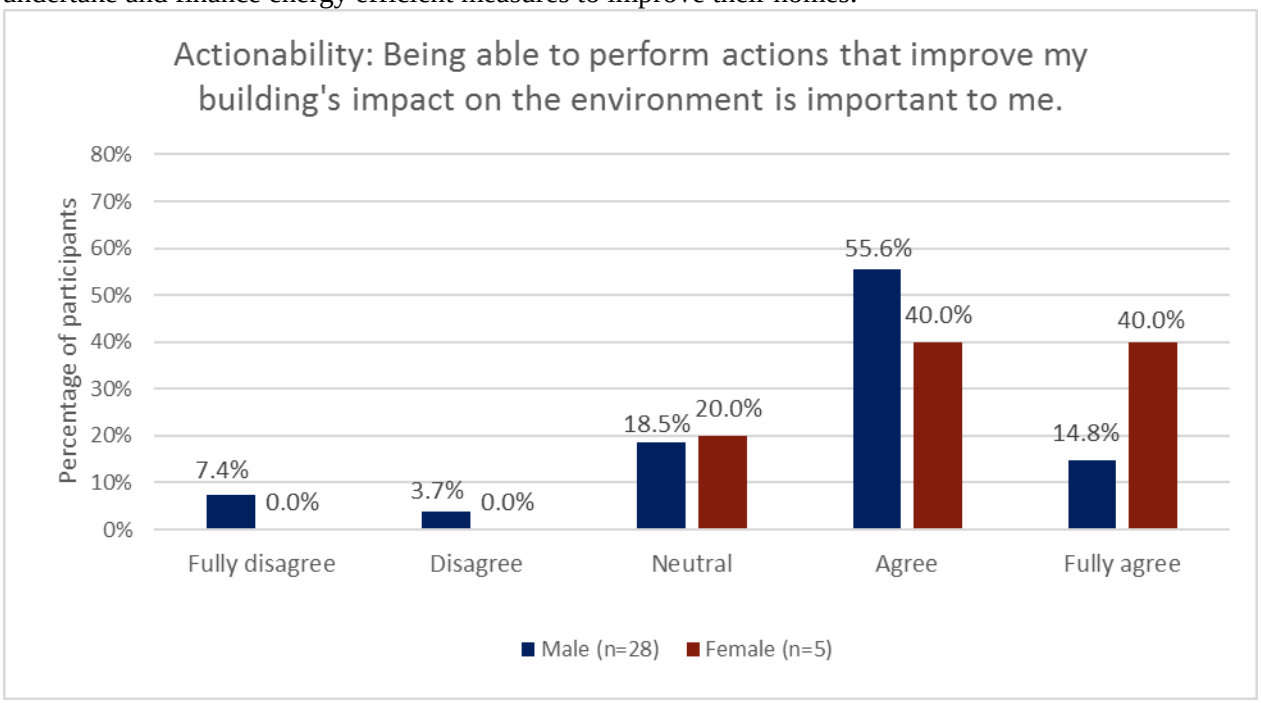


Figure 32. Actionability by gender

Figure 32 shows that the women feel more strongly drawn to take energy efficient action than the men. This ties in with findings from the literature, which suggest that women feel more emotionally touched by looming climate change and its adverse consequences than men. This makes them also more willing to change their personal behaviours in order to avoid it (see D.1.4.1 for further discussion). This finding also suggests that many women would like to become prosumers, even though their less favourable socio-economic circumstances might prevent them from realising this wish.

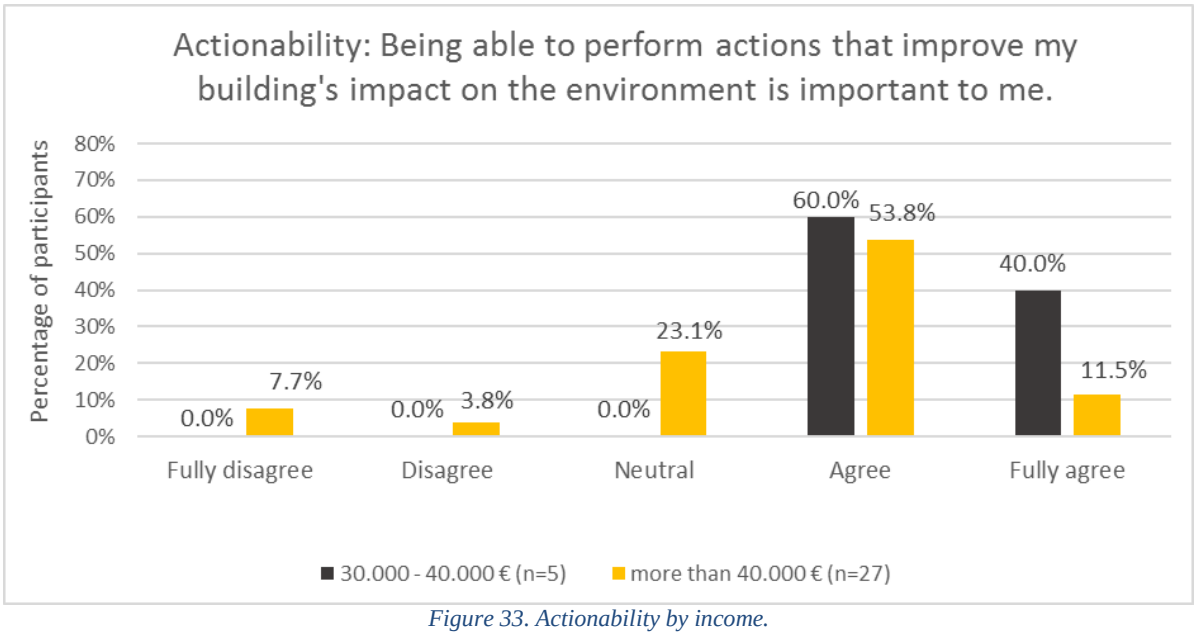


Figure 33. Actionability by income.

Figure 33 shows that it is the respondents from the lower income group that feel strongly compelled to act to improve the energy efficiency of their building. Like with the women in Figure 32 this might be an expression of a wish to become a prosumer. It could also be seen as a wish to keep energy bills low. The respondents in the higher income group have given more varied responses, including neutral and negative ones. This could be due to the fact that some of them might have already undertaken energy efficient measures to improve their building and do not see a need to do more.

In summary:

- Women, the youngest and oldest respondents and the lower income earners are the respondents with the highest levels of actionability. This might either be attributed to the wish to become a prosumer expressed by those who are currently not in the socio-economic situation to execute this wish or seen as the general 'can do' attitude expressed by those who have the financial means and/or technical skills to actively improve their buildings' energy efficiency.
- The middle aged group continues to emerge as the group, which tends to have some of the least developed attitudes towards energy efficiency, including their inclination to save energy, their willingness to learn about energy efficient production and their actionability. In all these categories, they tended to show less enthusiasm than the youngest and oldest age groups.

2.1.3.5 *Willingness to share resources*

This attitude refers to the respondents' interest to join an organised community of prosumers in order to share their resources. The idea of prosumer groups has come out of the discussion of how a new smart grid, consisting of utilities, consumers and prosumers, could be organised in order to achieve net efficiency and maintain the security of the energy supply. Prosumer community groups are conceptualised as 'goal-oriented prosumer community clusters, with relatively similar energy behaviors located in the same geographical area, to allow efficient energy sharing among local members.' (Parag & Sovacool, 2016, p. 10). They could potentially be key elements in the creation of a smart grid.

In order to ascertain their 'willingness to share resources' the respondents were asked the following question: 'Are you interested to be part of a community of prosumers and share resources?'[14].

[14] Due to a problem with the initial scale, the answers had to be re-coded by combining the answering categories ‚interested' and ‚very interested' to the single answering option ‚interested' in order to achieve a balanced scale for this question.

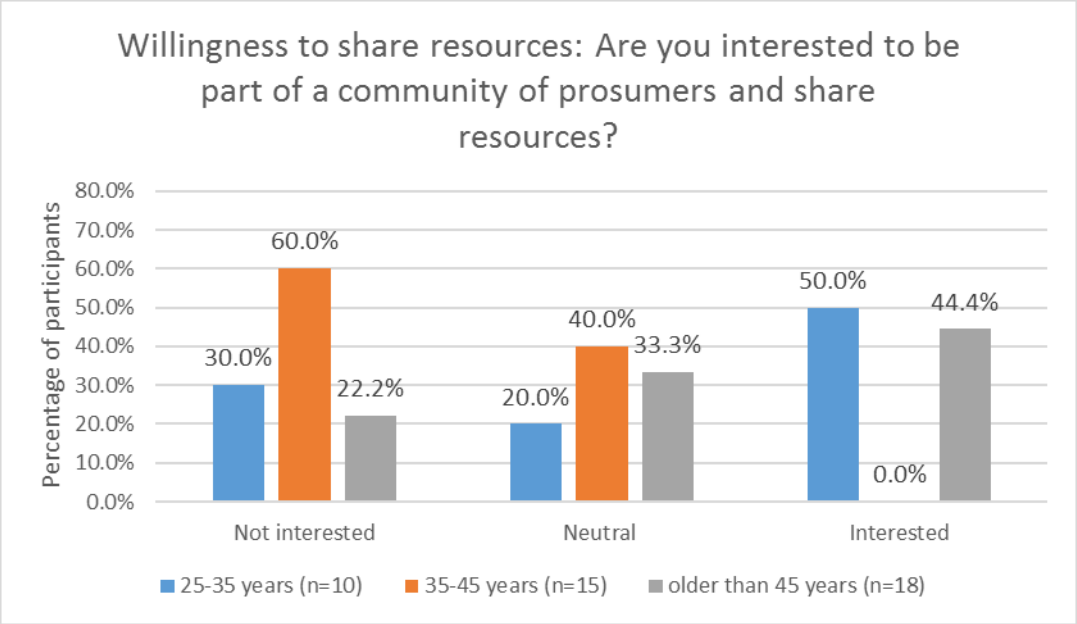


Figure 34. Willingness to share resources by age.

Figure 34 shows that only respondents of the youngest and oldest age groups are interested to join a prosumer community in order to share resources, while the majority of the middle aged respondents is not interested and the others feel 'neutral' about this possibility.

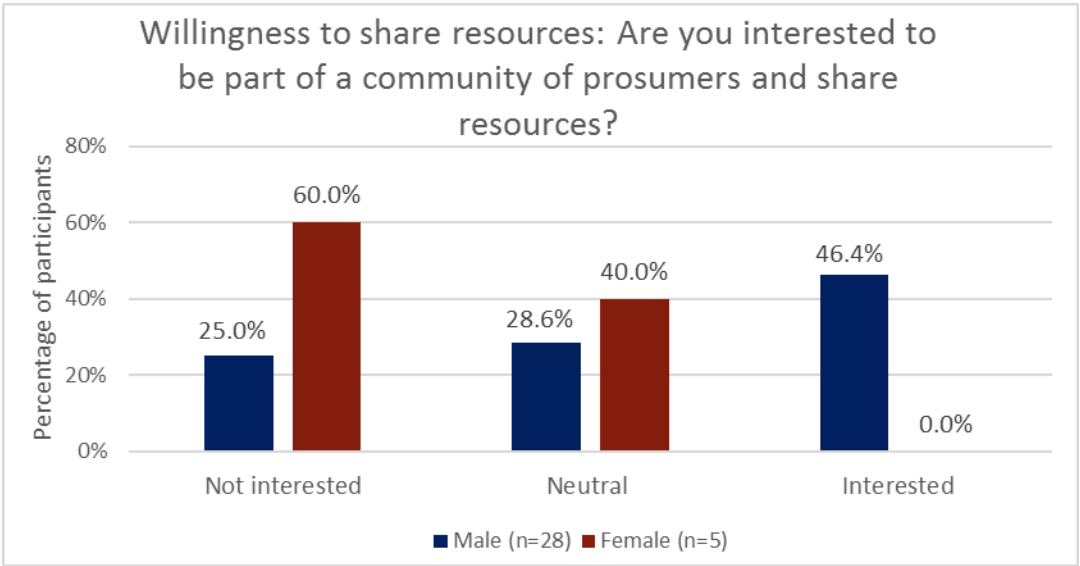


Figure 35. Willingness to share resources by gender.

Figure 35 shows that it is only the male respondents in this sample who are willing to join community groups, while the majority of the women is not interested and the others feel 'neutral' about this possibility.

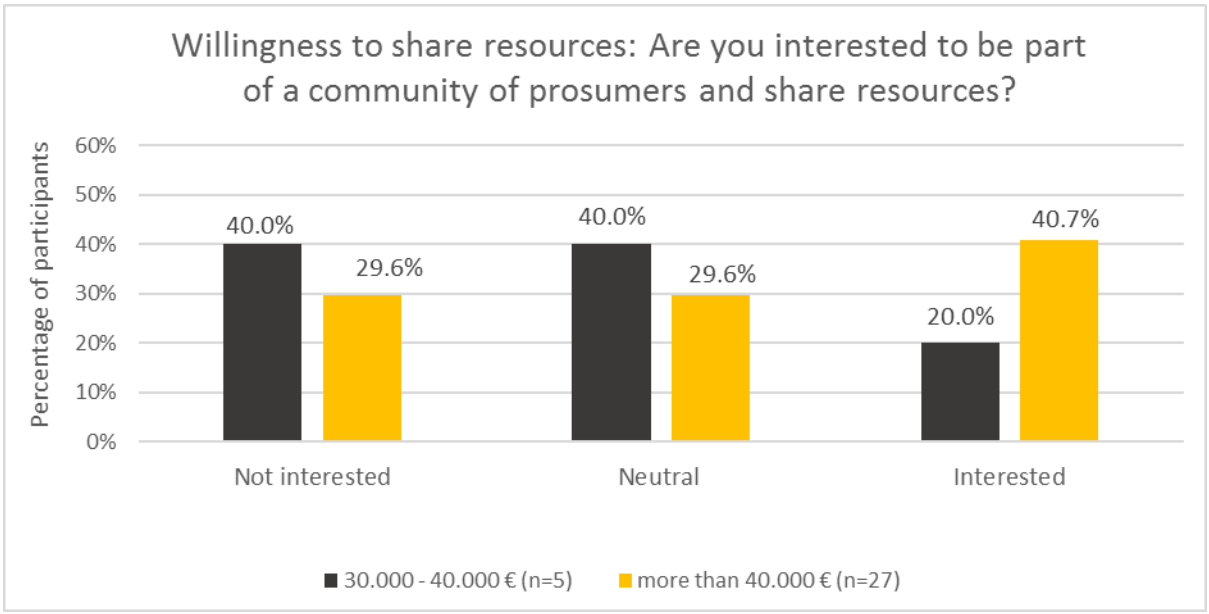


Figure 36. Willingness to share resources by income.

Figure 36 shows that it is mostly the high income earners in the sample who are interested to join a prosumer community. 41% indicated they would be interested, compared to only 20% of the lower income earners.

In summary:

- Only male respondents indicated an interest to join a prosumer community in order to share resources. None of the women in the sample expressed such an interest.
- It is mainly the youngest and the oldest respondents who are willing to join a prosumer community and share resources. None of the middle aged respondents in the sample were interested to do so.
- It is mainly the higher income earners who are interested in becoming a member of a prosumer community and share resources. Only 20% of the respondents in the lower income groups expressed an interest in this possibility.

2.2 Classification of Greek End-user types

In the following section, the survey results received from Greek end-users will be analysed. Not all questions used in the survey will be analysed here, but only the ones relating to socio-demographic factors, personality traits and attitudes factors. Furthermore, several questions of the survey providing insights into recommendations and their respective micro-moments, relevant to WP3 "Questions (15[15], 18[16], 19[17], 20[18], 21[19], 30[20], 31[21])" are excluded from this document and will be discussed in later WP3 deliverables. Finally, the questions 25[22] and 24[23] will also be excluded from this document as they

[15] What kind of tips would you be interested to receive?
[16] When would you like to receive notifications on your smartphone with tips for optimizing your energy use at your household?
[17] When would you like to receive notifications on your smartphone with tips for optimizing your energy use at your workspace? (Please go to the next question, if you are a student)
[18] How often would you like to receive notifications on your smartphone with tips for optimizing your energy use at your household?
[19] How often would you like to receive notifications on your smartphone with tips for optimizing your energy use at your workspace? (Please go to the next question, if you are a student)?
[20] Are you happy with your thermal comfort at your living space?
21 Are you happy with your thermal comfort at your working space? (Please go to the next question, if you are a student)?
[22] What kind of energy management services would you like to buy (Please, tick as many as you would like)?

have already been discussed in Deliverable *D.1.4.1. Analysis of factors influencing consumer choices* (Allemand, Akarmazyan, Chouliara, & Schneider, 2019).

2.2.1 *Socio-demographic factors*

A general overview of the socio-demographic characteristics of the obtained sample has already been reported in *D.1.1. Market Research Survey Tool* (Akarmazyan & Bravos, 2018). As a summary, a shortened version of the table will be repeated here:

Table 10: overview of the socio-demographic characteristics.

Socio-demographic variables	Percent (%)
Gender	
Male	58.1
Female	41.9
Age	
18-25	12.9
25-35	48.4
35-45	32.3
Over 45	6.5
Highest degree of education?	
Bachelor	25.8
Master	48.4
Doctorate	25.8
Occupation in university	
Researcher	46.7
Faculty member	6.7
Professor	3.3
Administrative employee	13.3
Student	20
Other	9.9
Household average yearly income is	
Under 20K	51.6
20K-30K	32.3
30K-40K	16.1
Over 40K	-

Around 58% and 42% of the respondents in the sample are male and female respectively, around 48% of the respondents are between 25-35 years old. Only 6.5% of respondents are older than 45 years of age. Around one third of the respondents are between 35-45 years old. Thus, the survey is a relatively male-dominated sample reflecting people in their early and a middle age. As the survey is filled out by academy representative therefore all respondents have university degree (around half of the respondents have a master's degree, one fourth hold doctorate degree and the other forth has bachelor degree). Around the half of the respondents are researchers; 20% of respondents are students. More than half of the respondents in households with incomes lower than 20.000€ a year. Overall, it could be stated that this sample reflects mainly members of the Greek low/middle classes. Given these particular characteristics of the sample, and also taking into account, the small sample size of n=31(posing some restrictions for the analysis) the following three socio-demographic variables have been chosen as key features to base the further analysis on:

- Age: divided into the age groups '18 - 25 years old', '25 - 35 years old' 35-45 years old and those 'older than 45 years'
- Gender: divided into 'male' and 'female' respondents

[23] How important is for you to pay for efficient energy management services and thus automatically minimize your energy consumption?

- Income[24] divided into three income groups: those living in households earning less than 20.000€ per year', '20.000 - 30.000€ per year' and respondents living in households earning '30.000- 40.000€ per year'.

Age, gender and income are commonly used variables of analysis that help describe groups of populations in more detail. In market research, they are often used as indicators for the definition of different target groups. In this analysis, they will be used as dividers across the sample in order to get a clearer image of the characteristics of SIT4Energy academic end-users.

2.2.1.1 *Socio-demographics by age*

The socio-demographic variables broken down by age, the following picture appears

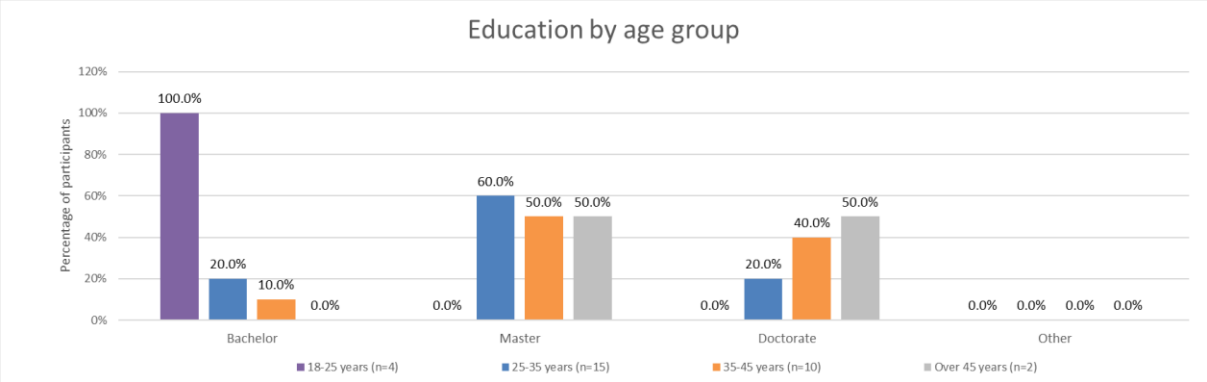


Figure 37. Education by age group.

The sample shows that all of the younger people (18-25 years old) have only Bachelor degree of education. The distribution is evenly spread across the Master's and Doctorate levels of education for the 25-35 and 35-45 year olds, while exactly one half of those over 45 years of age have Master's and another half Doctorate degree of educations.

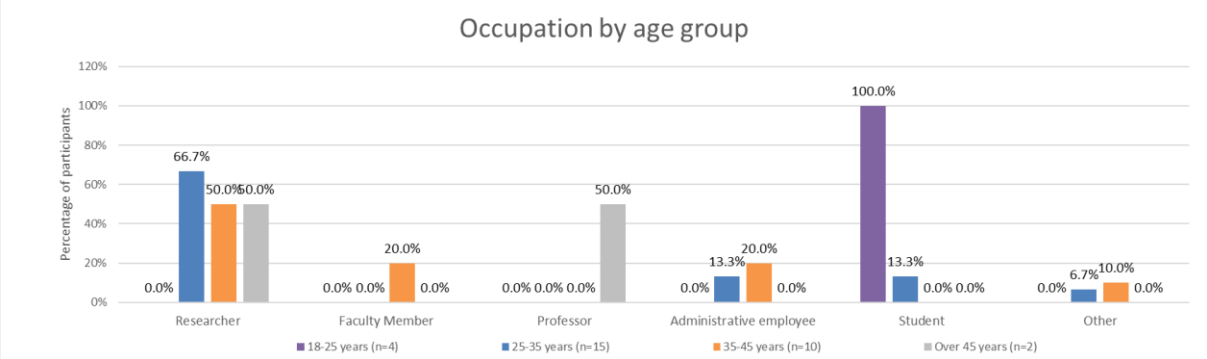


Figure 38. Occupation by age group

As shown in 100% of the young people (18-25 years old) in the sample are students, while 50% of people with an age over than 45 year olds are professors. In the middle-aged group of the 35-45 years old, 50% are researchers, 20% faculty members and 20% are administrative employees in the university, suggesting again rather stable career choices. Finally, more than 65% of 25-35 years old respondents are researchers in the university.

[24] Given the relatively small sample size, the sub-samples in the education category were too small to use for a meaningful analys. For this reason, income was chosen instead.

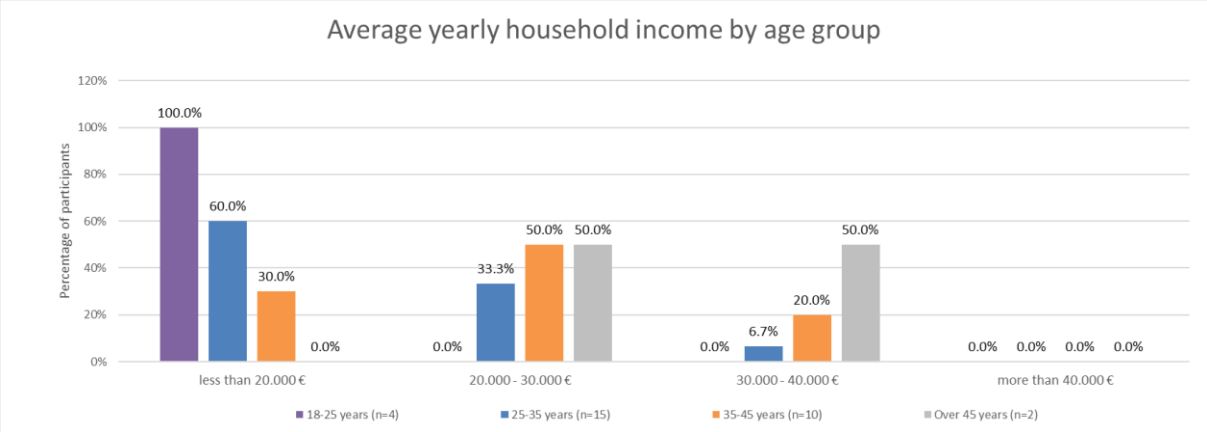


Figure 39. Average yearly household income by age group.

Figure 39 shows that the greatest educated respondents over 45 years old, with master's and doctorate degrees of education, have either 20.000 - 30.000 € or 30.000 - 40.000 € yearly household incomes. While the youngest respondents with only bachelor's degree of education have less than 20.000 € income.

2.2.1.2 *Socio-demographics by gender*

This variable, will further improve the developing picture of the SIT4Energy target users:

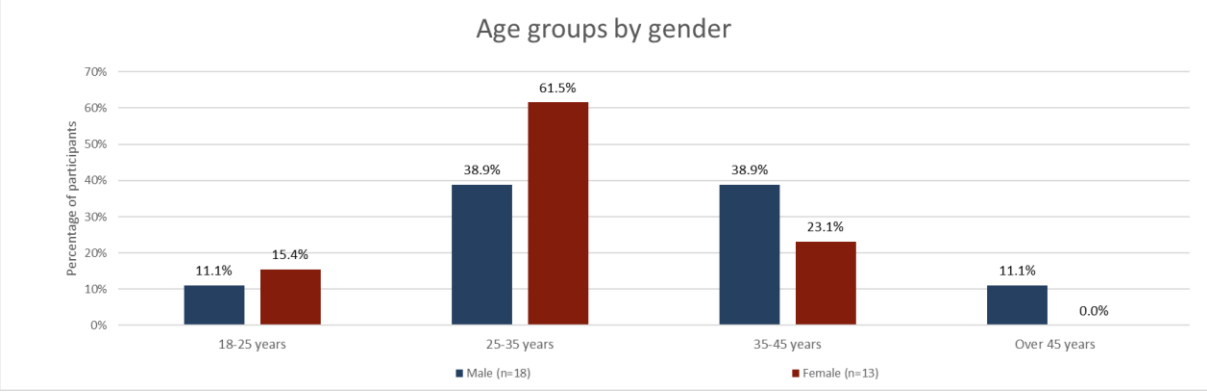


Figure 40. Age groups by gender.

Figure 40 shows that the female respondents tend to be slightly younger than the male respondents, especially for the 35 - 45 and over 45 age groups (in fact there is no any female respondent over 45 years old). The relatively similar gender distribution observed for the 18-25 years old respondents.

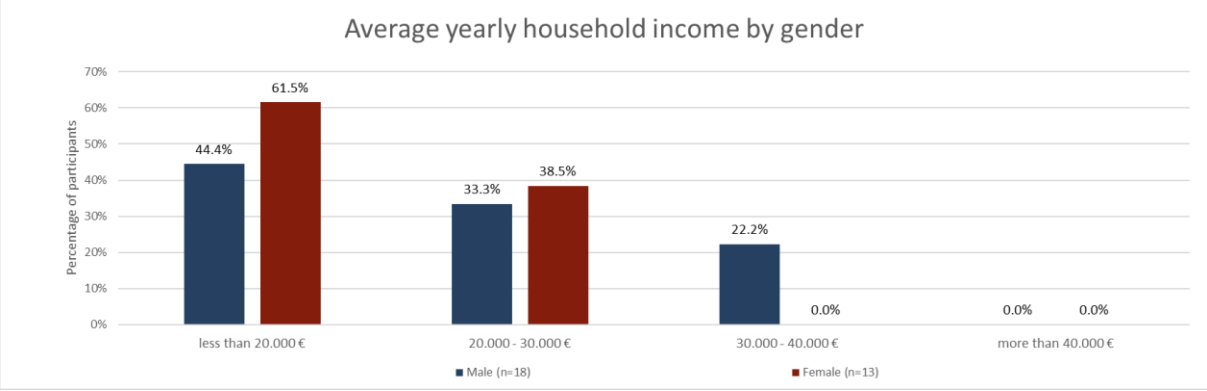


Figure 41. Average household income by year by gender.

Figure 41 indicates that none of the respondents have more than 40.000 € yearly income, furthermore only 22.2% and only male respondents have 30.000-40.000 €, confirming the fact that in academy women between the same ages still tend to earn less than men.
By summarising, we can refine our user groups as follows:

- The youngest age group people (mainly the student respondents) have only bachelor's degree of education and have the lowest yearly income.
- The oldest age group people possess the highest formally educational degree with the highest degree of occupation in university with the highest yearly incomes, who are predominantly male.
- None of the respondents have more than 40.000 € yearly income and the highest income earners in this sample are predominantly male (22%) the half of which belonging to the group over 45 years old.

2.2.2 *Personality traits*

This section will address the interaction of previously described variables with the sampled energy-related personality traits. As discussed earlier two main factors Openness and agreeableness will be analysed across the identified age, gender and income groups mentioned above.

2.2.2.1 *Openness by age*

Figure 42 shows the awareness of smart energy services as a function of the respondents' age. It can be seen that the older age groups are generally more aware of smart energy services, with the oldest age group also being 100 % aware and the youngest age group being not aware at all of energy management services. Almost half respondents belonging in the 25-35 year olds group and more than half of the respondents belonging in the 35-34 year olds group answered positively to this question.

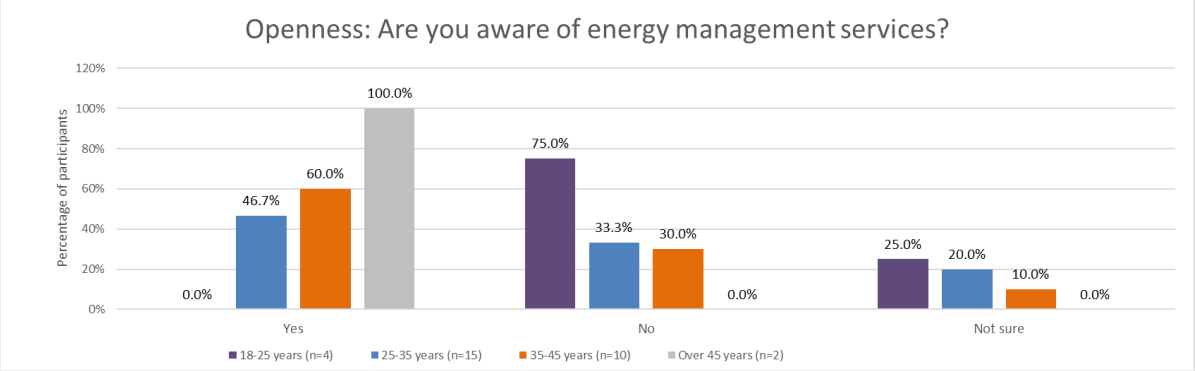


Figure 42. Awareness of smart energy services by age.

Almost no usage of smart energy consumption services both at household and workspace was observed amongst the all analysed aging groups (Figure 43 and Figure 44).

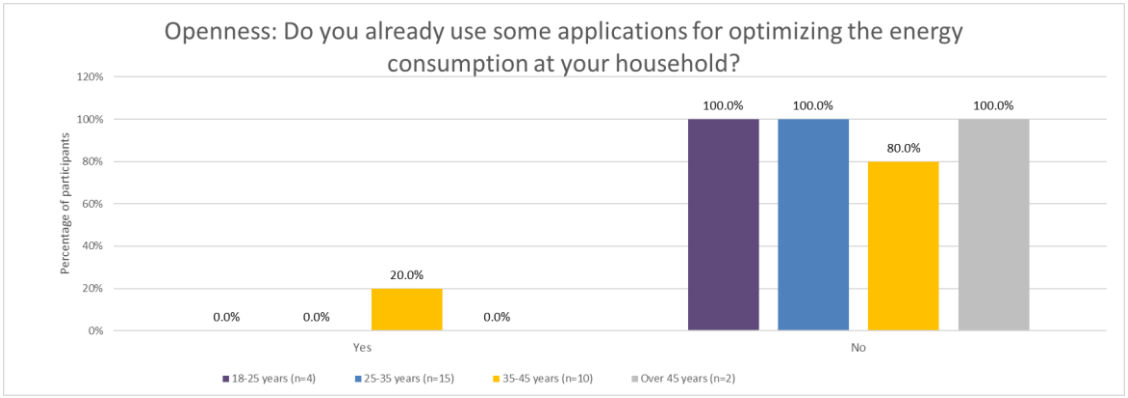


Figure 43. Use of smart energy services for optimization of energy consumption at household by age.

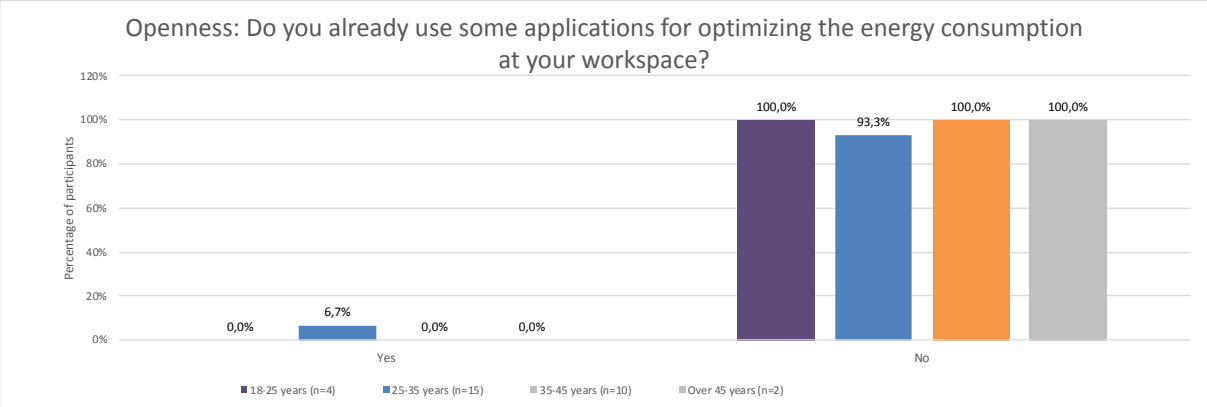


Figure 44. Use of smart energy services for optimization of energy consumption at workspace by age

2.2.2.2 *Openness by gender*

Figure 45 shows the awareness of smart energy services as a function of respondents' gender. Very small differences exist between male and female respondents in respect to their awareness of smart energy services, with the male respondents being a bit more aware (55.6%) than that of in female respondents (38.5%).

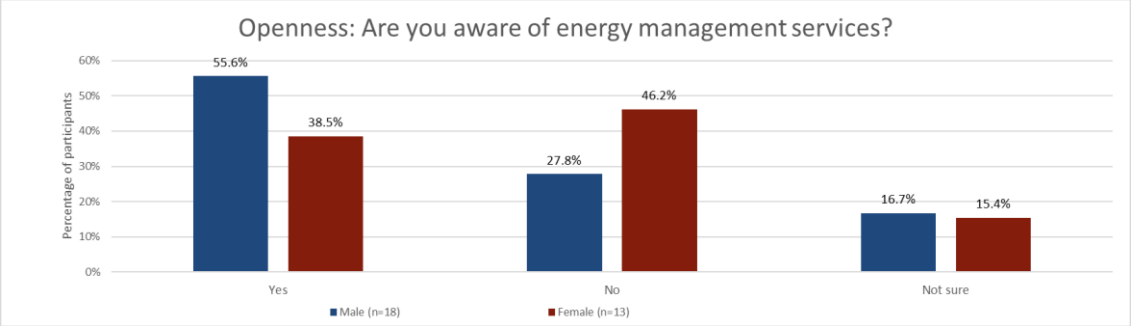


Figure 45. Awareness of smart energy services by gender.

Figure 46 and Figure 47 show the usage of the smart energy application at household and workspace as a function of respondents' gender. Again, as observed also in Figure 43 and Figure 44 almost no usage of smart energy consumption services observed both at household and workspace for two genders. However, given the very small amount of the answers in this sample, the interpretation of these findings should be done with attention.

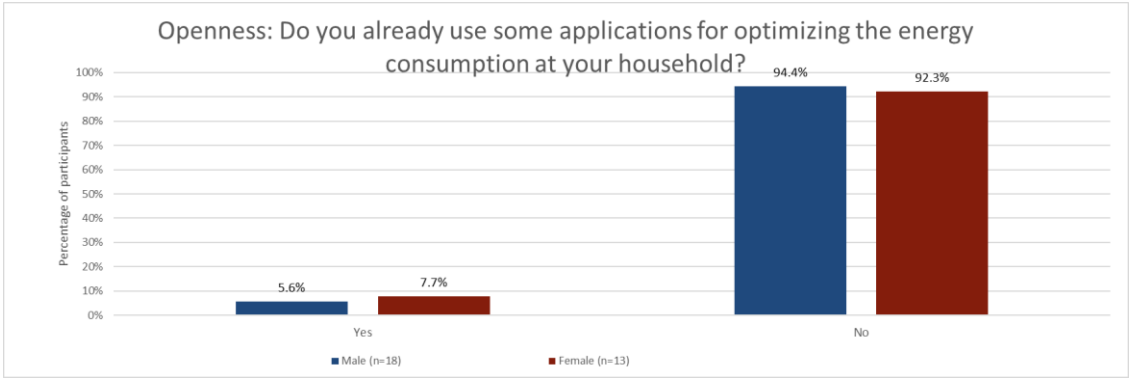


Figure 46. Use of smart energy services for optimization of energy consumption at household by gender.

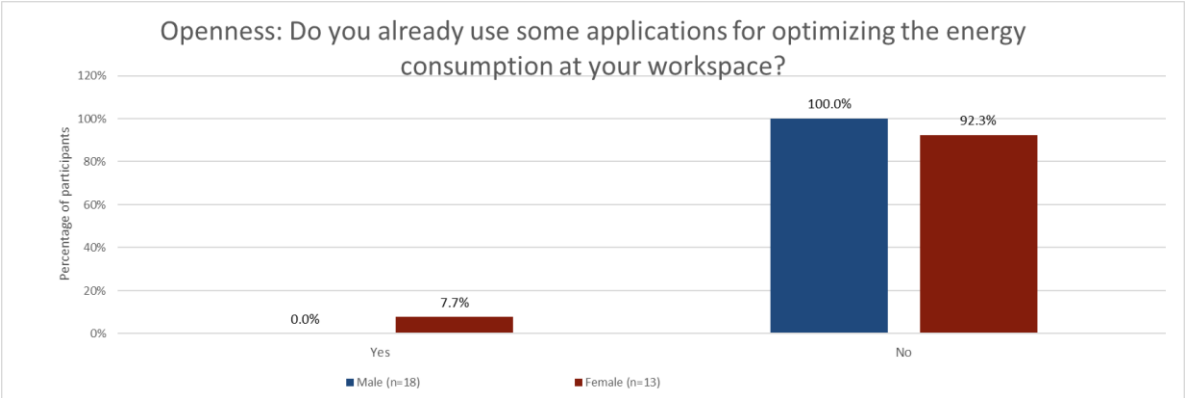


Figure 47. Use of smart energy services for optimization of energy consumption at workspace by gender.

2.2.2.3 *Openness by income*

Figure 48 shows that it is largely the well-earning respondents in the sample who are also aware of smart energy services. Figure 49 and Figure 50 show that it is also only the highest-earning income group, which is currently using such services. In particular, the 25% of respondents, having 30.000-40.000€ yearly income, are using smart energy services for optimization of their households' energy consumptions. The application of smart energy services at workspace is again very low (only 9.1% answered positively to this question).

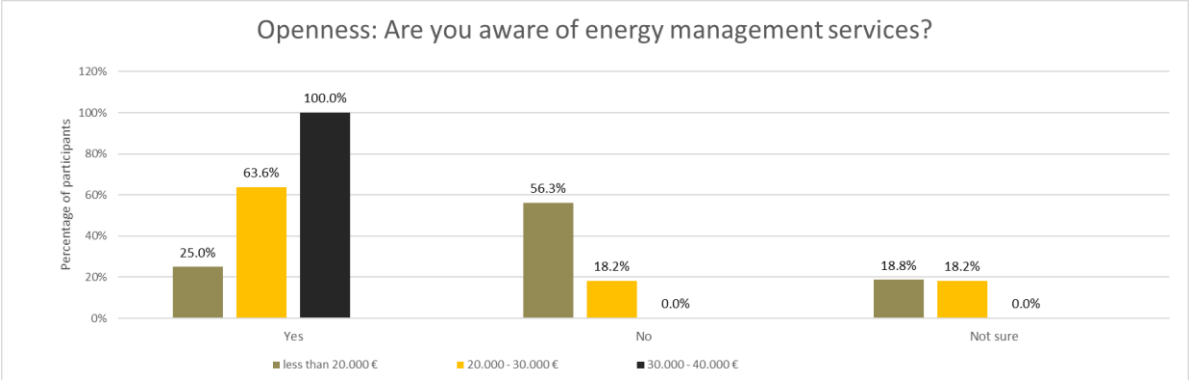


Figure 48. Awareness of smart energy services by income.

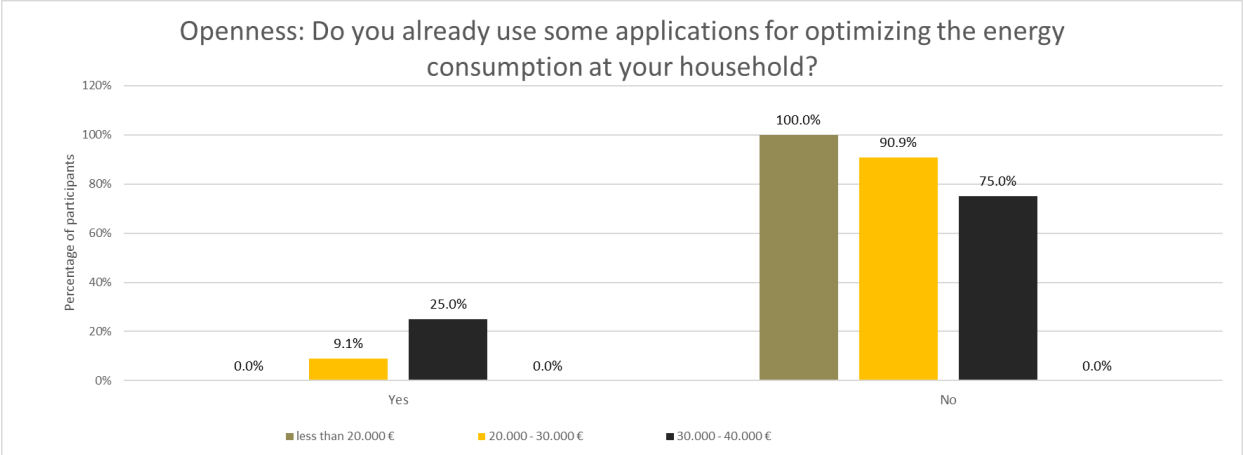


Figure 49. Use of smart energy services for optimization of energy consumption at household by income.

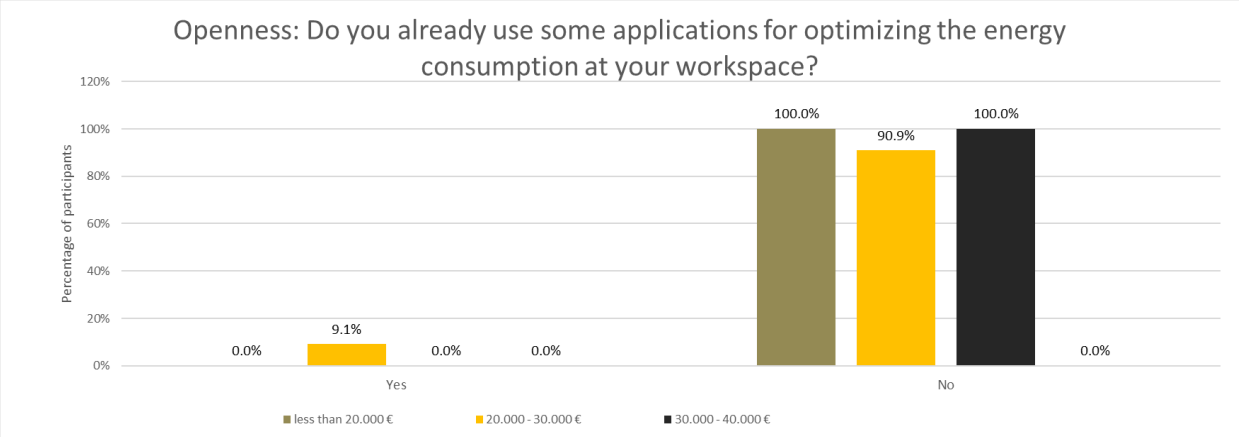


Figure 50. Use of smart energy services for optimization of energy consumption at workspace by income.

In summary:

These results show, that generally Greek academy respondents' are passive users of energy management services both at their households and at their workspaces. The highest income respondents are the ones who are the most aware of smart energy services and the most open to their use. None of the respondents in the lower income group is currently using smart energy services.

2.2.2.4 *Agreeableness*

The personality trait of 'agreeableness' in relation to energy-efficient behaviour has been identified through the question 'Would you be willing to switch off some of your a) household and b) workspace appliances during peak hours?'.

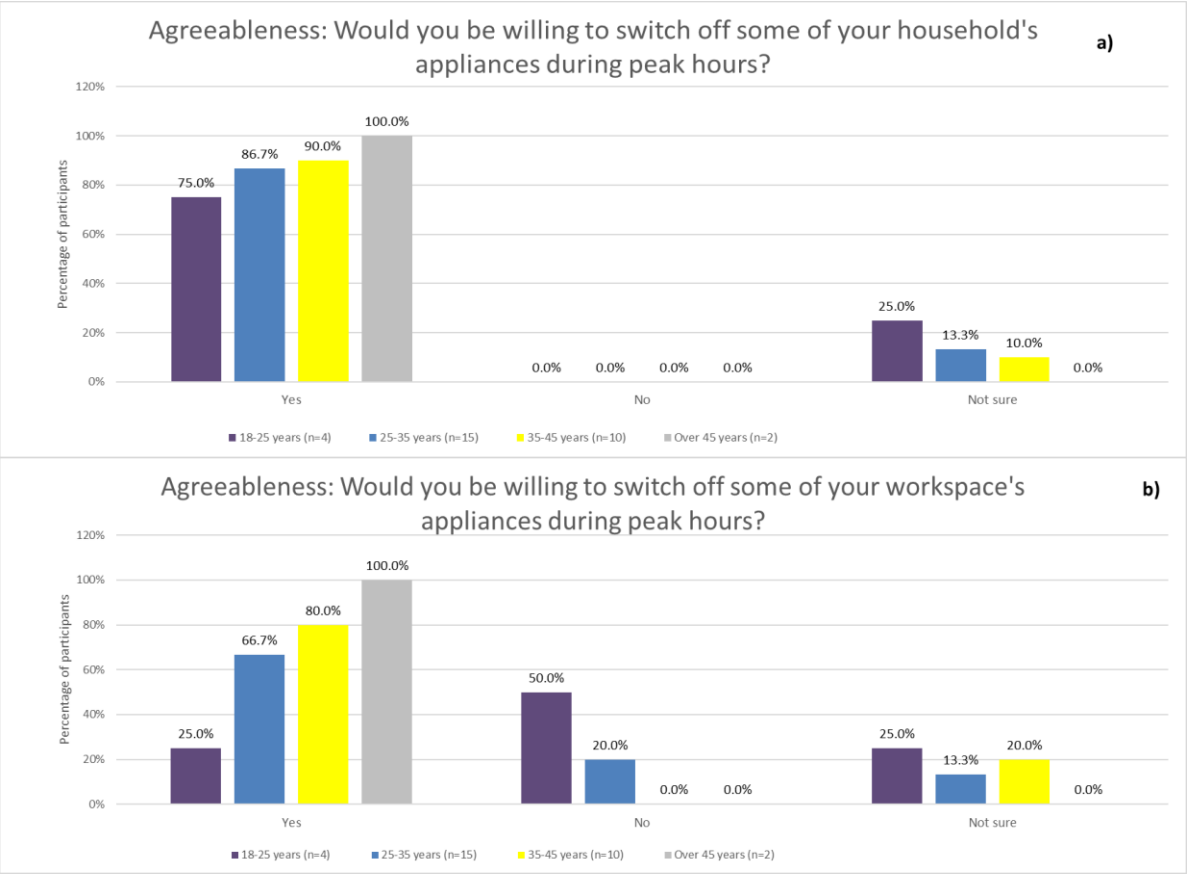


Figure 51. Agreeableness by age (a: household; b: workspace).

Figure 51 shows the agreeableness distribution in the sample broken down by age. The oldest age group is the most often willing to forego personal comfort and convenience in order to maximise grid efficiency: as 100% of the oldest respondents answered positively to this question both at household and workspaces. It should be mentioned that these findings are in well agreement with German respondents (Figure 16). Surprisingly, the rest of age groups are also answered positively to this question "75% yes"-18-25 years old, "86.7% yes" -25-35 years old and "90% yes" 35-45 years old respondents. These numbers are a little bit dropped down at workspace especially for youngest respondents (only 25% answered positively).

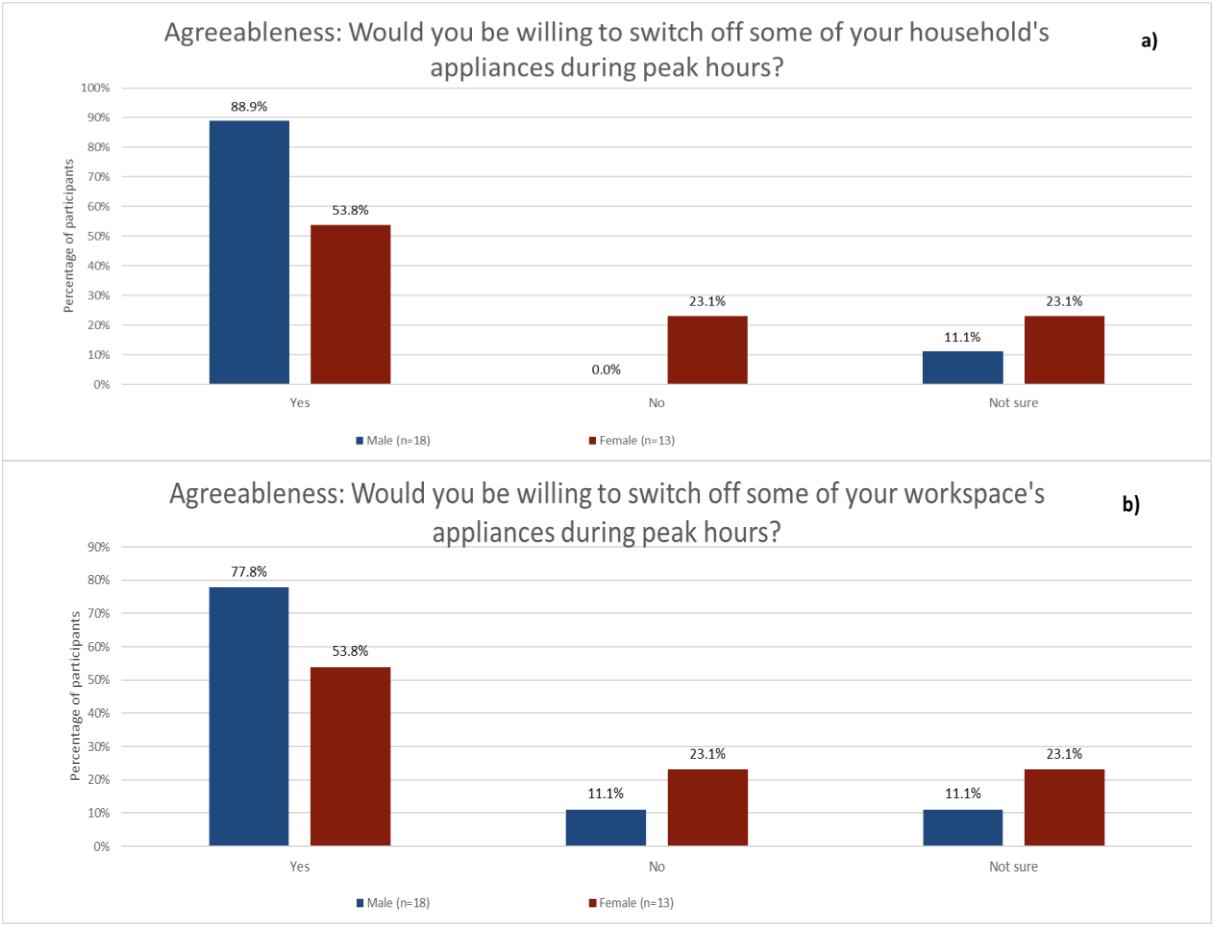


Figure 52. Agreeableness by gender.

Figure 52 shows that 88% of the male in the sample indicated agreeableness, compared to ca. 53% of the females. None of the male respondents openly refused to switch off appliances during peak hours at their households, on the contrary to female respondents where around one fourth of respondents do not like to switch off appliances at their households. Figure 53 does not show big differences in agreeableness between the three income groups. It is the middle earning group (20.000-30.000€) that also show 100% agreeableness, to switch off appliances at households, while the highest and lowest earning groups show 75 and 85% agreeableness respectively. These numbers are dropped down (approximately 15-20%) in the case of switching off appliances at workspaces (Figure 53 b).

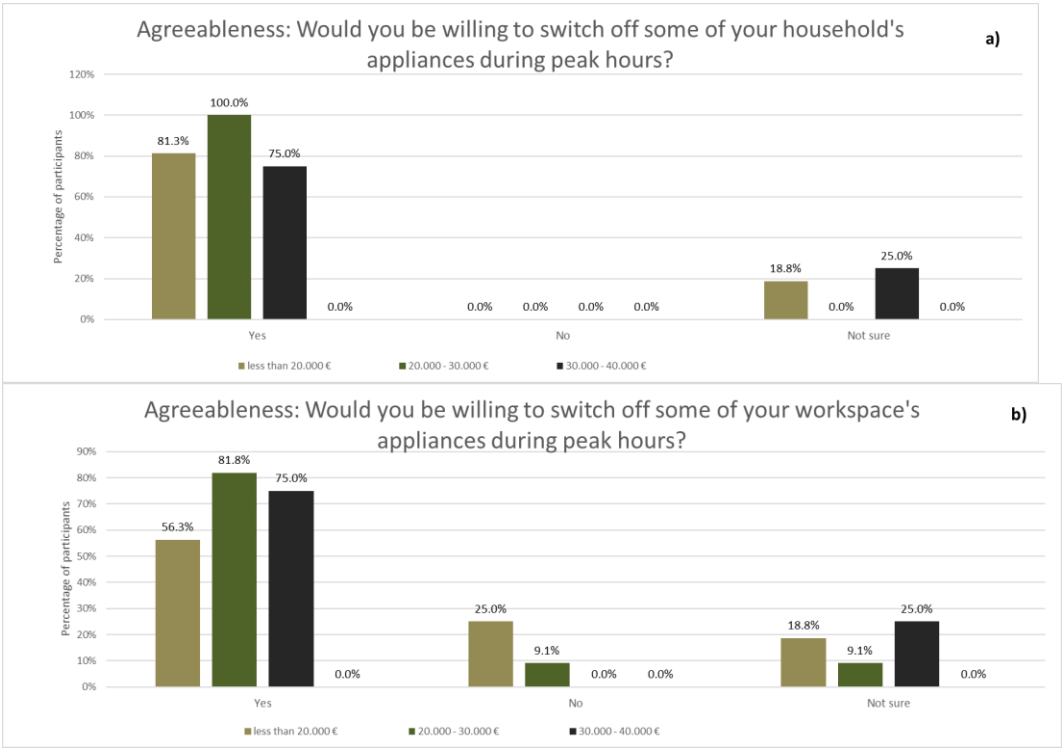


Figure 53. Agreeableness by income.

2.2.2.5 *Conscientiousness by age*

The last personality category analysed here refers to 'conscientiousness', which is measured as the desire to be able to control one's energy consumption and the desire to receive real-time feedback in order to stay informed. The question was: 'How important is it to you to control your electricity consumption at households and workspace and get real-time feedback onto your smartphone?'.

Overall, the oldest age groups are the most conscientious among all the age groups (the first half of the oldest age group respondents find the consumption control and feedback 'important' and the other half 'very important' for both at their households and workspaces). The least conscientious age group, with 20% of the respondents finding it neutral to control and be informed about their energy consumption at workspace was found to be 35-45 years old group (in fact this number was dropped to 10% in case of to control and be informed about their energy consumption at their households). Around 50% of 25-35 years old group answered 'very important' to control and be informed about their energy consumption at their households while in case of workspace this number has dropped to 33% for the same age group. 50% of the youngest age group (18-25 years old students) finds the energy consumption control and feedback 'rather important' and only 25% 'very important'.

Table 11. Conscientiousness: Energy consumption control and feedback at households and workspaces by age.

Conscientiousness: Consumption	How important is to you to be able to control your workspace's electricity consumption while getting energy real-time consumption feedback on your smartphone?			
	18-25 (n=0)	25-35 (n=13)	35-45 (n=10)	Over 45 (n=2)
Very unimportant	0.0%	0.0%	0.0%	0.0%
Unimportant	0.0%	0.0%	0.0%	0.0%
Neutral	0.0%	13.3%	20.0%	0.0%
Rather important	0.0%	40.0%	50.0%	50.0%
Very important	0.0%	33.3%	20.0%	50.0%

Conscientiousness: Consumption	How important is to you to be able to control your household's electricity consumption while getting energy real-time consumption feedback on your smartphone?			
	18-25	25-35	35-45	Over 45
Very unimportant	0.0%	6.7%	0.0%	0.0%
Unimportant	0.0%	0.0%	0.0%	0.0%
Neutral	25.0%	6.7%	10.0%	0.0%
Rather important	50.0%	33.3%	60.0%	50.0%
Very important	25.0%	53.3%	30.0%	50.0%

2.2.2.6 *Conscientiousness by gender*

As shown in Table 12 both women and men tend to think that energy consumption control and feedback is rather important and very important for both households and workspaces: only 20% men and 10% women answered "neutral" to have energy consumption control at their workspaces. Only very negligible percentage of women answer that the energy consumption control and feedback is very unimportant for their households.

Table 12: Conscientiousness: Energy consumption control and feedback at households and workspaces by gender.

Conscientiousness: Consumption	How important is to you to be able to control your workspace's electricity consumption while getting energy real-time consumption feedback on your smartphone?	
Label	Male (n=15)	Female (n=10)
Very unimportant	0,0%	0,0%
Unimportant	0,0%	0,0%
Neutral	20,0%	10,0%
Rather important	53,3%	40,0%
Very important	20,0%	50,0%
Conscientiousness: Consumption	How important is to you to be able to control your household's electricity consumption while getting energy real-time consumption feedback on your smartphone	
	Male	Female
Very unimportant	0,0%	7,7%
Unimportant	0,0%	0,0%
Neutral	11,1%	7,7%
Rather important	61,1%	23,1%
Very important	27,8%	61,5%

2.2.2.7 *Conscientiousness By income*

Table 13 shows the distribution of conscientiousness in the three income groups in percentages. The highest income earners also show higher levels of conscientiousness, which is not surprising, since the majority of the over 45 year olds discussed before are also part of this group. 75% of the high income earners find it important (and 25% very important) to control their households' energy consumption and receive feedback about it. In regard to energy consumption at workspace, the proportion remains almost similar (50% respondents answered important and 25% very important). In comparison, almost 45% and 55% of the respondents living in households with the 20.000-30.000 € yearly income, rated it rather important and very important to have control and feedback regarding their households energy consumption. In regards to energy consumption at workspace, the proportion is a little bit different (ca 55% important and 36% very important answers) including also 10% neutral answer to this age group.

Finally, none of the respondents think negatively about having control and receiving feedback regarding their households' energy consumption and only 6% of respondents rate that it is very unimportant to have control and feedback regarding their workspace energy consumption.

Table 13: Conscientiousness: Energy consumption control and feedback at households and workspaces by income.

Conscientiousness Consumption	How important is to you to be able to control your workspace's electricity consumption while getting energy real-time consumption feedback on your smartphone			
	less than 20.000 € (n=10)	20.000 - 30.000 € (n=11)	30.000 - 40.000 € (n=4)	more than 40.000 € (n=0)
Very unimportant	0,0%	0,0%	0,0%	0%
Unimportant	0,0%	0,0%	0,0%	0%
Neutral	30,0%	9,1%	0,0%	0%
Rather important	40,0%	54,5%	50,0%	0%
Very important	30,0%	36,4%	25,0%	0%
Conscientiousness Consumption	How important is to you to be able to control your household's electricity consumption while getting energy real-time consumption feedback on your smartphone			
	less than 20.000 € (n=16)	20.000 - 30.000 € (n=11)	30.000 - 40.000 € (n=4)	more than 40.000 € (n=0)
Very unimportant	6,3%	0,0%	0,0%	0%
Unimportant	0,0%	0,0%	0,0%	0%
Neutral	18,8%	0,0%	0,0%	0%
Rather important	37,5%	45,5%	75,0%	0%
Very important	37,5%	54,5%	25,0%	0%

In summary:

The highest percentage of respondents have high levels of conscientiousness in regards to energy consumption control and feedback especially at their households. Most of them find it either rather important or very important to have a control and feedback about their energy consumption regardless their gender, income or age.

2.2.3 *Attitudes*

In the following section, the central attitudes of Greek academy respondents will be analysed across the defined age, gender and income groups. The attitudes include their general inclination and motivation to save energy, their willingness to learn about efficient energy consumption (both and workspace and households), their actionability or interest to act towards energy efficiency in their homes.

2.2.3.1 *Inclination to save energy*

By age

The inclination to save energy has been identified via the question: 'What is your general attitude to energy saving?' Figure 54 shows that it is again the oldest aged group that has the most positive opinion about energy saving (100% positive answers). Meanwhile, none of the respondents indicate a "negative" attitude towards energy saving. Interestingly the "very positive" answers decrease gradually by the decrease of the respondents' age groups: 70% very positive answers gained from 35-45 years old group, 53% very positive answers gained from 25-35 years old group, and only 25% obtained from 18-25 years old group. The 50% of the youngest age group has positive inclination to save energy and only 25% of them have 'neutral' feeling towards saving energy (20%).

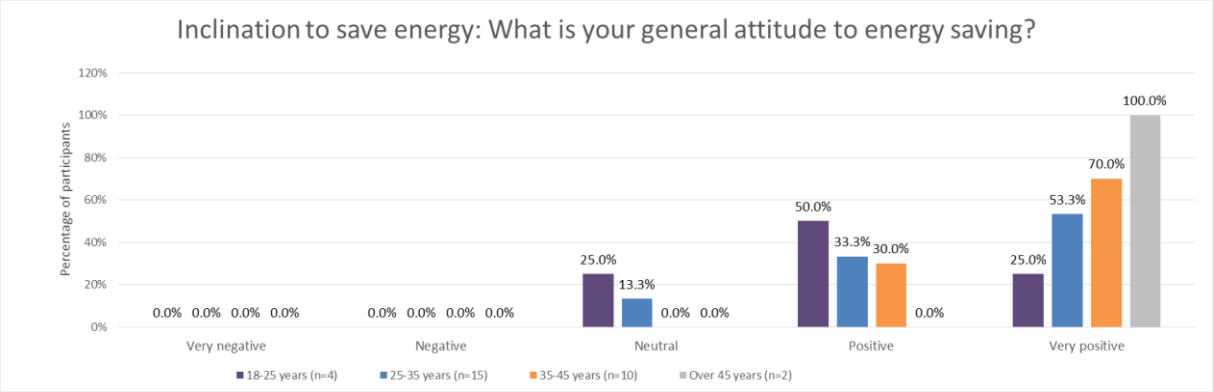


Figure 54. Inclination to save energy by age.

Figure 55 shows that the women in the sample are generally more inclined to save energy than the men. In particular, around 69% of women indicate a 'very positive' attitude towards energy saving compared to that in case of men around 20% less. Nevertheless only 7% of the women and 11% of men felt 'neutral' towards this question and all of them report a positive to very positive attitude towards energy saving without any negative answers.

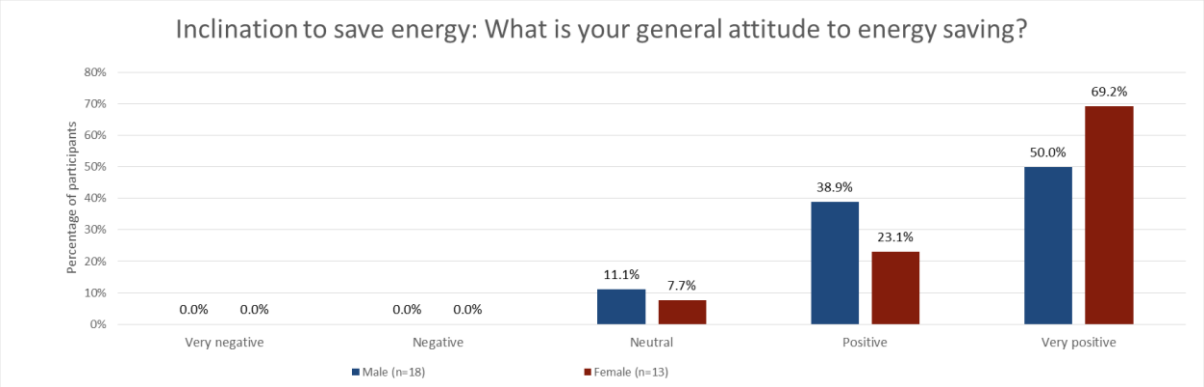


Figure 55. Inclination to save energy by gender.

In summary:

The inclination to save energy is high across the whole sample. Especially the oldest age group has very high inclinations to save energy. No negative inclination observed across the whole sample. The women in the sample are generally more inclined to save energy than the men. Similar to the inclination by gender, it is also the higher income group that has more respondents with a 'very high' inclination to save energy than the lower income group, while the lower income group is more inclined to save energy in general.

2.2.3.2 *Motivation to save energy*

By age

Figure 56 shows that across all age groups, the main two motivators to improve one's energy saving behaviour are the protection of the environment and saving costs. But there are differences as well. The oldest respondents in the sample are also the ones that are the most motivated by environment protection (100%), while this reason become less relevant in the middle years old groups (ca. 90%), and youngest group (50%). The half of the respondents regardless their ages (excluding the oldest age group) find that they can become motivated if they receive a simple and aesthetically appealing information. The youngest respondents find more important the financial aspect rather than environmental aspect, answering 100% motivation based on cost saving. Around 25% of youngest respondents and

20% of respondents belonging to the 35-45 years old group can be motivated also via receiving recognition from their family. Only a few of the respondents choose the "personal praise' option, to be a motivator for them to save energy.

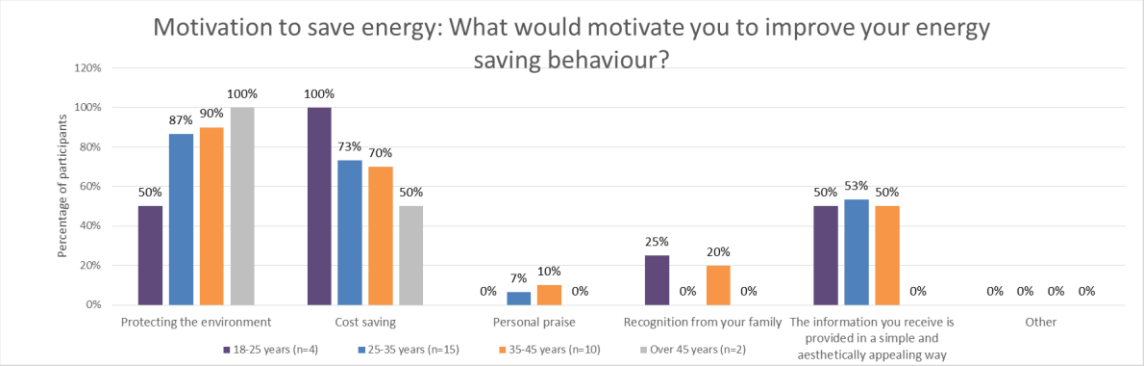


Figure 56. Motivation to save energy by age.

By gender

Figure 57 shows that both men and women are motivated by environmental concerns a bit more than by financial concerns. Both for men (44%) and women (54%) 'The information you receive is provided in a simple and aesthetically appealing way" was also an important reason to save energy. In addition, 15% of women can be motivated via "receiving recognition from their family" revealing that they are more family-oriented than the male respondents.

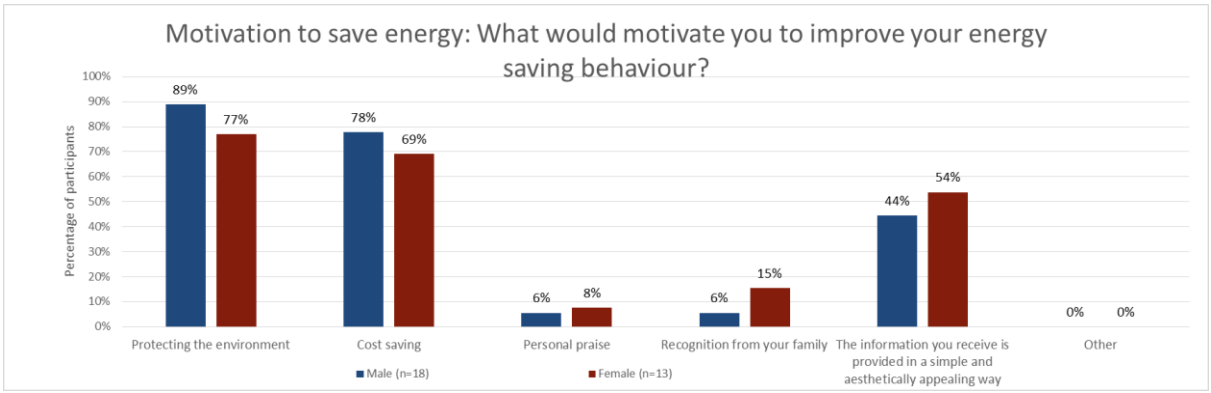


Figure 57. Motivation to save energy by gender.

By income

Figure 58 shows that the lower income earners are all motivated by financial reasons first, followed by environmental concerns. The higher income earners are slightly more often motivated by environmental concerns than by financial considerations. The quality of received information would motivate especially the lower income earners. Only a small percentage of respondents can be motivated via 'personal praise' or 'recognition from your family'.

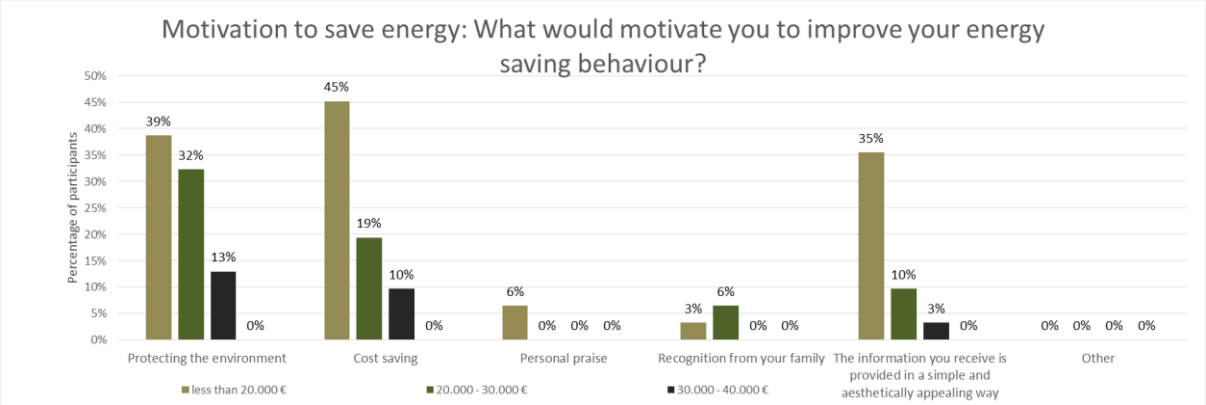


Figure 58. Motivation to save energy by income.

2.2.3.3 *Willingness to learn about saving energy/ efficient energy consumption at home and work-space*

By age

Figure 59 shows that it is the oldest age group that is the most willing to learn about energy efficient consumption; with 50% important and 50% 'very important' answers for both household and work-space options. Furthermore 25 % and another 25% of youngest respondents think that it is very important and important to receive tips about their energy consumption at households. The 35-45 years old group find mostly important to receive tips about their energy consumption at home (equally shared percentage for "very important" and "important options").

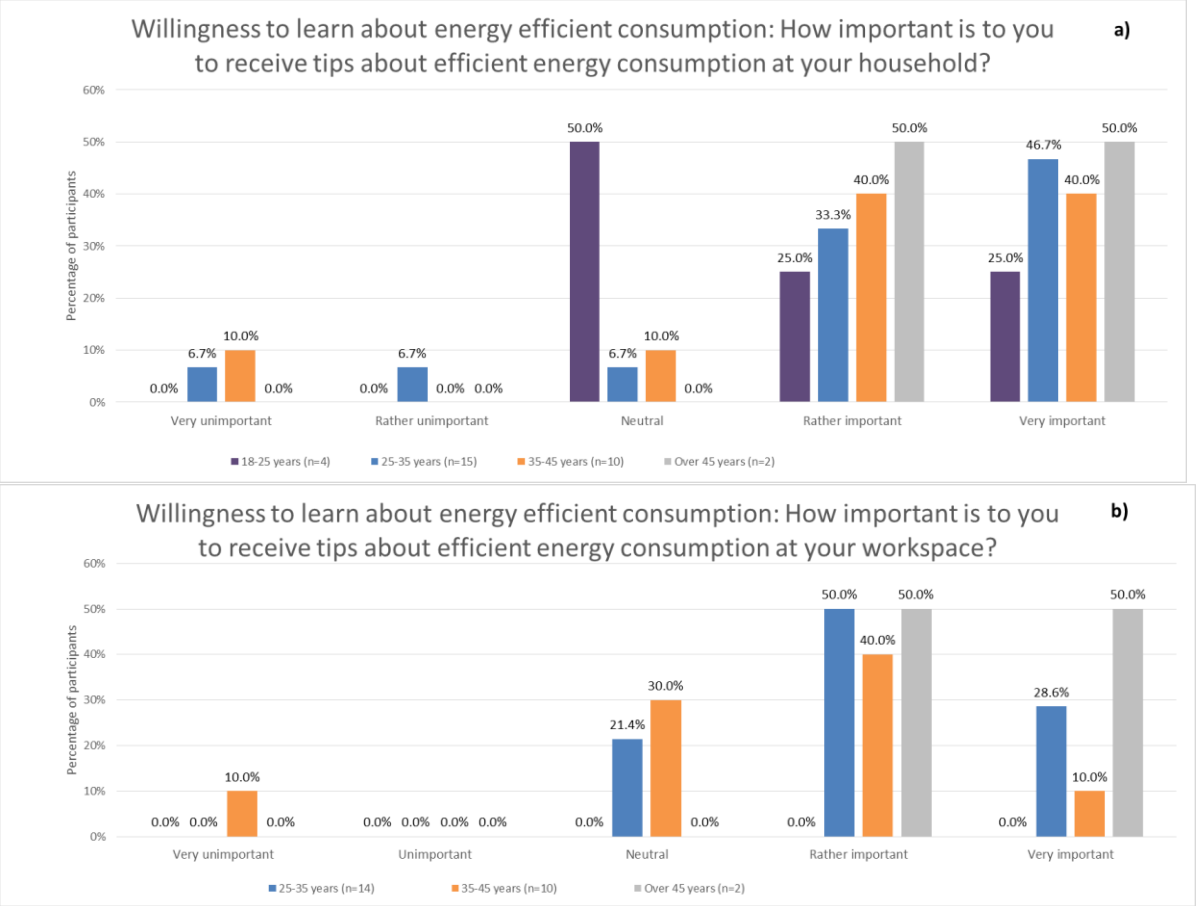


Figure 59. Willingness to learn about energy efficient consumption at household and workspace by age.

This age group is rather passive related to their energy consumption at workspace as only 10% find it "very important" and 40% "important" to receiving tips. 25-35 years old group observed to be quite motivated to receive tips about their energy consumption at both households and workspaces. In overall 47% "very important" and 33% "rather important" answers received for willingness to learn more about their household energy consumption and ca. 30% "very important "and 50% "rather important" answers gained for willingness to learn more about their workspace energy consumption.

By gender

Figure 60 shows noticeable differences in gender willingness in respect to learn about energy consumption at household and workspace. Most of the women more likely desire to learn about energy efficient consumption at household (61% "very important" and 23% "rather important") than that of at workspace (36% for both options). In addition ca. 18% feel 'neutral' about the possibility to learn about energy efficient consumption at workspace. On the contrary to this, more than 50% of male respondents find it "rather important" to learn about their workspace efficient energy consumption and 44% important to learn about their household efficient energy consumption.

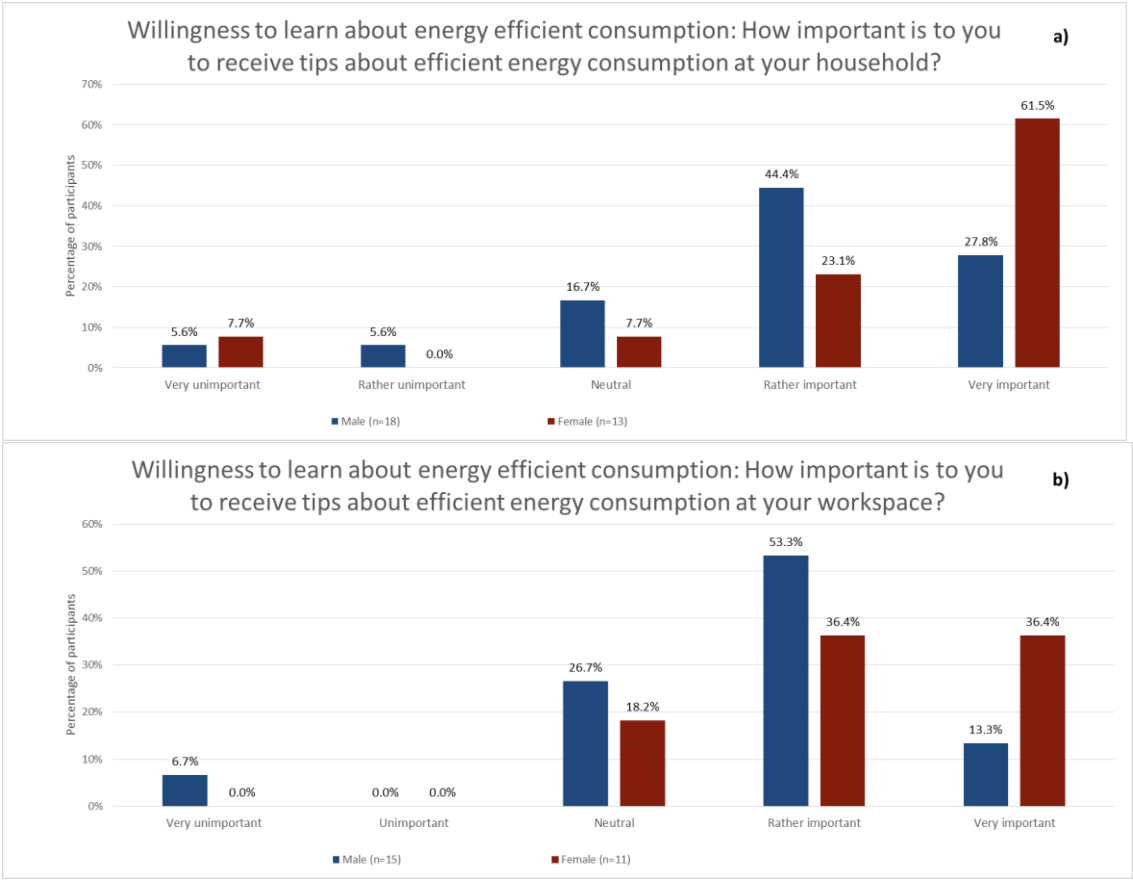


Figure 60. Willingness to learn about energy efficient consumption at household and workspace by gender.

Figure 61 indicates that learning about energy efficient consumption at households is of the interest of all respondents. Although very small percentage of the respondents having the lowest yearly income feel that is unimportant to learn more about the energy consumption.

In respect to learning more about energy consumption at workspace, together with the positive answers between the "very important" and "rather important" options, respondents choose also the "neutral" option. In this context the 50% respondents with the highest year income feel "neutral" to learn more about their workspace energy consumption. Interestingly, only 9.1% respondents with 20.000-30.000 € yearly earnings find if to be "neutral" to learn about energy consumption at their workspaces.

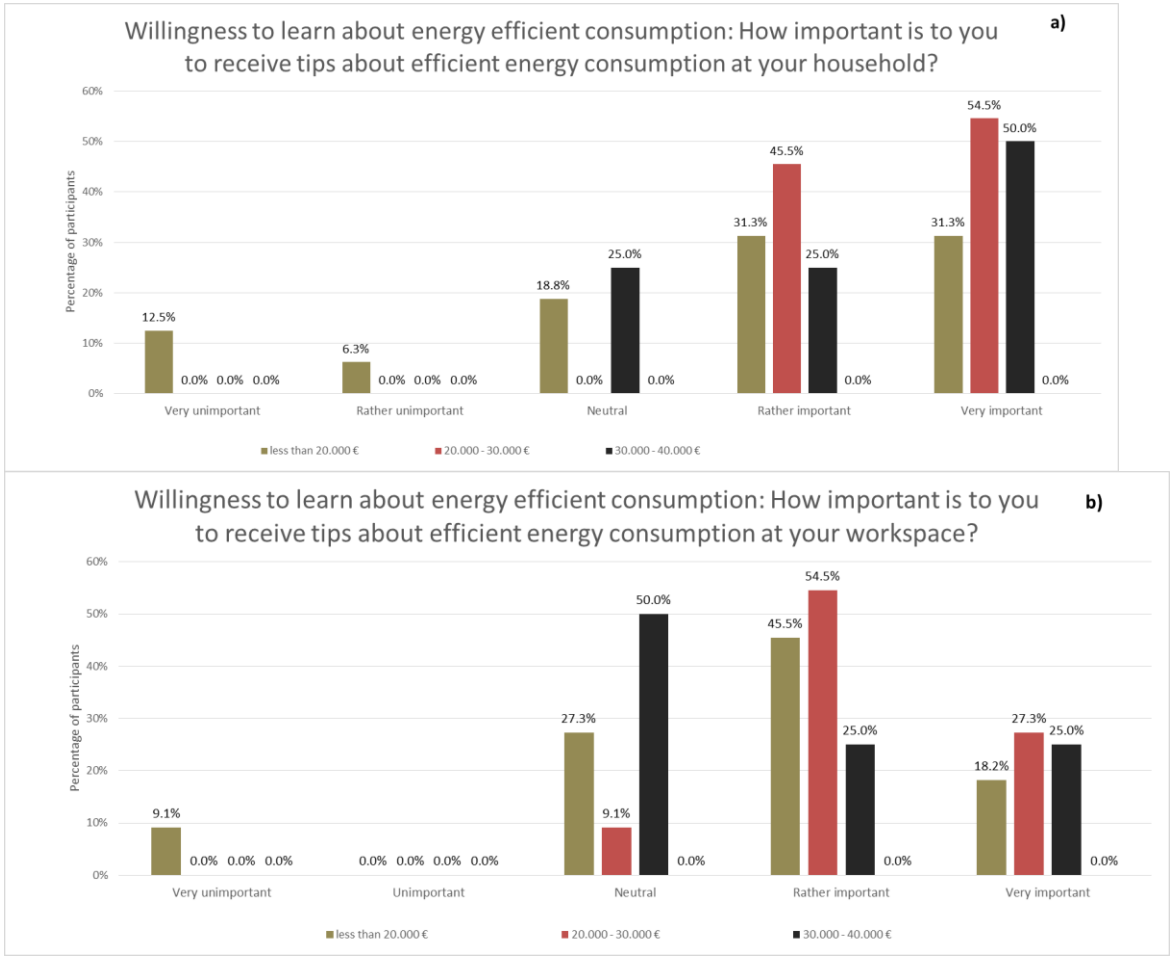


Figure 61. Willingness to learn about energy efficient consumption at household and workspace by income.

2.2.3.4 *Actionability*

By age

Figure 62 shows that the respondents mostly have positive attitude about the "Being able to perform actions that improve my building's impact on the environment is important to me" statement. Particularly, the oldest age group of respondents are 100% agree with the statement; while 35-45 years old, 25-35 years old and the youngest age groups are 70%, 40% and 50% fully agree with the statement, respectively. Only very small ca. 10% and 6% of respondents (35-45 and 25-35 years old) somewhat agree with the statement.

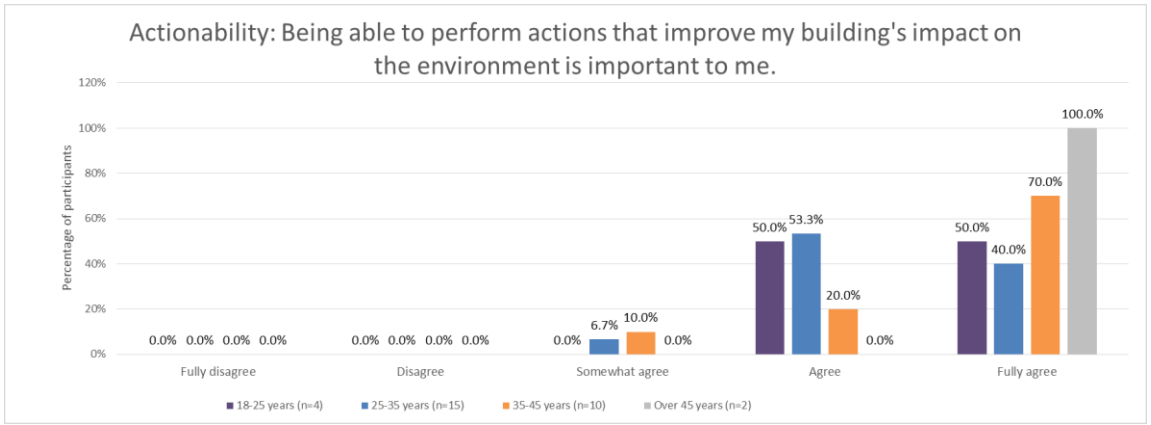


Figure 62. Actionability by age.

Figure 63 shows that both the women and men prone to take energy efficient action than the men. No negative answers were observed with only very small percentage less than 10% respondents with "somewhat agree" opinion. This finding are promising suggests that many of the respondents would like to become prosumers.

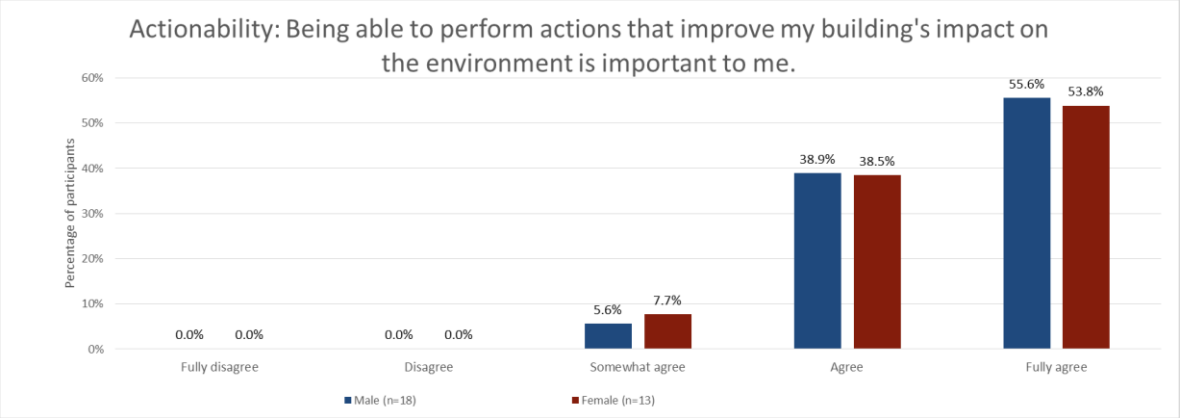


Figure 63. Actionability by gender.

Figure 64 illustrate that all the respondents, regardless of their yearly income, would like to take action to improve the energy efficiency of their buildings. Only ca 18% of respondents having 20.00-30.000 € yearly income express "neutral" opinion about this statement.

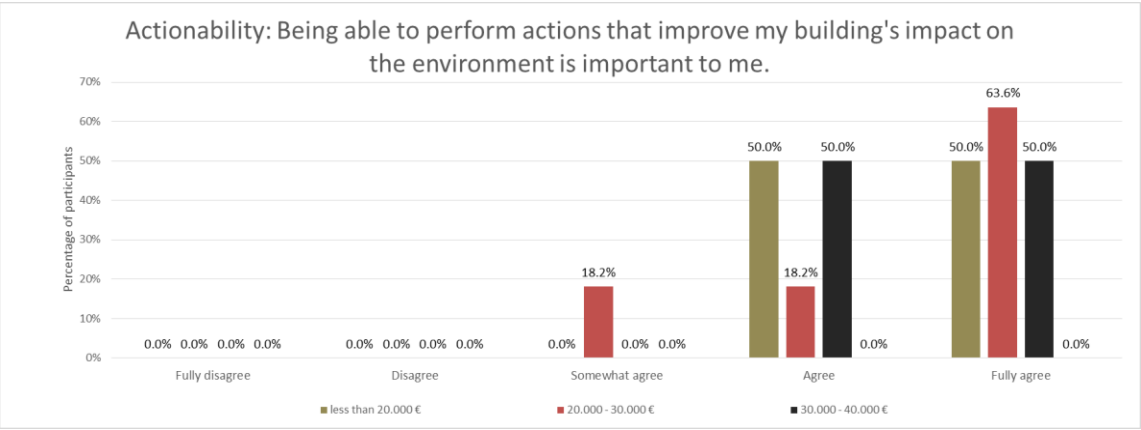


Figure 64. Actionability by income.

In summary:

- All the respondents regardless their age, gender and yearly income show high enthusiasm and high levels of taking action to improve their buildings' energy efficiency. These results are promising attributing their willingness to become efficient energy consumers or even become energy prosumers.

2.2.3.5 *Willingness to install Renewable Energy Sources (RES)*

As the Greek respondents are currently energy consumers, one last question was given to respondents in order to establish their 'willingness to install Renewable Energy Sources (RES). Below are presented the obtained results.

By age

Figure 65 shows that almost all respondents are interested to install RES systems in near future. The only exception here is the 50% of the oldest age respondents having "unlikely" opinion about this question.

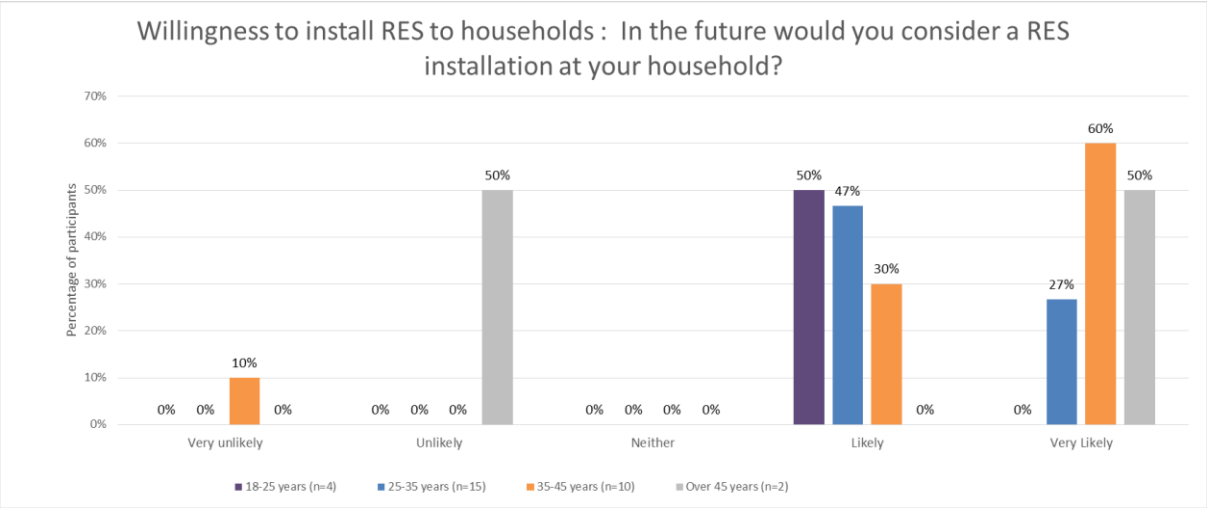


Figure 65. Willingness to install RES by age.

By gender

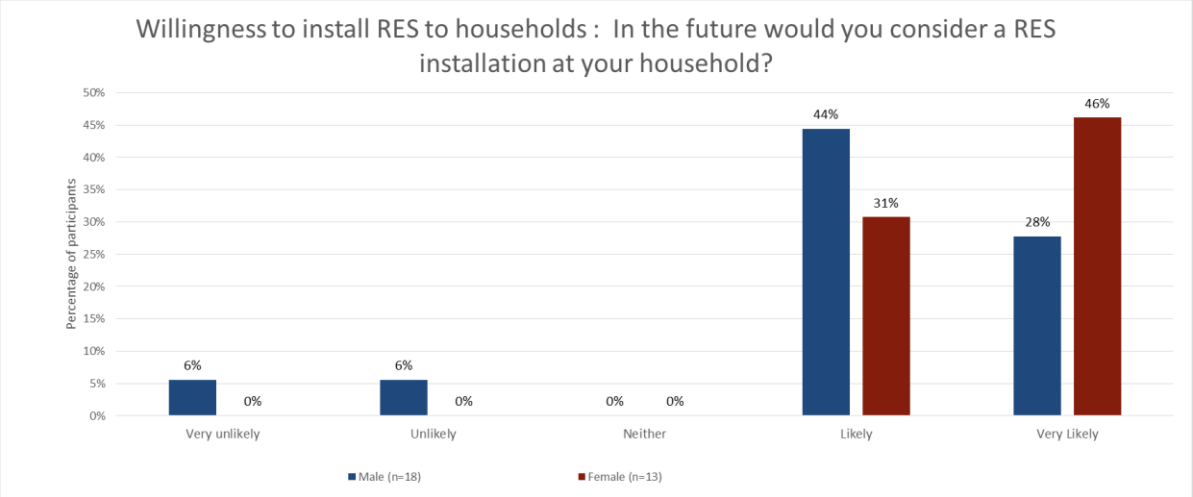


Figure 66. Willingness to install RES by gender.

Figure 66 shows that the women respondents are more interested to install RES system than male respondents while Figure 67 shows that it is mostly the respondents with the lowest yearly income who desire to install RES at their households in the future. Surprising the 25% of respondents with the highest yearly income have the "very unlikely" opinion to this action.

By income

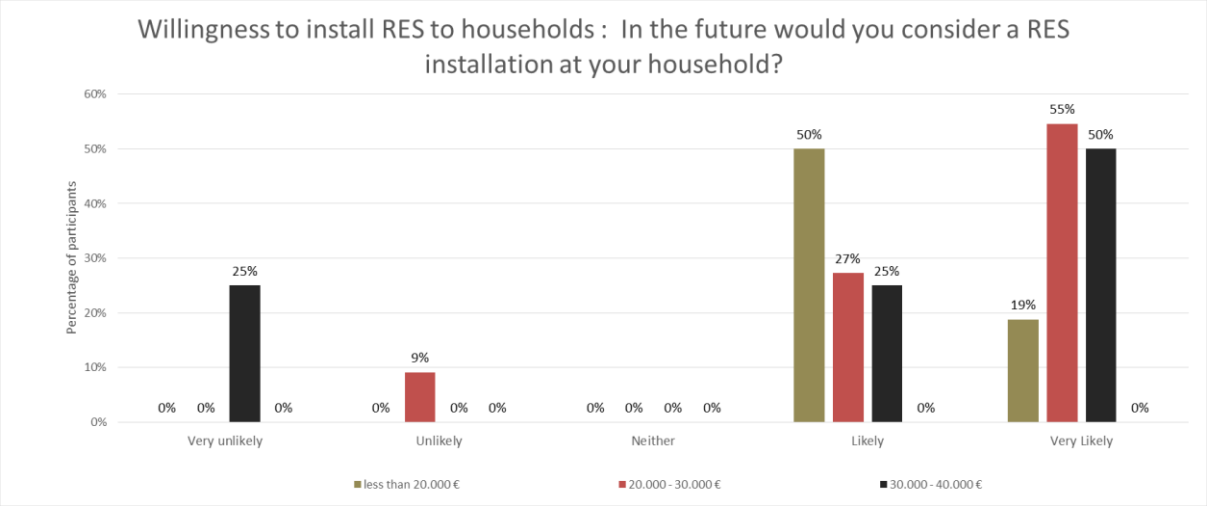


Figure 67. Willingness to install RES by income.

In summary:

The female respondents indicated more interest to install RES to their households than the male respondents. Although the positive and environmentally friendly attitude of the oldest respondents throughout of this sample 50% of them are not ready to install RES in the future. The lowest income earners are interested in becoming a member of a prosumers or to install RES to their households while on the contrary 25% of the respondents in the highest income groups do not expressed an interest in this possibility.

3 Energy Demand Analysis for Target Users

In this section the energy demand for the pilot specific target groups is done. In Germany the prosumer end-users are highlighted, whether in the Greek pilot case the TG3 is analysed. For the analysis historical consumption data of SHF's customers and ITML's scientific building site will be collected, processed and analysed due to the objects of the project. Starting with a presentation of data regarding the average use of energy in the pilot countries, the focus will break down the analysis to the target groups.

3.1 Greece

3.1.1 *Electricity generation and consumption in Greece*

In 2016, about 54,417.8 GWh (54.42TWh) of electricity was generated in Greece (Figure 68**a**[25]). About 18.883 GWh of the energy was generated from coal, 5.565 GWh from oil, 14. 868 GWh from gas and the rest around 14.641 GWh from different renewable energies sources (solar, wind, hydro).(Figure 68**b**[26])

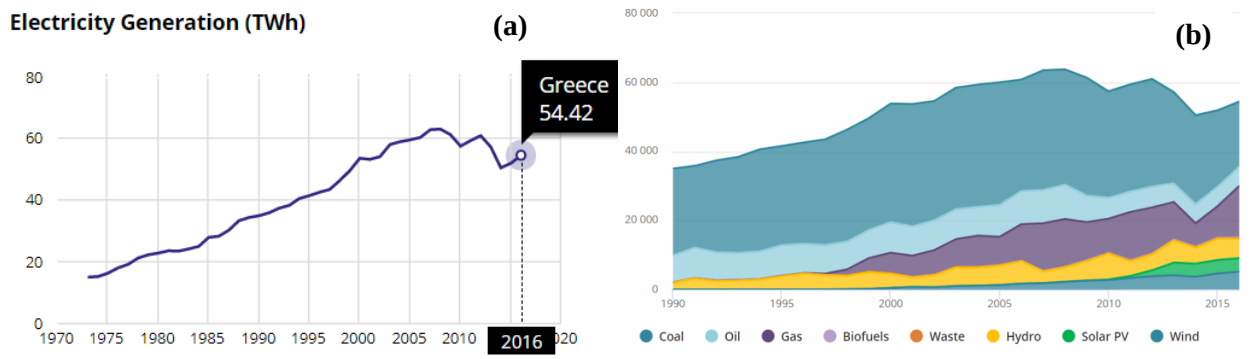
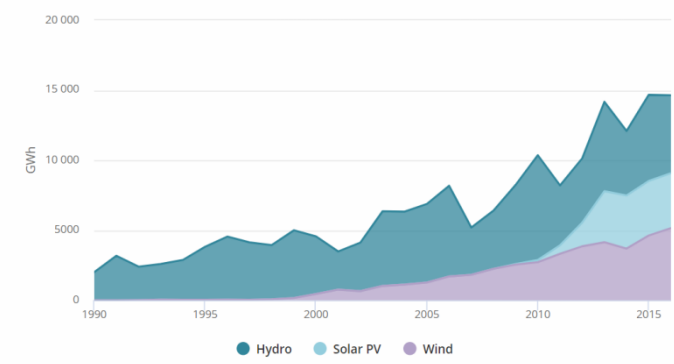
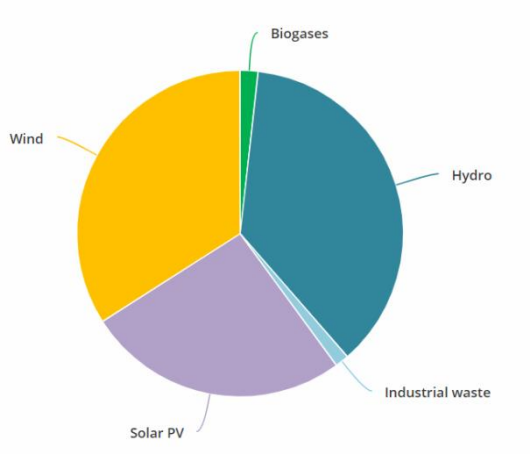


Figure 68: Electricity generation in Greece 2016 (TWh (a) and by fuel (b))



Electricity generation from renewables by source



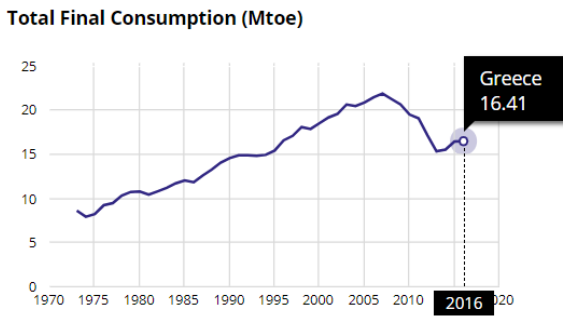
Share of sources in renewable electricity generation

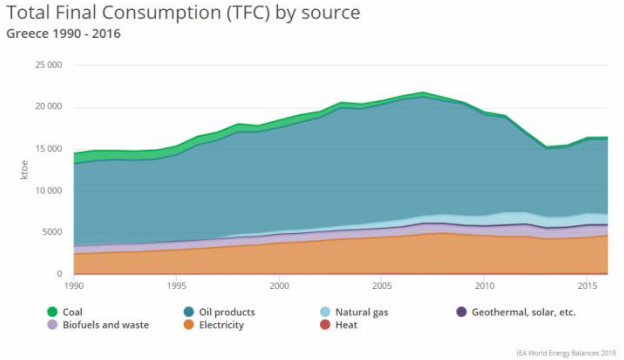
[25] http://energyatlas.iea.org/#!/tellmap/-1002896040/4

[26] https://www.iea.org/statistics/?country=GREECE&year=2016&category=Key%20indicators&indicator=NetImports&mode=chart&dataTable=INDICATORS

Figure 69: Electricity generation in Greece, 2016 from RES

Figure 70 illustrates the total final consumption (TFC) for 2016. As shown that TFC for 2016 was estimated 16.41 Mtoe (16,413Ktoe). The share of sources for the TFC is estimated as follows: Oil products: 9063 Ktoe, Coal: 199 Ktoe, Natural gas:1194Ktoe, Geothermal, solar:210 Ktoe, Biofuel and waste: 1108Ktoe, Electricity: 4588 Ktoe, Heat 51Ktoe

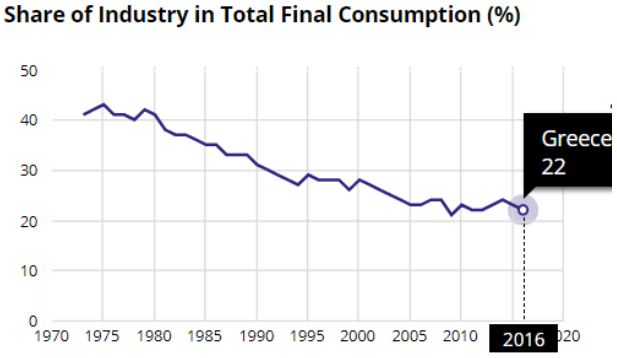


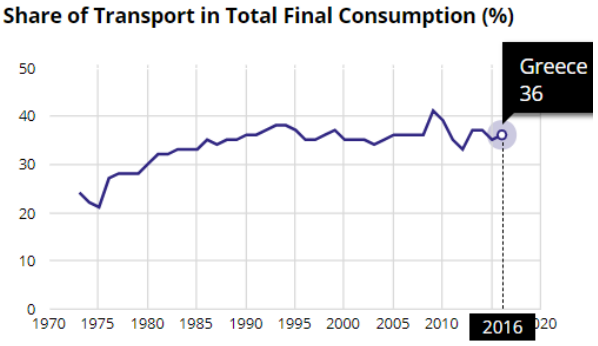


The Total Final Consumption in 2016 **The Total consumption by source in 2016**

Figure 70: Total Final Consumption in Greece, 2016 [27, 28]

The share of Industry, Transport and Residential sectors in TFC is given in Figure 71. The estimations of these three main sectors are as follows: Industry-22%, transport-36% and residential- 26% showing the Transport sector to be the biggest part of final energy consumption in Greece.





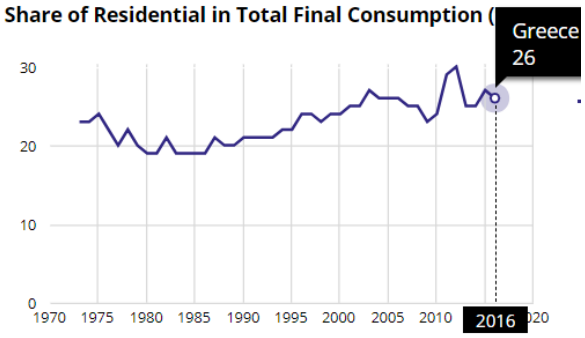


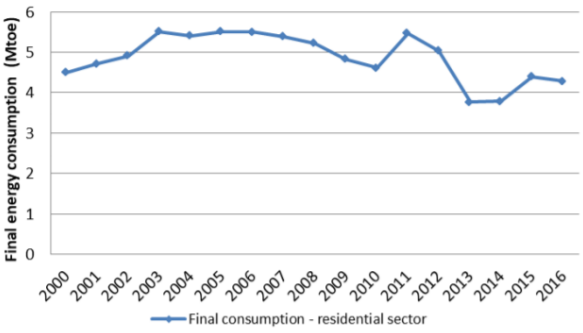
Figure 71: Share of Total Final Consumption (TFC) by sector in 2016 [27,28]

3.1.2 *Residential sector*

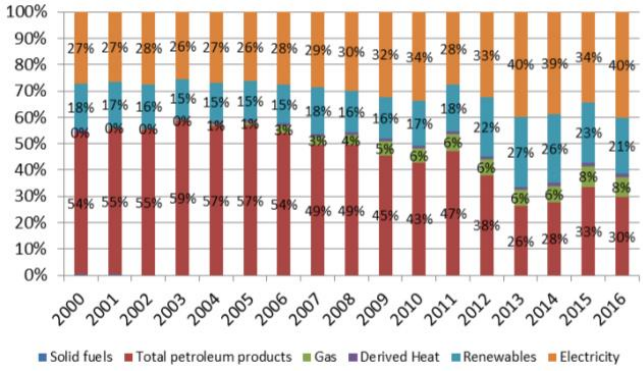
[27] http://energyatlas.iea.org/#!/tellmap/-1002896040/4

[28] https://www.iea.org/statistics/?country=GREECE&year=2016&category=Key%20indicators&indicator=NetImports&mode=chart&dataTable=INDICATORS

The building sector, which is consisting of the residential and tertiary sector, consumes the 4.2Mtoe of the final energy in Greece. From 2000 to 2006 the petroleum products are the main fuels that are used by the residential sector (more than 50%, Figure 72). After 2006, by the introduction of Natural Gas in the energy mix of the country, part of the needs of residential that had covered by petroleum products, started to cover by natural gas, fact that led to the reduction of the percentage of petroleum products at the mix of final energy consumption.



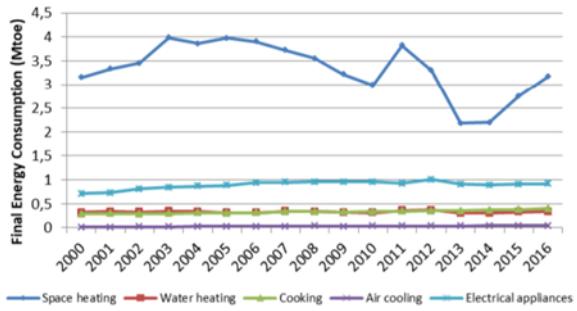
Final Energy Consumption in residential sector



Final Energy Consumption by fuel, residential sector

Figure 72. Energy consumption in Residential sector

Space heating absorbs the biggest amount of energy in the residential sector (Figure 73). Along with appliances & lightning, they are highly energy intensive. The energy share of electric appliances and lighting, between the years 2000 and 2015 has increased by 6% (
Figure 73) because of the increase of their number and size. Cooking and water heating follow with a smaller share of the total residential energy consumption and remain almost constant during the period 2000-2016.



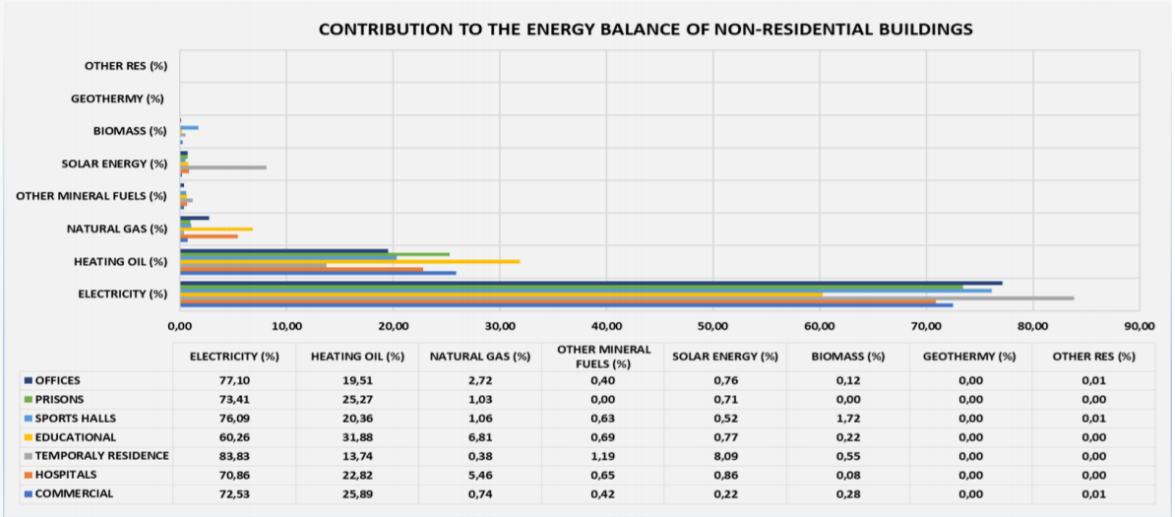
by Sector						
Industry	4.01	4.45	4.16	3.47	3.09	3.13
Transport	6.52	7.30	8.19	8.16	6.41	6.58
Residential	3.33	4.50	5.51	4.62	3.79	4.40
Services	0.94	1.31	1.95	1.95	1.71	1.87
Agriculture and Fishing	1.01	1.12	1.15	0.80	0.28	0.27
Other	0.00	0.00	0.00	0.00	0.24	0.25

Figure 73. Final Energy Consumption by End Use in Residential

Regarding the Hellenic non-residential buildings sector, it was recorded a 1.87 Mtoe energy consumption in 2015[[29]], mainly for building's space heating, cooling and lightening purposes.

The share of energy sources for the various non-residential buildings are presented in the figure below, among all the electricity has the highest value for all the different type of non-residential building[30].

[29] https://ec.europa.eu/energy/sites/ener/files/documents/pocketbook_energy_2017_web.pdf
[30] http://bpes.ypeka.gr/?page_id=68764



	ELECTRICITY (%)	HEATING OIL (%)	NATURAL GAS (%)	OTHER MINERAL FUELS (%)	SOLAR ENERGY (%)	BIOMASS (%)	GEOTHERMY (%)	OTHER RES (%)
OFFICES	77,10	19,51	2,72	0,40	0,76	0,12	0,00	0,01
PRISONS	73,41	25,27	1,03	0,00	0,71	0,00	0,00	0,00
SPORTS HALLS	76,09	20,36	1,06	0,63	0,52	1,72	0,00	0,01
EDUCATIONAL	60,26	31,88	6,81	0,69	0,77	0,22	0,00	0,00
TEMPORALY RESIDENCE	83,83	13,74	0,38	1,19	8,09	0,55	0,00	0,00
HOSPITALS	70,86	22,82	5,46	0,65	0,86	0,08	0,00	0,00
COMMERCIAL	72,53	25,89	0,74	0,42	0,22	0,28	0,00	0,01

Figure 74. Final Energy Consumption in Non-Residential sector

3.1.3 *Academic Staff at HUA Campus*

Yet, there is no specific data for Greek pilot. The installation of the meter infrastructure is being prepared and will be done soon. A further analysis of the energy demand will be made after the collection of the baseline was done in the next version of deliverable M24.

3.2 **Germany**

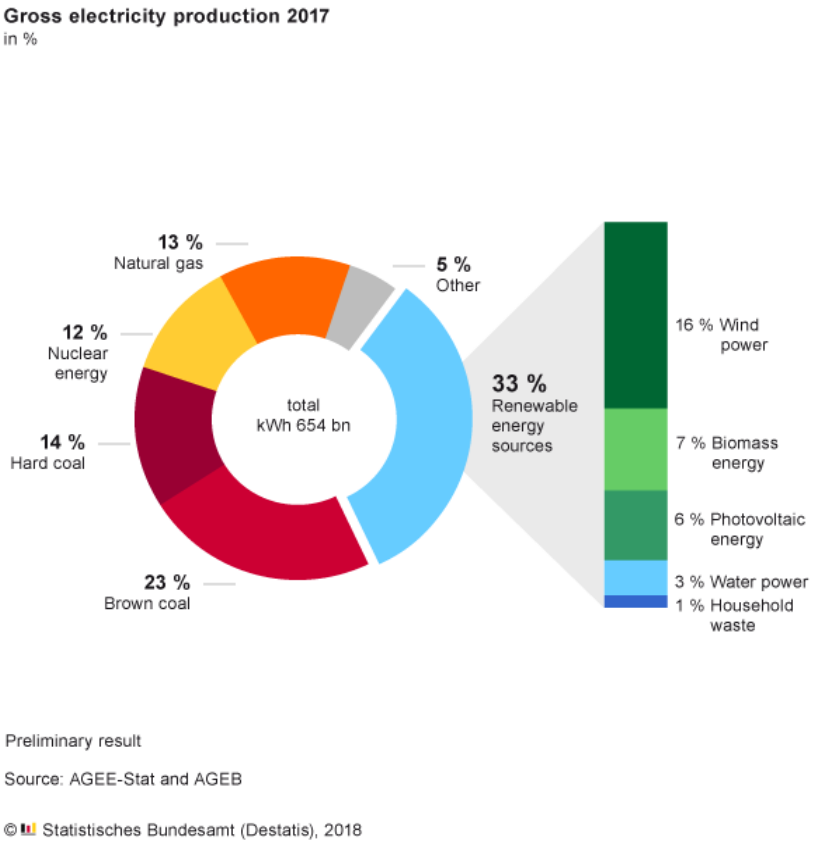


Figure 75: Gross electricity production 2017 in Germany, divided in energy source [5]

In 2017, 654 TWh of electricity were generated in Germany (cp. Figure 75). About 37% of the energy generated came from coal, 33% from renewable energies such as wind, water, photovoltaics and biomass. Nuclear energy (12%) and natural gas (13%) make up the remaining share of electricity generation. The electricity actually consumed was 515 kWh.

In 2016, approx. 2542 TWh of energy were consumed in Germany. Of this total, 16% (411 TWh) was consumed by trade and commerce, 26% by private households (665 TWh), 28% by industry (717 TWh) and the remainder by transport.

3.2.1 ***Households***

At 85% of the total energy consumption of a German household, heating is the main consumer. Of this, 14% is obtained from renewable heat such as heat pumps. The main electricity consumption of every German household consists of refrigerators and freezers (23%) as well as cooking, drying and ironing (30%). Only 7% is used for heating and 12% for hot water (cp. Figure 76). (BDEW Bundesverband der Energie- und Wasserwirtschaft e.V. 2017)

Thus it can be stated, that Germany procures its space heating only marginally from electricity generation, but rather from other primary energy sources such as gas, oil or coal.

A German household can be also classified into the household size. The electricity consumption of a household depends primarily on the number of inhabitants. As a rule, consumption increases with the number of people - although not linearly to the same extent as the increase in the number of people. The reason is, that household appliances such as refrigerators or washing machines are shared. There-

fore, per capita electricity consumption in larger households is usually lower than in smaller households. (cp. Table 14).

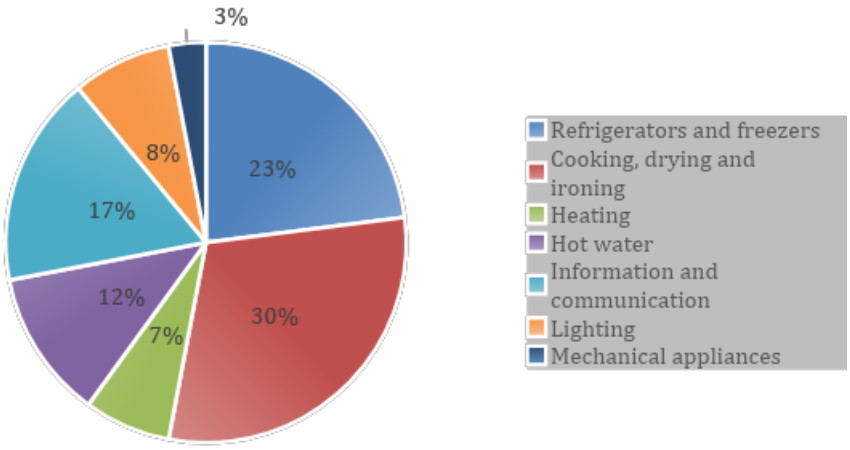


Figure 76: Structure of electricity consumption in Germany, year 2016 [1]

Moreover, the level of consumption also depends on whether it is a single-family house or a multi-family house (cp. Table 15 and Table 15). Electricity consumption in an apartment building is on average almost 30 percent lower than in a single-family house. In cause of the fact, that in a home of one's own, the exterior lighting, garden and garage provide additional electricity consumption.

Table 14: Classification of electricity consumption of households in single homes in Germany (co2online gemeinnützige Beratungsgesellschaft mbH 2018)

Household size	Electricity consumption	with electric water heating	Electricity costs without domestic water heating	Electricity costs with domestic water heating
1 person	2.300 kWh/year	2.800 kWh/year	675 €	820 €
2 person	3.000 kWh/year	3.700 kWh/year	880 €	1.085 €
3 person	3.600 kWh/year	4.500 kWh/year	1.055 €	1.320 €
4 person	4.000 kWh/year	5.000 kWh/year	1.170 €	1.465 €
5 person	5.000 kWh/year	6.300 kWh/year	1.465 €	1.845 €

Table 15: Classification of electricity consumption of multi-family houses in Germany 2016 [2]

Household size	Electricity consumption	with electric water heating	Electricity costs without domestic water heating	Electricity costs with domestic water heating
1 person	1.350 kWh/year	1.900 kWh/year	410 €	555 €
2 person	2.000 kWh/year	3.000 kWh/year	585 €	880 €
3 person	2.600 kWh/year	4.000 kWh/year	760 €	1.170 €
4 person	3.000 kWh/year	4.400 kWh/year	880 €	1.290 €
5 person	3.600 kWh/year	5.600 kWh/year	1.055 €	1.640 €

In 2016, 13385 people live in Haßfurt. This number increase steadily since the 1940th. The amount of female person is at 6767, this corresponds 51%. About 55% are more than 40 years old. The biggest age group is between 50 years and 60 years old (24,2%) [3]

3.2.2 *Working Space*

For office buildings, the energy consumption is very similar to that of a normal household. The heating system and space heating are the main consumer of energy in an office building (69%). Lightning needs nearly 8 to 10%, too. The difference is, that more energy is needed for office equipment (14%) than for household appliances.

Office buildings can also be differentiated according to their size. Here only a significant difference can be seen for the energy consumption of an air conditioning system. From 200 m² and more, the consumption for the air conditioning system increases from 2% to 8% percent. All other consumption values remain approximately the same (cp. Figure 77).

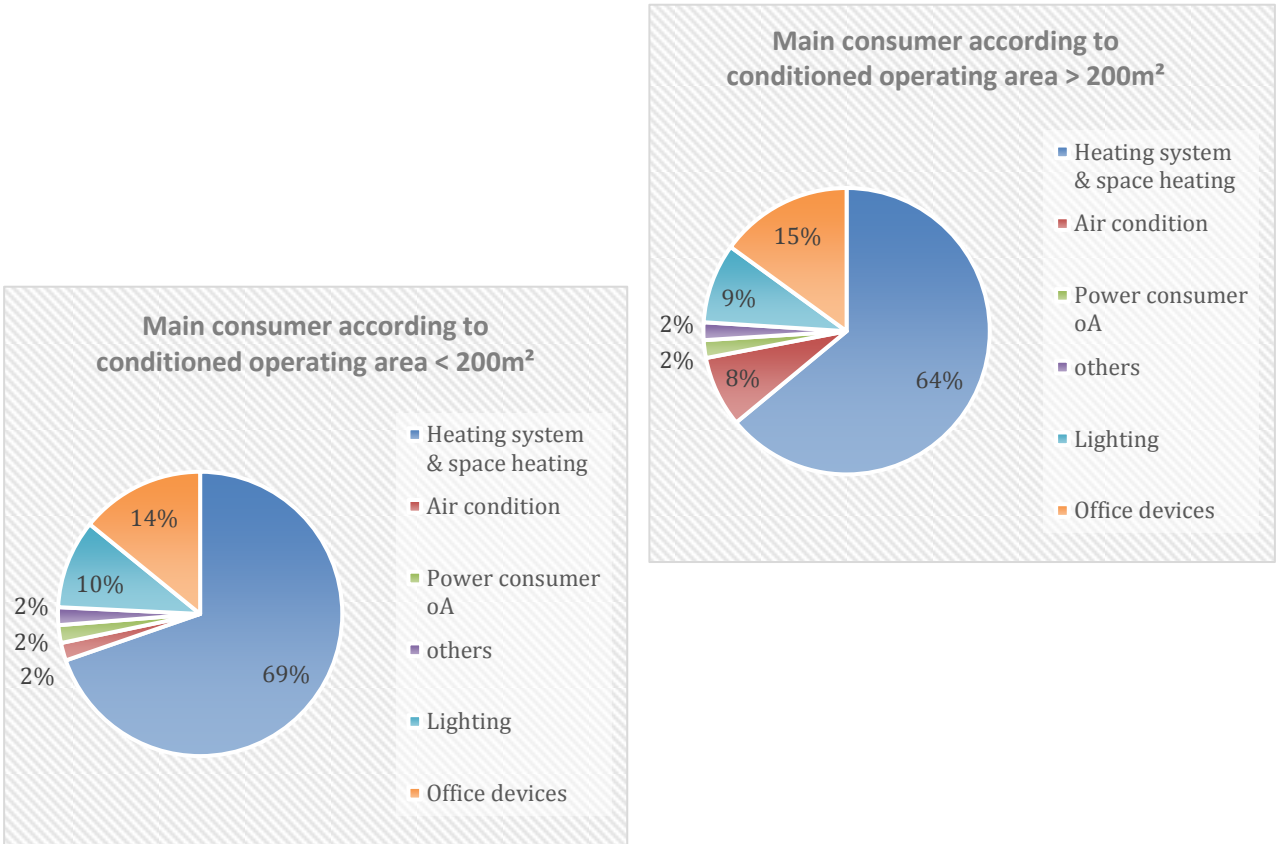


Figure 77: Main consumer according to conditioned operating area </> 200m² in working space [3]

3.2.3 *Prosumer customers in Haßfurt*

In the first period of Task 1.2 a classification in prosumer types was made. In cooperation with SHF's subcontractor EIPCM, three types of prosumers were carved out. Starting with an end-user, that simply installed an additional renewable energy plant to his building and gains reimbursement for produced renewable electricity for 20 years ([4], cp. Table 16, type I). Some other users are one step ahead. They produce and use the locally produced energy directly in their building. Only excessive or lacking energy is sold/bought from the contracted utility (cp. Table 16, type II). The same principle of operation is with prosumer type 3, but the technical difference is that a storage device is installed to store excessive energy and provide it in times of energy lacks. This helps to decrease the dependency to the electricity grid operator on the one hand and lower energy costs on the other hand (cp. Table 16, type III).

Table 16: Classification of prosumers, according to the prosumer workshop in Haßfurt, January 2019

Prosumer Type	I	I	III
Grid supply	Full consumption	Consumption of lacking energy	Consumption of lacking energy

RES production	Full feed	Feed of excessive energy	Feed of excessive energy
Storage capacity	none	none	up to 10 kWh

As explained, the annual consumption of the three prosumer types will still be the same proportion as shown in section 3.2.1, but the difference appears in the operation state, that has an impact on the consumption values billed by the utility company. To envision the impact of prosumer customers to the technical and financial situation of a local DSO, the current market share and total consumption analysis of SWH is done on the following pages.

In the year 2017 a total number of 588 decentral renewable appliances were listed. Compared to the total number of end-users in the electrical distribution grid of SWH, this is a share of approx. 7 percent. The split into the different sources of renewable energy appliances is shown in Figure 78. It occurs, that solar power plants play a major role in the production of renewable energy in southern Germany (97%).

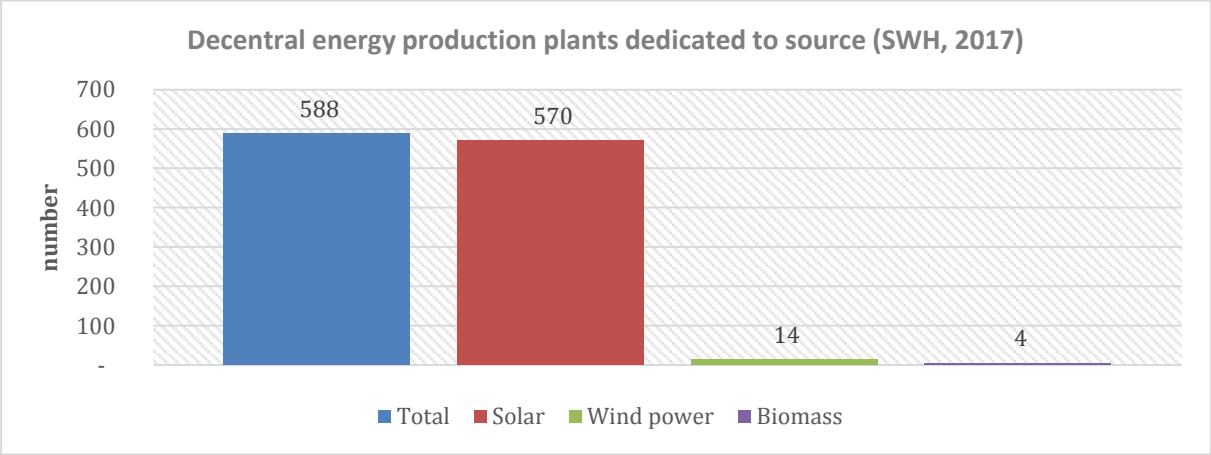


Figure 78: Decentral energy production plants dedicated to source (SWH, 2017)

These decentralised renewable energy production appliances have a total nominal power of approx. 47 MW. Figure 79 shows the big difference of provided power of wind power plants to solar power appliances, that is a lot less for solar panels, although it is very high in total numbers.

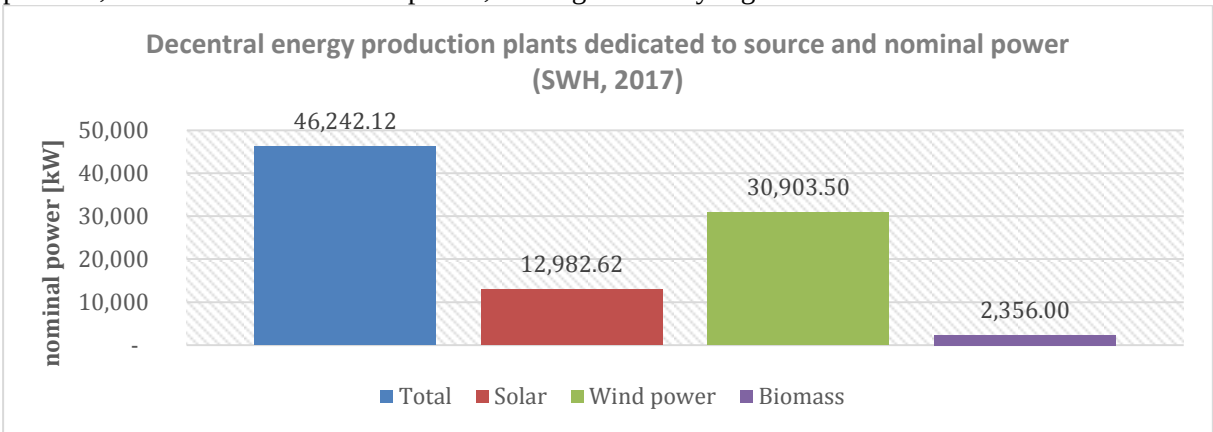


Figure 79: Decentral energy production plants dedicated to source and nominal power (SWH, 2017)

In Figure 80 the share of prosumer operated renewable production sources is analysed. Of 588 decentral energy production plants in Haßfurts grid, only 41 appliances are operated self-sufficiently. Compared to the overall grid customers of SWH, this is a share of 0,4 percent. Where only one of these is a micro wind power plant.

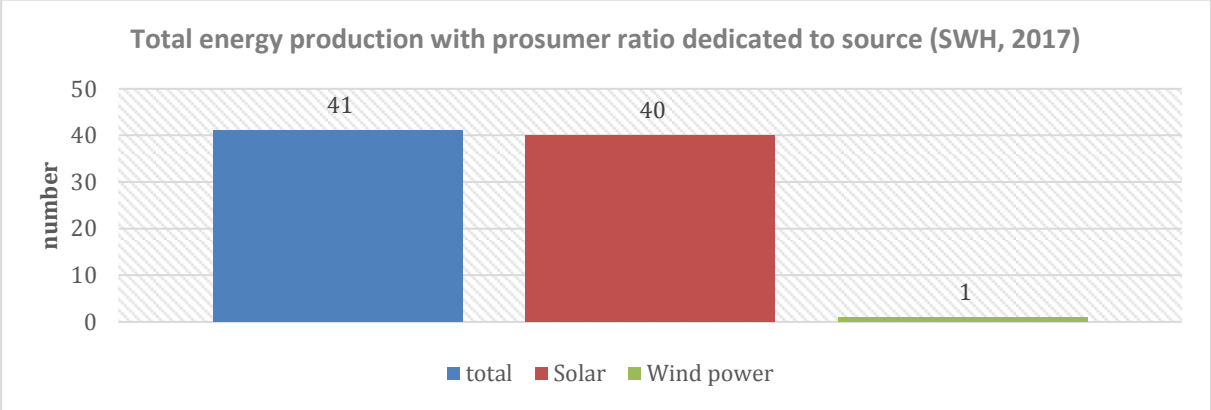


Figure 80: Total energy production with prosumer ratio dedicated to source (SWH, 2017)

However, micro wind turbines have a very low efficiency due to lower windspeed in domestic heights, compared to windspeed in 200 m altitude. According to Figure 81, solar power appliances are technically and economically the most effective ones.

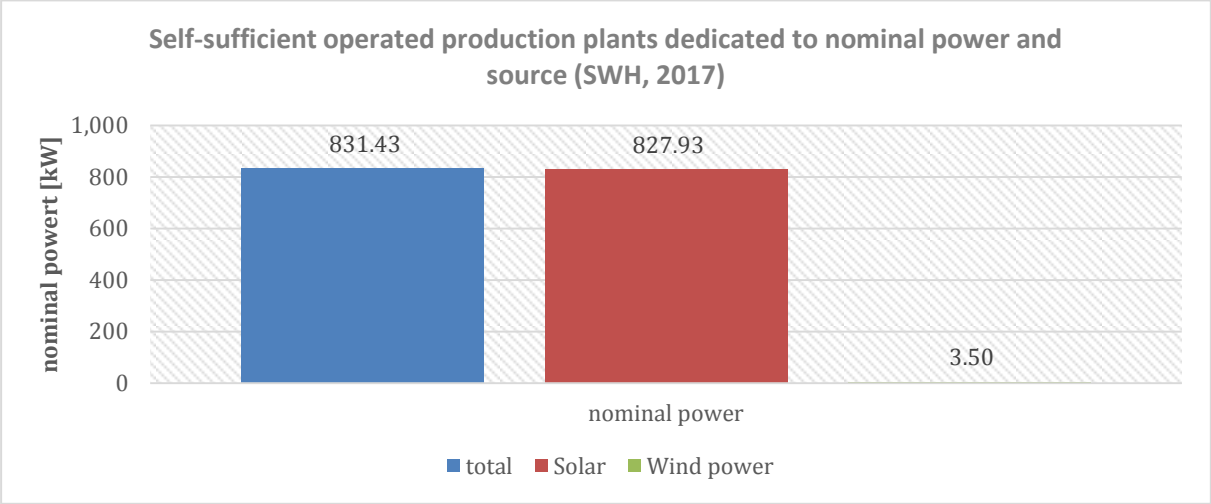


Figure 81: Self-sufficient operated production plants dedicated to nominal power and source (SWH, 2017)

In average, every prosumer household in Haßfurt has installed 20,27 kW of nominal power (cp. Figure 80 and Figure 81). It occurs, that there are some large non-residential prosumer installations registered. If these plants are being excluded of the analysis, the average of nominal power of prosumer households in Haßfurt decrease to 9,59 kW, which is an assumable dimension for (semi-) detached houses, that have a great share of Haßfurt's building structure.

The further progress of Task 1.2 the analysis of the specific influence of prosumer operation modes according to the three types (cp. Table 16) on the consumption patterns of SHF's customers will be done. This could not be finished due M12, because of extensive data collection and analytic processes had to be integrated manually in SHF's existing data handling processes. The findings will be included in the next update of this deliverable in M24.

4 Overall SIT4Energy User Taxonomy

In this section the SIT4Energy users, their needs and the specific energy demand is collaborated in a summarizing view. It is split to the pilot countries and the analysis is based on social and energy relevant factors.

Due to the first version of this deliverable in M12 the analysis based on social factors was fully executed. The energy demand analysis was started but is not finished, yet. The development of a user taxonomy based on energy demand will be shifted to the next versions of the deliverable in (M24).

4.1 German User Taxonomy

On the following pages the taxonomy of the German end-users is shown.

4.1.1 *German User Taxonomy based on socio-demographics, personality traits and attitudes*

In the following, the findings of Chapter 2.1 'Classification of German End-user types (consumers/prosumers)' will be presented in order to provide a rough taxonomy of the SIT4Energy target users based on the socio-demographic make-up, the energy-related personality traits and the attitudes towards energy efficiency detected in the German sample of household users.

4.1.1.1 *Social factors*

Socio-demographic make-up of the target user groups:

- The youngest age group consists of well-educated and well-earning young professionals in stable employment who also tend to be male.
- Respondents in the middle aged group tend to be male. They have the most varied educational backgrounds, but the group consists mainly of well-earning public and private sector employees.
- The oldest age group consists of the least formally educated, but best-earning respondents, who are also predominantly male. They have the most varied professional backgrounds of the age groups, including self-employment and retirement.
- The women in the sample tend to be older than 35 years of age, live in households that earn between 35.000 - 45.000€ per year and have no university education. They predominantly work as employees in the public sector. A smaller fraction is self-employed or employed in the private sector.
- The highest income earners in this sample are predominantly male and over 45 years of age (60%) or younger than 35 years (25%).

Openness to smart energy services

- The youngest respondents are the most aware of smart energy services and are open to their use, especially for the optimisation of their energy consumption. They might not have developed a need for production-related smart energy services yet.
- Despite their relatively high awareness of smart energy services, the middle aged groups are the least open to using them.
- Despite having the lowest general awareness of smart energy services of the three age groups, the oldest respondents are also the largest group currently using smart energy services for production and consumption optimization. This suggests the presence of a technology-affine subsection of prosumer pioneers in this age group.
- The female respondents are less aware of smart energy services and at lot less open to their use than the males. None of the female respondents are currently using smart energy services.

- The highest income respondents are also the ones who are the most aware of smart energy services and the most open to their use. None of the respondents in the lower income group is currently using smart energy services.

Agreeableness to net efficient curtailment behaviour

- Female respondents and respondents over the age of 45 are the most likely to agree with and actively conform to grid-efficient curtailment behaviour.
- The youngest age group is the least likely to actively exhibit 'agreeable' grid-efficient behaviour. Only half of the respondents indicated they would turn off appliances to support grid efficiency. One third refused to do so.
- In the middle aged group 60% of the respondents agreed to grid-efficient curtailment behaviour. 40% however did not. They are therefore the most reluctant age group to subject themselves to the behavioural constraints of grid-efficiency.
- There are no big differences in agreeableness between the two income groups. It is the highest earning group that also show the highest agreeableness, but overall the differences are negligible.

Conscientiousness

- The youngest and oldest age groups show similar distributions of conscientiousness across their groups. Both groups also tend to find production control and feedback slightly less important than consumption control and feedback.
- Overall, the youngest age group has the most respondents showing high levels of conscientiousness, which might be related to their general openness towards technological innovations and solutions. Since some of the young respondents are already earning well, some prosumers might be present in their age group as well.
- The fact that the oldest age group shows similar levels of conscientiousness to the youngest group might in their case be related to their financial prowess, which makes it more likely for them to be already prosumers. They might be members of the technology-affine sub-section of prosumer pioneers identified in this age group.
- The middle aged group gives the least importance to controlling their energy consumption/production and to receiving information about it. The majority in this group has a 'neutral' stance towards this possibility. Over the course of this analysis, this age group is emerging as the one with the lowest levels of openness to experience, agreeableness and conscientiousness of the three.
- Women have considerably lower levels of conscientiousness in regards to energy consumption/production control and feedback than their male counterparts. Their lack of interest is especially pronounced in the area of production control and feedback. As already seen above, they are also a group with very little openness towards smart energy management tools and technologies. At the same time, they are a group with many 'agreeable' personalities, which makes them a dormant but potentially interesting target group if activated to become prosumers.
- The highest income earners in the sample also have high levels of conscientiousness in regards to energy consumption and production control and feedback. Many of them are most likely already prosumers.
- The lower income earners have a lot lower levels of conscientiousness in regards to energy consumption and production control and feedback, which might also be related to the presence of many women in this group.

Inclination to save energy

- The inclination to save energy is high across the whole sample. Especially the youngest and the oldest age groups have similar high to very high inclinations to save energy, while the middle aged group is more neutral and less inclined towards it.
- The women in the sample are generally more inclined to save energy than the men. But the men who do feel inclined to save energy have a higher inclination to do so than most of the women.
- Similar to the inclination by gender, it is also the higher income group that has more respondents with a 'very high' inclination to save energy than the lower income group, while the lower income group is more inclined to save energy in general.

Motivation to save energy

- All respondents feel strongly motivated by environmental and financial reasons to save energy, with different emphasis and weighting across the groups. The third reason is most often 'recognition from your family', which emphasises the influence of significant others on individuals' energy behaviour.
- The youngest respondents, males and the lower-income earners are also motivated by 'personal praise' and the 'quality of the received information'. Only a small fraction of the higher income earners felt motivated by the 'quality of the information received'.
- The oldest respondents and the low income earners are most often motivated by financial reasons, followed by environmental concerns.
- All women equally valued the environment and cost saving, followed by 'recognition by your family'.
- The higher income earners are slightly more often motivated by environmental concerns than by financial considerations.

Willingness to learn about efficient energy production and consumption

- All respondents in the sample are generally more interested in learning about energy-efficient consumption than production, since not all of the them are currently prosumers, but consumers of energy.
- When looking at willingness to learn about energy efficient production and consumption by age, it is the youngest and middle aged groups that are the most willing to learn about it, even though they might not be prosumers yet. This shows that willingness to learn decreases with age and it can also be interpreted as a wish of the younger respondents to become prosumers later on.
- Women are generally more willing to learn about energy-efficient consumption than about energy-efficient production, which ties in with their lower incomes and openness towards technology in general, making them less likely to be prosumers.
- High-income earners are more interested in learning about energy efficient production, which makes sense, since they are most likely to also be prosumers. Lower income earners have a stronger interest in keeping energy bills low, which makes them more motivated to learn about energy-efficient consumption behaviours.

Actionability

- Women, the youngest and oldest respondents and the lower income earners are the respondents with the highest levels of actionability. This might either be attributed to the wish to become a prosumer expressed by those who are currently not in the socio-economic situation to execute this wish or seen as the general 'can do' attitude expressed by those older respondents who have the financial means and/or technical skills to actively improve their buildings' energy efficiency.
- The middle-aged group continues to emerge as the group, which tends to have some of the least developed attitudes towards energy efficiency, including their inclination to save energy,

their willingness to learn about energy efficient production and their actionability. In all these categories, they tended to show less enthusiasm than the youngest and oldest age groups.

Willingness to share resources

- Only male respondents indicated an interest to join a prosumer community in order to share resources. None of the women in the sample expressed such an interest.
- It is mainly the youngest and the oldest respondents who are willing to join a prosumer community and share resources. None of the middle aged respondents in the sample were interested to do so.
- It is mainly the higher income earners who are interested in becoming a member of a prosumer community and share resources. Only 20% of the respondents in the lower income groups expressed an interest in this possibility.

4.1.1.2 *Identified user groups*

Based on the previous findings, the following broad user groups can be identified:

Young environmental individualists

They are well-earning, well-educated male, young professionals who are aware of smart energy services and are open to their use, especially for the optimisation of their energy consumption. They have high levels of conscientiousness and are also willing to learn about energy efficient production and consumption. A minority might already be prosumers. They have a high to very high inclination to save energy and are mainly motivated by environmental reasons, followed by financial considerations. Unlike most others, they are also motivated by 'personal praise' and the 'quality of the received information'. They have high levels of actionability and are the most willing to share resources as part of a prosumer community. At the same time, they have the lowest levels of agreeableness to comply to curtailment behaviour made necessary by the demands of grid efficiency.

Middle-aged sceptics

They tend to be middle aged males with varied educational backgrounds and high incomes in stable employment. They give the least importance to controlling their energy consumption/production and to receiving information about it. The majority in this group has a 'neutral' stance towards saving energy. They are the group with the lowest levels of openness, agreeableness and conscientiousness of the three. They also the group, which tends to have some of the least developed attitudes towards energy efficiency, including a comparatively low inclination to save energy, no willingness to share resources as part of a prosumer community and low actionability. Across all attitudinal categories, they tend to show less enthusiasm than the other respondents.

Older tech-affine pioneers

They are well-earning older workers with a low formal education but high levels of openness towards smart energy services for production and consumption optimization. They have a high inclination to save energy and are often motivated by financial reasons, followed by environmental concerns. They also have high levels of conscientiousness, but a lower willingness to learn about energy efficient production and consumption. They have high levels of actionability and agreeableness and are also interested in joining a prosumer community in order to share resources. They are most likely already prosumers.

Female traditionalists

The women in the sample are their own group, since they have specific socio-demographic, personality-related and attitudinal characteristics, in which they differ from the rest of the sample. They tend to be older than 35 years of age, earn moderate incomes and have no university education. They predom-

inantly work as employees in the public sector. A smaller fraction is self-employed or employed in the private sector.
They are inclined to save energy and are equally motivated by environmental and financial concerns, as well as by their family orientation. They are a group with very little awareness of and openness towards smart energy management tools and technologies: none of them are currently using smart energy services. They are also not interested in joining prosumer communities. They have low levels of conscientiousness, especially in the area of production control and feedback. They are generally more willing to learn about energy-efficient consumption than about energy-efficient production, which ties in with their lower incomes and their little openness towards technology in general, which makes them less likely to be prosumers. At the same time, they belong to the respondents with the highest levels of actionability and have many 'agreeable' personalities in their group, which is also shown by their high family orientation. This makes them a dormant but potentially interesting target group if activated to become prosumers.

4.1.2 *German User Taxonomy based on energy demand*

Mainly due to measurements heterogeneity for selected/agreed pilot buildings, energy data is being currently collected and their analysis will follow on the second version and will be delivered in the next version of the document (M24).

4.2 Greek User Taxonomy

On the following pages the taxonomy of the Greek end-users is shown.

4.2.1 *Greek User Taxonomy based on socio-demographics, personality traits and attitudes*

In the following, the findings of Chapter 2.2 'Classification of Greek End-user types (consumers/prosumers)' will be presented in order to provide a rough taxonomy of the SIT4Energy target users based on the socio-demographic make-up, the energy-related personality traits and the attitudes towards energy efficiency detected in the German sample of household users.

4.2.1.1 *Social factors*

Socio-demographic make-up of the target user groups:

- The youngest age group people (mainly the student respondents) have only bachelor's degree of education and have the lowest yearly income.
- The oldest age group people possess the highest formally educational degree with the highest degree of occupation in university with the highest yearly incomes, who are predominantly male.
- None of the respondents have more than 40.000 € yearly income and the highest income earners in this sample are predominantly male (22%) the half of which belonging to the group over 45 years old.

Openness to smart energy services

- Generally, Greek academy respondents' are passive users of energy management services both at their households and at their workspaces.
- The highest income respondents are the ones who are the most aware of smart energy services and the most open to their use. None of the respondents in the lower income group is currently using smart energy services.

Agreeableness to net efficient curtailment behaviour

- The oldest age group is the most often willing to forego personal comfort and convenience in order to maximise grid efficiency.

- None of the male respondents openly refused to switch off appliances during peak hours at their households, on the contrary, around one fourth of female respondents do not like to switch off appliances at their households.
- The middle earning group (20.000-30.000€) shows 100% agreeableness to switch off appliances at households, while the highest and lowest earning groups show 75 and 85% agreeableness respectively.

Conscientiousness

- The highest percentage of respondents have high levels of conscientiousness in regard to the energy consumption control and feedback especially at their households.
- Both women and men tend to think that energy consumption control and feedback is rather important and very important for both households and workspaces.
- The highest income earners also show higher levels of conscientiousness, which is not surprising, since the majority of the over 45 year olds discussed before are also part of this group.
- In overall, most of them find it either rather important or very important to have a control and feedback about their energy consumption regardless their gender, income or age.

Inclination to save energy

- The inclination to save energy is high across the whole sample. Especially the oldest age group has very high inclinations to save energy. No negative inclination observed across the whole sample.
- The women in the sample are generally more inclined to save energy than the men.
- Similar to the inclination by gender, it is also the higher income group that has more respondents with a 'very high' inclination to save energy than the lower income group, while the lower income group is more inclined to save energy in general.

Motivation to save energy

- The oldest respondents in the sample are also the ones that are the most motivated by environment protection (100%), while this reason become less relevant in the middle years old groups (ca. 90%), and youngest group (50%).
- Both men and women are motivated by environmental concerns a bit more than by financial concerns. Both for men (44%) and women (54%) 'The information you receive is provided in a simple and aesthetically appealing way" was also an important reason to save energy. In addition, 15% of women can be motivated via "receiving recognition from their family" revealing that they are more family-oriented than the male respondents.
- The higher income earners are slightly more often motivated by environmental concerns than by financial considerations. The quality of received information would motivate especially the lower income earners.

Willingness to learn about efficient energy consumption

- It is the oldest age group that is the most willing to learn about energy efficient consumption; with 50% important and 50% 'very important' answers for both household and workspace options. The 35-45 years old group find mostly important to receive tips about their energy consumption at household (equally shared percentage for "very important" and "important options"). 25-35 years old group observed to be quite motivated to receive tips about their energy consumption at both households and workspaces.
- Most of the women more likely desire to learn about energy efficient consumption at household (61% "very important" and 23% "rather important") than that of at workspace (36% for both options). On the contrary to this, more than 50% of male respondents find it "rather important" to learn about their workspace efficient energy consumption and 44% important to learn about their household efficient energy consumption.
- Learning about energy efficient consumption at households is of the interest of all respondents regardless their yearly income. Although very small percentage of the respondents having the lowest yearly income feel that is unimportant to learn more about the energy consumption. In

respect to learning more about energy consumption at workspace, together with the positive answers, 50% respondents with the highest year income feel "neutral" to learn more about their workspace energy consumption

Actionability

- The respondents mostly have positive attitude about the "Being able to perform actions that improve my building's impact on the environment is important to me" statement and regardless their age, gender and yearly income show high enthusiasm and high levels of taking action to improve their buildings' energy efficiency. These results are promising attributing their willingness to become efficient energy consumers or even become energy prosumers.

Willingness to install Renewable Energy Sources (RES)

- The female respondents indicate more interest to install RES to their households than the male respondents.
- Although the positive and environmentally friendly attitude of the oldest respondents throughout of this sample 50% of them are not ready to install RES in the future.
- The lowest income earners are interested in becoming a member of a prosumers or to install RES to their households while on the contrary 25% of the respondents in the highest income groups do not express an interest in this possibility.

4.2.1.2 *Identified user groups*

Based on the previous results the following user groups can be identified:

Young individuals

They are mainly university students (currently studying) with the lowest yearly income. They are aware of smart energy services and are open to their use, especially for the optimisation of their energy consumption at their households. The have a positive inclination to save energy and are mainly motivated by financial considerations followed by environmental reasons. Unlike most others, they are also motivated by 'recognition from family' and the 'quality of the received information'. They have medium levels of actionability and willingness to install RES to their households. Currently not using any energy management services/tools

Middle-aged university occupants

They tend to be middle aged males and females university occupants with Master's and Doctorate levels of educational and low/medium yearly incomes. Currently, they do not use smart energy consumption services at their households or workspaces although they show medium towards high levels of openness, agreeableness and conscientiousness. They give the significant importance to controlling their energy consumption and to receiving information about it. The majority in this group has a 'neutral' stance towards saving energy. They tend to be motivated firstly by environmental concerns, by cost also by receiving recognition from their family. They have some of the least developed attitudes towards energy efficiency at their workspaces, including a comparatively low inclination to save energy. They show willingness to install RES systems and become prosumers.

The elder academics

They are well-earning oldest age male academic representatives with the highest level of formal education, highest levels of openness towards smart energy services for energy consumption optimization both at households and workspaces. They have the highest inclination to save energy and are often motivated by environmental concerns followed by financial reasons. They also have high levels of conscientiousness and willingness to learn about energy efficient consumption, high levels of actionability and agreeableness. Despite these facts none of them currently use any kind of energy management services nor at their households neither at their workspaces.

4.2.2 *Greek User Taxonomy based on energy demand*

Energy measurement equipment hasn't been deployed yet so the demand analysis couldn't be finalised at the delivery time for the first version. This will be delivered in the next version of the document (M24).

5 Conclusion

In this deliverable the analysis of target users (household/prosumer in Germany and academic staff in Greece) in matters of social factors (sociodemographic, personality traits and attitudes) was done, based on findings of Task 1.1 *"Market Research Design"* respectively *D1.1 "Market Research Survey Tool".* Furthermore, the analysis of the energy demand of end-users was started until M12 of the project. So far, the general analysis of energy use in the pilot countries with respect to the residential sector was done. It could not be finalized in deep due the deadline of the first deliverable version, because of various technical and organisational reasons.

For the German pilot site in Haßfurt historical consumption and production data is stored in the database of SHF back to 2012. Yet, there are no processes defined to collect, extract and analyse such a baseline data. The new processes were initiated and first data-sets were extracted. In the further runtime the baseline data for several types of prosumer customers of SHF will be extracted and presented in the next version of the document in M24.

The energy demand analysis of the Greek pilot site could not be started, because the installation of the meter infrastructure in the buildings is being prepared and will be done soon. A further analysis of the energy demand will be made after the collection of the baseline was done in the next version of deliverable M24.

The analysis of the social factors gave the following findings of both pilot countries:

Table 17: Identified user groups of the SIT4Energy user taxonomy, according to social factors

Identified user group	Germany	Greece
1	**Young environmental individualists** • well-earning, well-educated young professionals • aware of / open to smart energy services • high levels of conscientiousness • willing to learn about energy efficient production and consumption. • high inclination to save energy • mainly motivated by environmental reasons • motivated by 'personal praise' and 'quality of the received information' • high levels of actionability • most willing to share resources as part of a prosumer community • lowest levels of agreeableness to curtailment behaviour to the demands of grid efficiency	**Young individualists** • low income, university students • aware of / open to smart energy services • positive inclination to save energy • mainly motivated by financial considerations • motivated by 'recognition from family' and the 'quality of the received information' • medium levels of actionability • medium levels of willingness to install RES to their households • not using any energy management services/tools
2	**Middle-aged sceptics** • high income, varied educational backgrounds stable employees. • give the least importance to con-	**Middle-aged university occupants** • low/medium yearly incomes, university occupants with Master's and Doctorate levels • do not use smart energy consumption

Identified user group	Germany	Greece
	trolling their energy consumption/production and to receiving information about it • 'neutral' stance towards saving energy • the lowest levels of openness, agreeableness and conscientiousness • tend to have some of the least developed attitudes towards energy efficiency • low inclination to save energy • no willingness to share resources as part of a prosumer community • low actionability • tend to show less enthusiasm than the other respondents.	services • show medium/high levels of openness, agreeableness and conscientiousness • give importance to controlling their energy consumption and to receiving information about it • 'neutral' stance towards saving energy • motivated firstly by environmental concerns, by cost also by receiving recognition from their family • least developed attitudes towards energy efficiency at their workspaces • low inclination to save energy • show willingness to install RES systems and become prosumers.
3	**Older tech-affine pioneers** • well-earning older workers • low formal education • high levels of openness towards smart energy services for production and consumption optimization • high inclination to save energy • motivated by financial reasons, followed by environmental concerns • high levels of conscientiousness • low willingness to learn about energy efficient production and consumption • high levels of actionability and agreeableness • interested in joining a prosumer community in order to share resources • most likely already prosumers.	**Elder academics** • well-earning oldest age academic representatives • highest level of formal education • highest levels of openness towards smart energy services for energy consumption optimization • highest inclination to save energy • motivated by environmental concerns followed by financial reasons • high levels of conscientiousness and willingness to learn about energy efficient consumption • high levels of actionability and agreeableness • not using any kind of energy management services nor at their households neither at their workspaces
4	**Female traditionalists** • specific socio-demographic, personality-related and attitudinal characteristics • employees with moderate incomes • inclined to save energy • motivated by environmental and financial concerns, as well as by their family orientation	

Identified user group	Germany	Greece
	• very little aware of / open tosmart energy management tools and technologies • not using smart energy services • not interested in joining prosumer communities • low levels of conscientiousness • willing to learn about energy-efficient consumption • highest levels of actionability • high family orientation	

Concluding can be retained, that the influence of social factors is quite similar in the pilot countries through all ages. It has to be considered, that in both pilot countries different target groups were asked, so the outcome of identified user groups is different in its names, according to the occupation and the general living conditions.

It is observed, that in Greece the respondents are not familiar with prosumer systems at all and do mostly not have installed a RES at home or at the working space. Whether in Germany, more people do know RES, but have a lack of information how to use it efficiently. The highest claim of the SIT4Energy project will be to close this gap of information knowledge of energy end-users in Germany, Greece and all over Europe with its developed assets and services.

References

[1] BDEW Bundesverband der Energie- und Wasserwirtschaft e.V., "bdew - Energie.Wasser.Leben," 11 2017. [Online]. Available: https://www.bdew.de/service/daten-und-grafiken/stromverbrauch-der-haushalte/. [Accessed 21 02 2019].

[2] co2online gemeinnützige Beratungsgesellschaft mbH, "CO2online," 27 11 2018. [Online]. Available: https://www.co2online.de/energie-sparen/strom-sparen/strom-sparen-stromspartipps/stromverbrauch-im-haushalt/. [Accessed 21 01 2019].

[3] Bayerisches Landesamt für Statistik, "Statistik kommunal - Stadt Haßfurt 09674147," 02 2018. [Online]. Available: https://www.statistik.bayern.de/statistikkommunal/09674147.pdf. [Accessed 26 02 2019].

[4] Federal Ministry for economy and energy, Germany, "Informationsportal Erneuerbare Energien," Init AG, 2019. [Online]. Available: https://www.erneuerbare-energien.de/EE/Redaktion/DE/Dossier/eeg.html?cms_docId=73930. [Accessed 01 03 2019].

[5] Energieinstitut der Wirtschaft GmbH, "Energiekennzahlen in Dienstleistungsgebäuden," Wien, 2012.

[6] "DESTATIS," 2018. [Online]. Available: https://www.destatis.de/EN/FactsFigures/EconomicSectors/Energy/Production/GrossElectricityProduction.html. [Accessed 14 02 2019].