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SCHOOL OF MARKETING AND COMMUNICATION

DEPARTMENT OF MARKETING

Paula Korpi

CONSUMERS IN ENERGY TRANSITION

Motives and barriers for prosumption

Master's thesis in
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FIGURES AND TABLES

LIST OF SYMBOLS AND ABBREVIATIONS

CFA	Confirmatory Factor Analysis
DER	Distributed energy resources
DSM	Demand-side management
DR	Demand-response
EESC	European Economic and Social Committee
EFA	Exploratory Factor Analysis
G-D	Goods-dominant logic
GHG	Greenhouse Gas emissions
KMO	Kaiser-Meyer-Olkin’s test
KPI	Key performance indicator
PV	Photo Voltaic panels
S-D	Service-dominant logic
SESP	Smart Energy Systems Research Platform
VBN	Value-Belief-Norm theory
VIP	Value Identity Personal norm model
WT	Wind turbines

UNIVERSITY OF VAASA
Faculty of Business Studies
Author: Paula Korpi
Topic of the Thesis: Consumers in Energy Transition
Degree: Master of Science in Economics and Business Administration
Department: Department of Marketing
Supervisor: Arto Rajala
Year of Entering the University: 2018
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ABSTRACT:

Due to the climate change, energy industry is in continuous change. The importance of committed consumers is rising as they need to reduce their energy consumption in the households too. In this thesis the main focus is on consumers' energy consumption and possible motivations or barriers to become small-scale electricity producer with sustainable energy technology such as solar panels.

This study is part of Smart Energy Systems Research Platform (SESP) and Fleximar projects in which the main focus is on smart energy and in flexible business models in smart energy. The empirical part of this study was performed with a survey that was exploited in a Facebook group *Tuuli-, aurinko- ja pienvesivoiman itserakentajat* that consists of members who have an interest in small-scale energy production. The aim of this research is to create an overview for the reader about energy transition, prosumption and consumer's role in the energy transition. The aim is to examine what kind of motives and barriers consumers might have towards prosumption and how consumers can be classified in different groups based on their environmental self-identity, energy literacy and energy behavior.

With the results of this research can be identified five different consumer groups that consist of consumers who either already are prosumers, are considering to begin prosumption or are not prosumers. These groups were named as passive consumers, green consumers, engineers, expert engineers and unknown consumers. The groups were classified based on their environmental self-identity, energy literacy and energy behavior.

KEYWORDS: Energy transition, prosumption, renewable energy, energy behavior, energy literacy

1 INTRODUCTION

As the energy consumption is constantly changing and rising globally, the importance of committed consumers is even higher. The global emission targets have driven also the households to reduce their energy consumption. (Pakkanen & Tuuri, 2015) This has led to the rapid growth in the adoption of renewable energy technologies such as photo voltaic (PV) and wind turbines (WT) that are considered as a key to reducing the threat of global climate change. (Palm 2018; Palm & Tengvard 2011) This has motivated households to produce energy on a micro-scale at home. Consumers that simultaneously produce and consume (energy) are called as prosumers. (Toffler 1980)

The model of today's electricity market is plain. Electricity companies have two different options to attain energy: they generate needed energy in enormous centralized utilities or buy it from wholesale markets. After that the energy transfers through the transmission grid to the distribution grid and the retailer sells and distributes the energy to the end-user (customer) who consumes it. Nowadays, the prosumers of small-scale renewable energy systems have become more noticeable source of energy generation. (Richter 2013)

The dominant design of today's electricity market is fracturing. Through the digitalization the markets are changing and the consumers are becoming a much more important part of the market than ever before. Consumers are beginning to produce energy by themselves with photo voltaic panels and wind turbines, making them prosumers. This thesis will discuss about the prosumers' role in Smart Grid innovation ecosystem as part of the energy market transition from traditional energy system to future flexible energy ecosystem based on renewable energy sources.

The transition to more flexible energy ecosystem is facilitated by international agendas and governments' actions to slow down climate change globally and to achieve technological advancements in multiple areas like consumer electronics (Kotilainen, Mäkinen, Järventausta, Rautiainen & Markkula 2016).

Prosumers share the surplus energy generated by renewable energy sources with other consumers through a smart grid. Smart grid is an intelligent power system with integrated communication infrastructure, which allows consumers to create communities according to various criteria, such as energy consumption behaviour (Zafar, Mahmood, Razzaq, Ali, Naeem & Shehzad 2018; Verbong, Beemsterboer & Sengers 2013).

The behavior and identities drive people toward sustainable energy behavior. In practice, individuals' attitudes have a high impact in their energy behaviors and therefore, changing behaviors is essential for improving energy conservation (Khansari, Mostashari & Mansouri 2014). Hence, it is important to understand what kind of identities and attitudes consumers have towards energy consumption.

1.1 Aim and research questions of the thesis

The purpose of this thesis is to identify different consumer identities regarding to renewable energy consumption and production and also to identify households' motives and barriers of becoming a prosumer. The research is part of the SESP[1] (Smart Energy Systems Research Platfrom) and Fleximar[2] projects, which studies new smart energy solutions and flexible energy market platforms. This thesis discusses about energy markets in general but focuses more on the electricity market as a part of the energy markets. The aim is to open up the situation of today's electricity market and consumers' role in it. To achieve the purpose of the research, the following research questions (RQs) are formulated:

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[1] SESP – Smart Energy Systems Research Platform is a project that is part of the AIKO program and it is associated with the collaboration between the government and the Vaasa region. The head executor of the project is the University of Vaasa and its partial executor is Hanken – School of Economics (Svenska Handelhögskolan) Vaasa unit. The aims of this project are in smart energy systems in laboratory environment that includes real-time simulator, in Big Data reserve and in Living Lab application. In addition, in this program new business model concepts and models are developed and they base on smart energy systems and their data exploitation. (SESP 2018)

[2] Fleximar – Novel marketplace for energy flexibility. The aim of this research project is to "enable also participation of distribution network connected smaller, flexible energy resource large-scale utilization in future power systems" (Fleximar 2019).

RQ 1. *What are the motives and barriers for households to become an electricity prosumer?*

RQ 2. *What kind of consumer/prosumer groups can be found by means of a survey made for consumers about their energy consumption and willingness to become an energy prosumer?*

The main purpose of this research can be achieved by approaching different objectives. The objectives provide a direction for the research, they construct the theoretical part and support the researcher while answering the research questions. The objectives for this particular research are as followed:

- to examine variables of consumers' intention to become a prosumer
- to explain and chart the today's situation of energy markets
- to identify different consumer groups regarding to micro-scale electricity production
- to understand what kind of motives and barriers consumers have towards prosumption

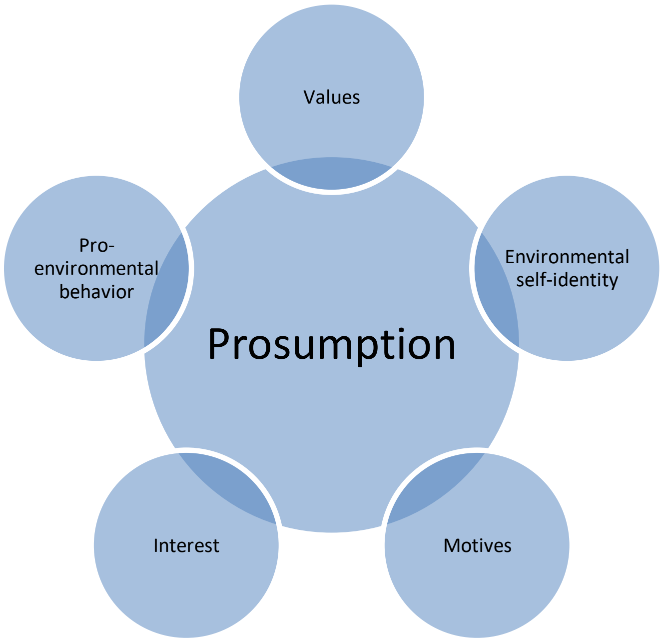

Figure 1. Key points of the thesis.

1.2 Research approach and limitations

The main point of view of this thesis is the view of consumer in the energy transition. How does the consumer see the electricity market, what is the role of a consumer in it and what are the motives and barriers of presuming energy in the customer viewpoint? The electricity markets and especially the micro-scale production of solar power is the main focus of this study, but due to the importance of the electricity market in the energy industry, the term energy industry will be used when discussed the whole industry in general. In this study, the term user refers to households, customers and consumers.

The primary data will be collected with structured interviews such as surveys from households in Finland. Because the main objective of this thesis is to chart the means how to motivate households to start producing energy.

1.3 The structure of the thesis

This thesis consists of six different chapters. The first chapter reviews the background of the topic, along with the purposes, objectives, research approach and limitations.

The present situation and the characteristics of the energy industry is discussed in the second chapter along with the consumers' role in the energy market. The acceptance of new technologies is also considered in this chapter.

In the third chapter, the consumers' role in the energy transition is taken into a closer observation. Theoretical framework for the empirical study is demonstrated in this chapter. Important terms and phenomena are defined with current secondary material. Energy behaviour of the consumers, behavioural trends and also the energy literacy are discussed. Also, different prosumer identities are discussed.

The fourth chapter examines the methodological choices of the research examined along with the theories of the study. The way of collecting the data is also described in this chapter.

Chapter five describes the results of the study starting with the demographic and background information about the survey respondents. The following chapter six concludes the whole research.

1.4 Key definitions

In this section few of the key concepts are defined and explained briefly. These concepts will be discussed more thoroughly in the chapters 2 and 3 that build theoretical background for the research.

One of the most important concepts of this research is **prosumption** which means that consumers produce something for their own use and also for selling. Consumer who consumes and produces at the same time, can be called as **prosumer**. (Xie, Bagozzi & Troye 2007)

Another important concept is **energy transition** or specifically a sustainable energy transition that can be characterized by a system that uses less energy overall and is made up of an increasing share of renewable energy (Steg, Shwom & Dietz 2018). Energy transition is also a way towards transformation of the global energy sector from fossil-based energy to zero-carbon energy. Energy transition is caused by the need to reduce energy-related CO_2 emissions to fight the climate change. (IRENA 2019)

2 ENERGY SECTOR IN TRANSITION

The transition of the electricity market towards a more sustainable form of energy production based on renewable energies is a key action to fight climate change. (Richter 2013) “It is necessary to secure a safe, reliable and sustainable future” (Schuitema, Ryan & Aravena 2017). The new energy generation that consists of renewable energy, such as solar and wind energy, has more irregular nature than the traditional energy generation and that is why it will introduce new challenges for flexibility, storage and energy transmission. Consumers play a crucial role in achieving the energy transition, as their flexibility is required to adjust variable generation and peak loads. Consumers become more supple in their energy usage and may adopt technologies that enable greater trust on renewable energy sources. (Schuitema et al. 2017) The full potential of the distributed energy resources is best utilized when its enabled by local energy markets. A local energy market is a kind of marketplace where the end-users (prosumers) can trade and share their self-generated surplus energy locally among each other. Local market can also be a platform for the end-users to trade the energy with each other no matter the location. (Kilkki, Lezama, Nylund, Mendes, Honkapuro, Annala, Trocato & Faria 2018)

In this thesis the focus is in the motives and barriers that guide consumers to become prosumers. According to Koirala, Koliou, Friege, Hakvoort & Herder (2016), end-users will take part of the electricity markets much more actively than before. In a research, made by Academy of Finland, was found out that 35 percent of Finnish residents are interested in small-scale electricity production (prosumption). Also, over 70 percent would be ready to decrease their electricity consumption if there would be electricity shortage. These findings are interesting as researchers believe that consumers are not yet motivated to adopt new ways to use and produce electricity by themselves even if they are becoming more positive towards new energy-related technology. However, this research was based on that Finnish government’s goal to increase the amount of renewable energy to over 50 percent of the total energy usage by the year 2030 as it was 34 % in 2016. (Laatikainen 2018)

2.1 The present situation and future in the electricity market

According to the Energy Authority, Finnish office for energy regulation, in 2016 the installed capacity of solar energy was about 27 MW, when in 2018 it was already five times more, 120 MW. Hence, these numbers don't include off-grid installations. (Finsolar 2019) This shows that solar energy is taking place on the electricity market in Finland. It is approximately 0,2 % of the whole electricity production in Finland. The total amount of renewable energy production and usage in 2016 was 34 %. (Laatikainen 2018) While the European Union drives its own regulations with Europe 2020 Strategy, targeting to increase renewable energy sources 20 %, reduce the greenhouse gasses from 1990 levels by 20 % and improve energy efficiency by 20 % by the year 2020, consumers are trending about their own renewable energy installations (Richter 2013).

For electricity industry, the change is enormous. Today's markets are very simple: Electricity company generates the needed energy in big centralized utilities or buys it from wholesale markets (for example Europool Spot or Nordpool Spot), then the energy transfers through the transmission grid to the distribution grid, where retailer sells and distributes it to the end customer who consumes it (Richter 2013). Thus, the information of demand flows from customer to generation and needed supply correspondingly flows from generators to customers. However, to maintain nationwide power balance, production and consumption must be balanced at all times hence forecasting consumption plays a key role (Partanen, Viljainen, Lassila, Honkapuro, Salovaara, Annala & Makkonen 2014).

The electricity market system consists of electricity transmission and consumption. The transmission includes production, sales, transmission and distribution. In Finland the transmission and distribution are natural monopoles, but production and sales are open for competition, which were opened in steps for everyone in 1995 by electricity market laws. (Sähkömarkkinalaki 386/1995, later 588/2013) From 1998 all electricity users in Finland have been able to tender out their electricity supply. (Finlex 2013) This reform of the electricity laws has had as a target to improve and increase the operational efficiency and integrate Finnish electricity market to the Nordic electricity markets.

In the beginning of 2019 EU accepted the new electricity market reform where, for example, the market models will be adjusted to fit renewable energy by adding flexibility to trading, transmission and demand. The role of the customers will be stronger as there will be, for example, more information and the own production will become more desirable. (Salomaa 2017)

2.2 Electricity market in Finland

Finnish electricity market has been divided to two different markets; wholesale electricity market and retail electricity market. The wholesale electricity market in Finland is part of the Nordic power exchange, which consists of Nordic and Baltic countries. About 70 % of the used electricity in the Nordic countries comes from the power exchange. In the retail electricity market, the retailers sell the electricity to the consumers. Retailers either produce the energy themselves or buy it from the power exchange. (Energiateollisuus 2019)

The electricity market in Finland was opened for competition in 1995. The transmission, production and sales are working as their own business fields. Production and sales are operating under competition unlike transmission, which works as a regional monopoly. All the regional monopolies are regulated and controlled by the Finnish Energy Authority. (ELFI; Ministry of Economic Affairs and Employment) Generally, electricity market system is divided into four different sectors; production, transmission, distribution and consumption. Each one of these sectors have their own focus, but as the technology has developed in past years, the differences between pure electricity producers and -consumers have faded. Consumers have now more options to consume, produce and also store electricity by themselves with or without the support of electricity and transmission companies.

The electricity price on the retail market consists of company’s distribution fee and transmission costs. In addition, the price consists also of different taxes, such as, electricity tax, strategic stockpile fee and value added tax (see figure 1.). (Vantaan Energia

Sähköverkot Oy 2019) The electricity bill for the consumer consists of taxes (about 32 %), transmission (about 29 %) and energy sales (about 39 %).

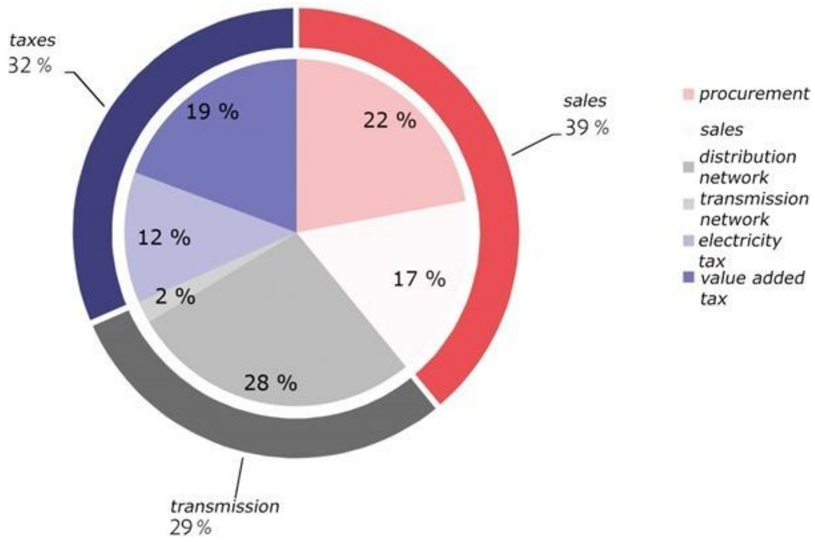

Figure 2. Electricity price for consumers (Energiateollisuus 2019).

Consumers are now interested in lowering their electricity bills and also cutting CO2 emissions which creates potential to the renewable energy markets. According to Ruostetsaari, Kotilainen, Aalto, Harsia, Heljo, Järventausta, Kallioharju, Kojo, Mylläri, Pääkkönen, Repo, Sorri and Uski (2018), the most popular way to lower one's electricity bills is to replace old electricity devices with new ones. They made a survey for Finnish residents between ages 18 and 75, in which three fifth said to be interested in trying new solutions for electricity consumption. The major result of their study was that Finnish residents are attitude-wise ready to lower their electricity bills with their own actions.

2.3 Consumers' role in the energy transition

As the energy transition is happening all the time, the consumers' role in it has become more important. Pierre Jean Coulon, the president of the EESC's section for Transport, Energy, Infrastructure and the Information Society said in February 2019 that "the energy transition cannot be successful if all stakeholders are not on board – we have to take into account the needs of all actors involved". (PEi 2019)

The daily life of consumers is going to be influenced by the future electricity grid that not only promises to be a radical technological, environmental and economic upgrade of the old system but it will also be a more pervasive technology. (Verbong et al. 2013) Consumers are interested in lowering their electricity bills and also lowering the carbon dioxide emissions at the same time. (Nasti 2012)

The users have not been actively involved in the grid innovations before, but they will likely play an important role in the future of smart grids. The extent to which users are willing to accept changes in their homes and daily routines will not only shape what smart grids will look like, it will also have an impact on the chances of successful implementation (Verbong, Beemsterboe & Sengers 2013)

Stakeholders are expecting that energy will become more significant theme for the end-users. The attention is expected to rise when the users are put together with the relative proportion of the assets spent on energy. Reasons given for an increase in energy expenditures focus primarily on an increase in demand (Verbong et al. 2013). In particular loads such as heat pumps, solar panels and electric vehicles are expected to have an enormous impact on the electricity demand in the future. However, the challenge in the future will be motivating the end-users. How are stakeholders going to motivate end-users to play a more active role in their home energy management, to induce behavioral change (Verbong et al. 2013).

To accomplish behavioral changes, it requires long-term engagement of end-users and a need to focus on their daily routines. There are different views advocated to induce behavioral change (Verbong et al. 2013) and they generally involve some feedback and economic stimulus. (Verbong et al. 2013) Most people might not be very interested, but some end-users do want to know more about their energy usage in comparison to other households and about the effectiveness of energy saving measures. Thus, information sharing has an important role in the change. (Verbong et al. 2013)

2.4 Future flexible energy systems

As the number of variable renewables, such as wind and solar power, increases, it means that the energy supply varies more in the energy system. Therefore, without flexible energy demand, the energy supply will most likely require an extra storage and volume in the system. Here the consumers' role becomes important, as they can advance the flexibility of the energy system by playing an active role in both the demand for and supply of energy. Consumer flexibility is needed in order to shift the energy demand to times of the day when renewable energy is available, for example when it is windy (WT) or the sun is shining (PV panels). It is also needed to reduce energy demand when the supply of energy is inadequate. (Schuitema et al. 2017)

The used term to describe various measures for improving the efficiency and flexibility of energy demand from the consumer side is **demand-side management** (DSM). One part of the DSM is **demand-response** (DR) measures which are designed to boost consumers to change their energy consumption. (Schuitema et al. 2017)

In households, demand response can be seen in a few different ways: automatic control from the retail side, automation in buildings and manually. With automatic control, the retailer or distribution system operator manages the load control according to predefined settings. In other words, this means that the controller may turn off the heating with control relays during a peak of demand and put it back on after the load is stabilized and prices are lower. For consumers, this decreases the electricity bill and retail side benefits from steadier loads and lower peaks. With automation in buildings, different loads are connected behind different relays, which can control the usage of, for example lightning and heating. Essentially, the customer can also control manually one's own load, but this requires high motivation and real-time price information. In the future also electric vehicles with their batteries can be part of demand response, for example charging and discharging the batteries depending on if the price is high or low and function as power supply for the electricity system. All of the ways mentioned above require smooth data transfer between customer and retail or system operator side and reliable relay procedure. (Välkkilä & Rajala 2018; Sähköala 2017)

2.5 Acceptance of the new energy-related technology

Consumers are often skeptical when new technologies such as electronical vehicles or renewable energy technologies are introduced, as they are normally seen as novel technologies of which mass-market consumers have only a little experience of (Schuitema, Anable, Skippon & Kinnear 2013). However, consumers can enable a flexible energy system by adopting new technologies. (Schuitema et al. 2017) Resistance from the side of consumers to the new technology "can complicate the implementation of sustainable energy technologies which may make the attainment of important environmental or societal goals" (Huijts, Molin & Steg 2012).

PV panels can be seen as transformational innovation to electricity markets, as they are still a minor part of electricity production, although, the line between general market segments and big-bang market segments is mainly blurry. More and more consumers are interested in PV panels and micro-scale electricity production and the users of PV panels are not anymore only innovators and early adopters (see figure 2). Vast majority is adopting the new electricity technology.

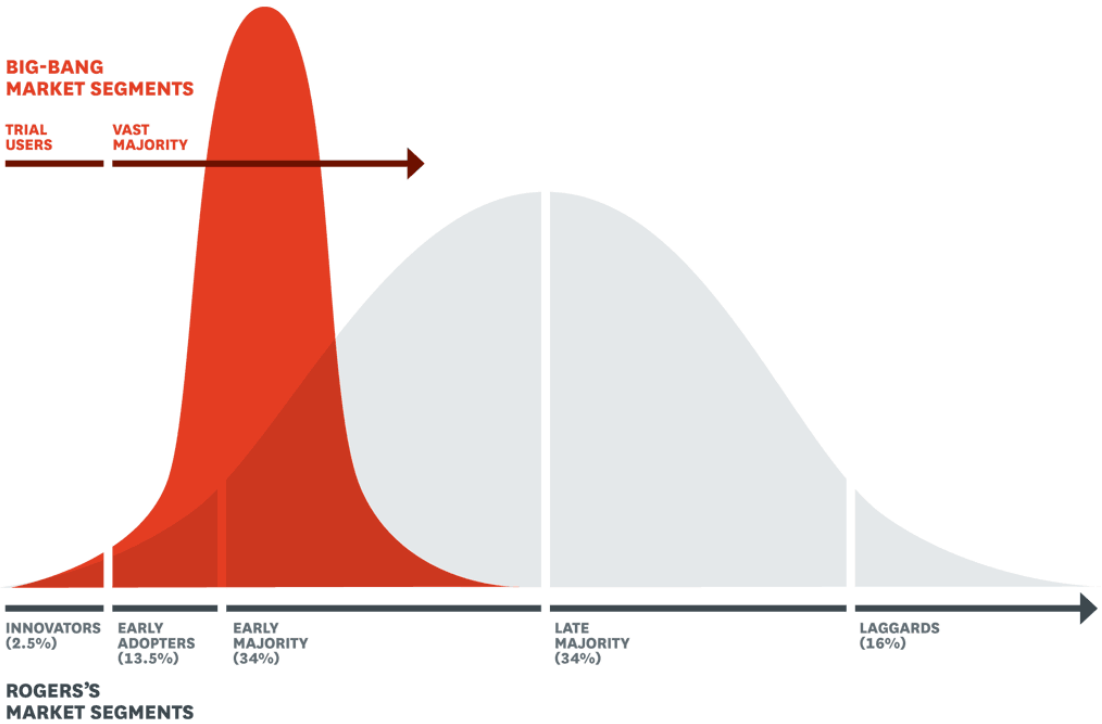

Figure 3. Big-bang disruption model (Downes & Nunes 2013).

As the transition in energy market is happening, the acceptance of new energy-related technologies has become higher. “Consumers can facilitate a flexible energy system by adopting new technologies and investing in them” (Schuitema et al. 2017). This kind of investments are typically enormous and might act as a barrier for consumers. There are various economic instruments though that can support consumer investment in clever and efficient technology that supports flexibility. According to Schuitema et al. 2017, one option is to increase overall energy prices. This may make energy-efficient technologies more attractive for consumers because of a higher rate of return or shorter payback time. This may though affect the most low-income groups as they cannot answer to the increased energy prices with investments. Schuitema et al. (2017) propose also as an alternative to increasing energy prices that incentives or subsidies could be provided to encourage investment in technologies that would improve the flexibility of energy systems.

One important part of the acceptance of new energy-related technologies is social influence as it appears that the more people who have adopted a particular technology, the more likely it is that others will do the same because of a neighboring effect. (Schuitema et al 2017) According to Schuitema et al. (2017) some consumers will adopt new technologies that hardly no one else has. These consumers are called innovators or early adopters (see figure 3) and they are described by a strong sense of innovativeness. On the other side of the curve in figure 3 are the other laggards, who are waiting that majority of others have adopted a technology before they will consider to do so too. Solar contagion can occur in neighborhoods where PV panels are installed visible and other neighbors see them and want to buy some own PV panels. The visibility of PV panels triggers others to adopt them too. This phenomenon is “connected to the symbolic functions of technology and the desire to express one’s identity, for example as an innovator or a green consumer” (Schuitema et al. 2017).

According to Schuitema et al. (2013), consumers’ intention to adopt new technologies is linked to their innovativeness, which can be defined as their tendency to buy new products in a certain product category shortly after they appear in the markets and also relatively earlier than other consumers. Vandecasteele and Geuens (2012) distinguished three main motivational dimensions of consumer innovativeness; instrumental, hedonic and symbolic (see figure 3).

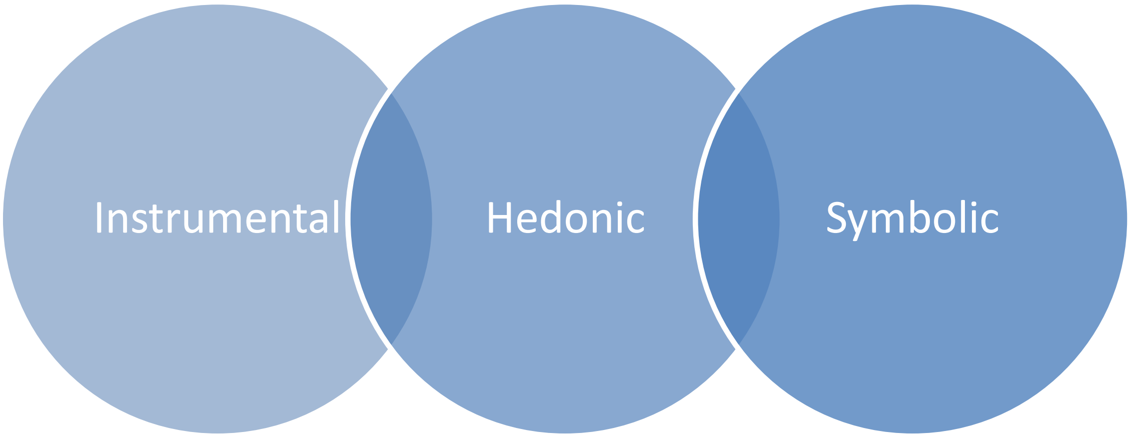

Figure 4. Main motivational dimensions of consumer innovativeness.

Generally, consumers focus most strongly on instrumental attributes when they have instrumental motives to adopt a product (Schuitema et al. 2013). Instrumental attributes mean the functionality or utility that may be led from functions that are performed by new technologies. When instrumental attributes are led from function, hedonic innovativeness probably leads to a strong focus on hedonic attributes that point to the emotional experience led from using new technologies. Symbolic innovativeness leads to a strong focus on symbolic attributes that refer to a sense of self or social identity that mirrors the possession of new technologies. (Schuitema et al. 2013)

3 CONSUMERS IN THE ENERGY TRANSITION

This chapter focuses on consumers as prosumers and on their identities and behaviour. Who prosumers are and how do they behave? What are consumers' motives and barriers towards prosumption? Energy literacy plays also a big part of this chapter. Holbrook's typology of consumer value acts as theoretical framework for this study and will be introduced in this chapter.

3.1 Definition of prosumption

Traditional thought of prosumption came from Toeffler 1980, when he stated that prosumers are consumers who produce for themselves by adapting, modifying or transforming a proprietary offering (Chandler & Chen 2014). Toeffler's idea of prosumers was to explain a certain transition in modern society. According to him, consumers were the first producers who satisfied their own needs by producing mostly for themselves. (Chandler & Chen 2014) Also Xie et al. (2007) state that prosumption stands for that buyers *pro*duce products for their own con*sumption.*

Xie et al. (2007) state that prosumption is a one whole process rather than a single act such as purchasing of a product. The process consists of integration of three different parts; physical activities, mental effort and socio-psychological experiences. Consumers participate in the process by providing their input on money, time, effort and skills. Therefore, prosumption is often defined as "value creation activities undertaken by the consumer that result in the production of products they eventually consume and that become their consumption experiences" (Xie et al. 2007). In that way prosumption is separated from customer participation in firm service. (Chandler & Chen 2014)

Traditionally in marketing there has been a consistent goods-dominant logic (G-D) that views consumers as passive buyers of what they or a company produce. At the present, service-dominant logic (S-D) is challenging the traditional view in marketing, as customers are seen as co-creators of value in the service-dominant logic, and this role involves customers producing products for their own consumption. (Xie et al. 2007; Vargo & Lusch 2007)

3.2 Consumer awareness of energy consumption

There are many studies done across the world showing that consumers are not really aware of their energy consumption. For example, Kalmi, Trotta and Kazukauskas (2018) found out that Finnish households have low levels of energy literacy, although one-fifth of total global energy demand comes from residential sector, such as requirements to heat and cool the households. Therefore, the energy efficiency should begin from the residential sector, from the consumers. (Brounen, Kok & Quigley 2012)

Policymakers have tried to design policies to reduce energy consumption through energy efficiency measures in the residential sector, but they have typically been based on engineering calculations and differed from outcomes observed in practice (Kalmi et al. 2018). This failure of consumers to make cost-effective investments in energy efficiency has often been referred as "energy efficiency paradox". Brounen et al. 2012 found out that the main reason for these behavioral failures is the lack of information and knowledge about the energy costs, which may lead to the efficiency gap. They also suggest that the increased transparency in energy consumption can encourage energy conservation among consumers. Ayers, Raseman and Shih 2009 showed that providing information to consumers about their energy consumption may reduce energy bills. However, a person who is knowledgeable about energy will not necessarily adopt energy saving behaviors or take part in actions that promote sustainable energy consumption in the future. (Kalmi et al. 2018)

Costa and Kahn (2013) identified several difficulties to realize the energy saving potentials. First, consumers may lack the information needed in order to act in their best interest; second, they may not be that interested in energy conservation even if they would in principle know what is in their best interest; third, consumers are probably more heterogeneous with respect of their attitudes towards energy conservation and their attitudes may influence their behavior. (Kalmi et al. 2018)

Khansari et al. (2014) showed in their studies that if consumers have improved access to information on energy consumption, they can make better use of energy which results in increased sustainability. Consumers as individuals and their energy behavior can be positively affected by focusing on information and feedback strategies to decrease energy consumption. As a result of their study, Khansari et al. (2014) found out that information provided by ICT technologies, such as smart phone apps, can shift the consumers' behavior towards a more efficient and sustainable utilization of energies.

3.3 Behavioral trends related to sustainable energy consumption

The consumer behavior changes all the time, and the change can be caused by economic crisis, war or lately because of the climate change. The concept of habits is an essential part of analyzing the determinants of domestic energy and particularly electricity consumption. Energy consumption is rising day after day, even when there is an evident increase of awareness and concern about energy-related environmental issues as climate change. Habits, such as switching off the lights or turning off appliances, can become counter intentional. (Maréchal 2010)

In the electricity market, four major behavioral trends between consumers have emerged; increasing environmental friendliness, control of own electricity consumption, utilization of electric vehicles and demand for better quality electricity supply.

The first behavioral trend, the increasing environmental friendliness has been a huge topic globally the last years, especially 2018 and 2019, as the young people of today have risen to draw attention to the global climate change. Around the world governments have introduced different regulatory frameworks to support consumers and industries to change their behavior towards renewable energy consumption. For example, different feed-in tariffs, taxing pollution and building infrastructure to ease the green investments have occurred in the new regulations. (Shomali & Pinkse 2016)

The second behavioral trend between consumers is the drive to have more control over own electricity consumption. (Clastres 2011) Because of the constantly increasing number of electric devices and appliances, the consumption of electricity is rising, as well are the prices, which makes consumers afraid. However, the willingness to make investments for future savings has emerged (Mardookhy, Sawhney, Ji, Zhu & Zhou 2014). With smart grids and smart metering, the tracking of own consumption in real-time has become easier and it gives an opportunity for the consumers to adopt their behavior and profile to save electricity. But not only the tracking of own consumption makes consumers change their behavior, but also the willingness for savings, which can be affected by consumers' urge for green values. This also has an impact on the whole value proposal and might lead to changes from selling electricity as a commodity to providing energy efficiency as a service (Fox-Penner 2010).

The future utilization of electric cars and other vehicles is the third behavioral trend. Electric cars become more common all the time, and they are having significant impact on total electricity demand. Due to their charging activities, the overall energy demand will increase. In the future also recharging stations for the electric vehicles with high power and efficient recharging could contain new ways to create value. (Carillo-Aparicio, Perez-Hidalgo & Heredia-Larrubia 2013)

The last and fourth trend is a demand for more secure and higher quality electricity supply. Transportation and many industries can be electrified in the future which relies on the electricity supply.

Our behavior is guided by habits. Some previous studies have shown that consumers have thoughts unrelated to the task at hand while performing a habit while the thoughts they have when performing a non-habitual form of behavior are connected with the task (Maréchal 2010). Hence, we are aware of the fact that we rely on habits even though we might not be completely conscious of it while performing the behavior caused by certain habits. (Maréchal 2010)

3.4 Energy behavior

Many studies have shown that human behavior and consumer behavior is an important factor in determining the effects of energy conservation and environmental protection (Shi, Wang & Wang 2019). Therefore, it is reasonable to start solving global environmental problems from human behavior and focus on exploring the factors that influence the formation of energy conservation behavior.

Earlier studies have found out that energy conservation behavior is people's choice based on comparing the costs and benefits of energy consumption. Price and households' income are the key factors that affect the behavior. According to Shi et al. (2019) it is generally believed that household income has a positive affect to households' energy consumption because when households' incomes increase so does the households' energy consumption. Studies have shown though, that families who earn more, tend to invest more in energy conservation technology, such as buying energy-efficient products, while low-income families rely on changing their behavior to save energy, such as use less products that spend more electricity like Saunas. (Shi et al. 2019)

Nevertheless, economic considerations alone do not explain the energy conservation behavior. For example, some people choose to travel green and eat only organic food that has been produced in ecological ways to practice their beliefs on environmental protection. This shows that people's behavior may not be only based on income or cost but also on their beliefs and habitual decisions.

Consumers are often driven by individual factors, such as values, identity, beliefs and norms, but also by features of the contexts in which individuals act, such as access to information, financial circumstances and social network connections. (Steg et al. 2018) But not only individual factors have an effect to consumers' behavior, also contextual factors may have an effect to it. Contextual factors are for example economic or cultural factors.

3.4.1 Individual and contextual factors

According to Steg et al. (2018) the first step to change consumers' behavior towards more sustainable energy, is to understand and be aware of how they use energy in general and what it needs to change towards more sustainable energy. People often underestimate the effect of changes that have large impacts and also overestimate the effect of changes that have small impacts. People might not understand the big picture, so they have a lack of information in order to behave effectively. Often information is not enough alone, then motivational factors play the key role. Motivational factors in general drive a wide range of behaviors, making them an important target for promoting consistent sustainable energy behavior (Steg et al. 2018).

Values are one of the most important motivational factors that influence consumers' energy behavior. There are four types of general values that are most relevant to understanding sustainable energy behavior: hedonic, egoistic, altruistic and biospheric values (see figure 4). Hedonic values are often described as values that make people focus on what makes them feel good and on ways to reduce effort, while egoistic values are described as making people focus on how to increase their resources like money or status. Altruistic values make people think of the ways to benefit others and biospheric values make people focus on consequences for nature and the environment. (Steg et al. 2018)

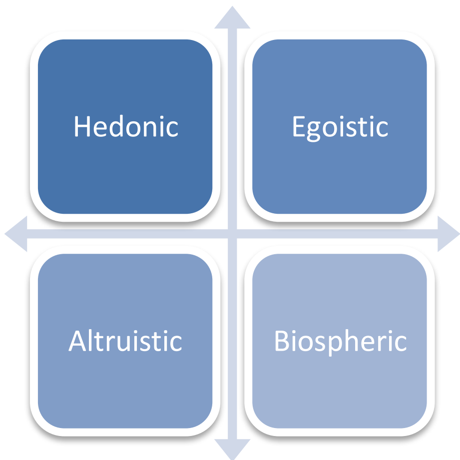

Figure 5. Four relevant values to understanding sustainable energy behavior.

According to Steg et al. (2018) strong altruistic and biospheric values encourage sustainable energy behavior. However, Mirosa, Lawson & Gnoth (2011) claimed that previous empirical work has shown low and sometimes nonexistent correlations between values and environmental behavior. In their findings, they found also relatively weak relations between behaviors and values, because they couldn't identify many of the underlying values for the behaviors. In the end they also state, that it is after all important to understand values in the context of energy behavior, because most people are likely to adjust their behavior to act more consistently with their values (Mirosa et al. 2011).

Van der Werff and Steg (2016) state that biospheric values have an influence on environmental self-identity. That means, the stronger the biospheric values are, the stronger environmental self-identity appears.

Along with the individual factors, also contextual factors may affect consumers' energy behavior. Contextual factors include spatial and infrastructural, economic, and cultural factors; institutional arrangements; and access to technology, products, services, and information (Steg et al. 2018). These contextual factors may also affect behavior directly by influencing the opportunities and constraining people to face and define the cost and benefits of different actions. For example, solar panels are easier to install to some houses than for other houses. (Steg et al. 2018)
Among other things, financial costs, time and effort are also defined as contextual factors. These factors can vary in different social groups and affect the equity effects of sustainability policies (Steg et al. 2018). Contextual factors do not only affect negatively on consumers' energy behavior, but they can also encourage consumers to focus on particular consequences of choices. For example, environmental symbols on products can remind consumers of their biospheric values, which make the values even more influential in decision making. (Steg et al. 2018)

3.4.2 Pro-environmental behavior

As stated before, less forceful policy tools such as giving out information, rely on the knowledge and willingness to change individual's behavior. Thus, informational policies only give the desired outcomes when households are willing to change their bad behavior patterns related to energy use. This implies an increased reliance on psychological factors, like pro-environmental attitudes and norms, in order for people to adopt environmentally beneficial behaviors (Andersson, Eriksson & von Borgstede 2012).

People are more likely to change their behavior in an environmentally friendly direction when the cost difference is small, as when it is compared to a large difference. Attitudes are stronger predictors of behaviors that are relatively easy or inexpensive to perform (low-cost) than of behaviors that are more demanding or costly to perform (high-cost) (von Borgstede, Andersson & Johnsson 2013). Von Borgstede et al. (2013) have divided behaviors related to energy conservation in two different sub-categories: high-cost energy behaviors and low-cost energy behaviors. Low-cost energy behavior is when a person fills up the dishwasher or switches off the lights when no one is using the room. High-cost energy behavior is in question when a person is choosing more environmentally friendly commuting modes or for example in this study, choosing more environmental way to produce electricity. (von Borgstede et al. 2013)

When talking about consumers' energy-using behavior, there are two different types of energy behaviors that should be distinguished: efficiency behaviors and curtailment behaviors. Efficiency behavior means such behavior that has happened only once, such as purchasing an energy-efficient car or household appliances. Curtailment behavior means behavior which involves repetitive efforts to reduce energy use, such as lowering thermostat settings at home. Curtailment behaviors are often based on the idea that a person consumes less and reduces the usage of equipment. These both types of energy behavior are important to prevent the climate change and to achieve energy efficiency. (von Borgstede et al. 2013)

3.4.3 Attitudes, norms and willingness to pay

Commonly known explanation for people's actions is that they are driven by their attitudes. Attitude formation is generally initiated by cognitive beliefs about a certain attitude object. These beliefs may or may not be facts about the object, like when a consumer reads something about a new technology, beliefs about that technology are formed based on both previous knowledge and on the new information. These beliefs together with the previous knowledge and new information may form an attitude that can be positive or negative towards the new technology. (von Borgstede et al. 2013)

Along with the attitude, also norms have an impact on how an individual consumer acts. Norms are generally defined to be expectations held by an individual about how one should act in a certain social situation. There are two types of norms; social norms and personal norms that act in different levels. "Social norms that have been internalized and that gain strength from personal conscience rather than from what others may expect are referred to as personal norms" (Schwartz 1977). These personal norms reflect commitment to internalized values and they are experienced as feelings of personal obligation to engage in particular behavior and an ascription to a personal responsibility to take action (Schwartz 1977). Both of the behaviors of others and individual's personal motivation are important in increasing the level of positive environmental behavior. (von Borgstede et al. 2013; Michaels & Parag 2016)

Personal action in environmental behavior can be visible in the way to accept to pay more in order to protect the environment. This thought is based on the notion that if something is worth having it is also worth paying for. Willingness to pay for new energy-related technology in household may be depending on the attitudes and norms of the consumer. A consumer who has environmental behavior and cares about the environment, may be more interested in to invest in new energy-related technology such as PV panels. (Von Borgstede 2013; Scarpa & Willis 2010)

According to Van der Werff and Steg (2016) value-belief-norm (VBN) can explain the environmental behavior (see figure 5). VBN theory focuses on normative considerations and it proposes that general factors such as values and environmental concern affect behavior specific variables, for example problem awareness, outcome efficacy and personal norms. Van der Werff and Steg state that in VBN theory, people tend to engage in pro-environmental behavior when they are feeling that they have to and they are morally obligated to do so. Consumers feel moral obligation stronger when they are aware of environmental problems caused by their own behavior (problem awareness) and when consumers feel they can do something about these problems (outcome efficacy).

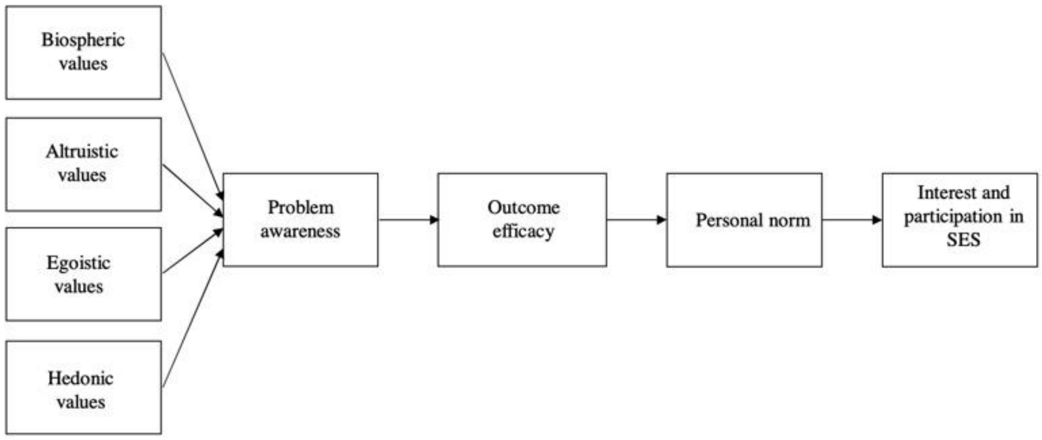

Figure 6. The Value-Belief-Norm theory (van der Werff & Steg 2016).

Earlier studies have demonstrated that the VBN theory predicts many environmental behaviors and perceptions among the consumers, for example, willingness to sacrifice (pay higher prices and reduce one's standard of living), the acceptability of energy policies, pro-environmental behaviors, the intention to use green devices, and many other. According to van der Werff and Steg (2016) it would be beneficial to identify general antecedents of environmental actions that may more likely to have effects on environmental behaviors. They suggest that by targeting such general factors, it may increase the probability that consumers engage in many pro-environmental actions which would have a more remarkable impact on environmental quality.

Van der Werff and Steg (2016) have created a new model for focusing on general antecedents of environmental actions: the Value Identity Personal norm model (VIP) (see figure 6). This model proposes that environmental behavior is influenced by feelings of moral obligation to engage in environmental behavior.

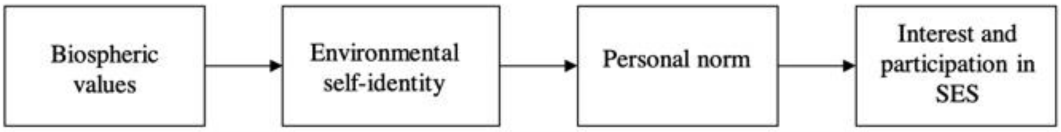

Figure 7. The Value-Identity-Personal norm model (Van der Werff & Steg 2016).

The VIP model focuses on general predictors of environmental actions, such as values and environmental self-identity whereas personal norm is behavior specific variable (van der Werff & Steg 2016). In van der Werff & Steg's model the environmental self-identity is found to mediate the relationship between biospheric values and the intention to use sustainable energy, energy behavior and recycling. The personal norm again is found to mediate the relationship between environmental self-identity and the intention to use renewable energy and product preferences. (Van der Werff & Steg 2016)

3.5 Electricity prosumer

Who then are the prosumers? Prosumers, as mentioned before, are regular consumers, who are interested in producing electricity by themselves and also in sharing it with other consumers by selling the produced electricity to the grid. The decentralized nature of renewable energy technologies gives the possibility for the producers to consume the production directly at site hence they become prosumers (Kästel & Gilroy-Scott 2015). Prosumers are not a new concept, they have been active in other industries, such as agriculture, for a long time. (Kästel & Gilroy-Scott 2015)

Electric power systems are traditionally divided into four different sections that are strictly producing, transporting or consuming electricity. These sections are generation, transmission, distribution and consumption. The boundary between producers and consumers is becoming blurrier as emerging technologies allow consumers to produce electricity by themselves. Therefore, ordinary consumers transform into hybrid agents: prosumers. (Nazari, Costello, Feizollahi, Grijalva & Egerstadt 2014)

Prosumers are not just people, but they can also be independent system operators, utilities, microgrids or even buildings. According to Nazari et al. (2014) all prosumers have to have three different layers; physical layer, control layer and communication layer. The physical layer includes devices inside a prosumer, such as generators. The control layer consists of control devices of the prosumer and the communication layer allows the prosumers to communicate with others and to share important, local information.

Personal identity is one of the relative motivational factors for sustainable energy behavior. It is especially important when promoting consistent engagement in sustainable energy behaviors because of the positive spillover effects referred to previously. (Steg et al. 2018) Self-identity has been defined as the label used to describe oneself (van der Werff, Steg & Keizer 2013; Cook, Kerr & Moore 2002). According to van der Werff et al. (2013) environmental self-identity is relevant to understanding pro-environmental actions, as it reflects pro-environmental actions, rather than the importance of the environment as such for the self.

"-- Consumers can potentially identify with a nearly limitless array of different category labels" (Reed II, Forehand, Puntoni & Warlop 2012). These category labels invoke a mental representation of what a person looks or feels like. Identities can be relatively objective, such as one's mother, daughter, etc. or they can be more subjective, like athlete or thrifty. However, consumers can be potentially self-identified with any possible category label, not all category labels will be essential to the consumer's self-definition. Reed II et al. 2012 highlights the fact that a category label becomes an identity only once the consumer has started to incorporate it into own sense of who they are and has initiated the process to become that person.

3.6 Consumer value

Holbrook defined consumer value with three continuous dimensions; intrinsic-extrinsic continuum, self- or other-orientation and value is either active or reactive. In the first one, intrinsic-extrinsic dimension, extrinsic value relates to the function of items which are valued for its ability to perform a task, such as hammer is valued for its functional ability to hammer and not valued for itself as a hammer. Intrinsic value on the other hand is related to a consumption experience that is appreciated for itself, for example participating in the sporting event. (Holbrook 1999)

In the second dimension, self- or other-orientation, self-oriented value is experienced directly by the consumer and the other-oriented value is captured only when other people are involved in the consumption experience. For example, participating in a charity bicycle ride in which the enjoyment of the ride is self-oriented value captured. But when the individual receives some recognition from the charitable organization due to their fundraising effort that is other-oriented value captured. (Loane, Webster & D'Alessandro 2015; Holbrook 1999)

The third dimension sees value either active or reactive. According to Holbrook, active value is created when a consumer does something, physically or mentally, as a part of a consumption experience. An example of active value is when a consumer watches television for the enjoyment of TV entertainment content. "Reactive value again is created when a good or service being consumed does something to or with the consumer, such as a beauty salon providing a visually pleasing manicure" (Loane et al. 2015).

In Holbrook's typology from 1999, these three dimensions are classified in eight types of consumer value; efficiency, excellence, status, esteem, play, aesthetics, ethics and spirituality. Later in 2006, Holbrook organized them into four general value categories; economic value, hedonic value, social value and altruistic value. Holbrook's typology is demonstrated in the table 2 below. In the newest version, economic value comprises of efficiency and excellence and hedonic value comprises of play and aesthetics. Social value consists of status and esteem and altruistic value includes ethics and spirituality. (Loane et al. 2015)

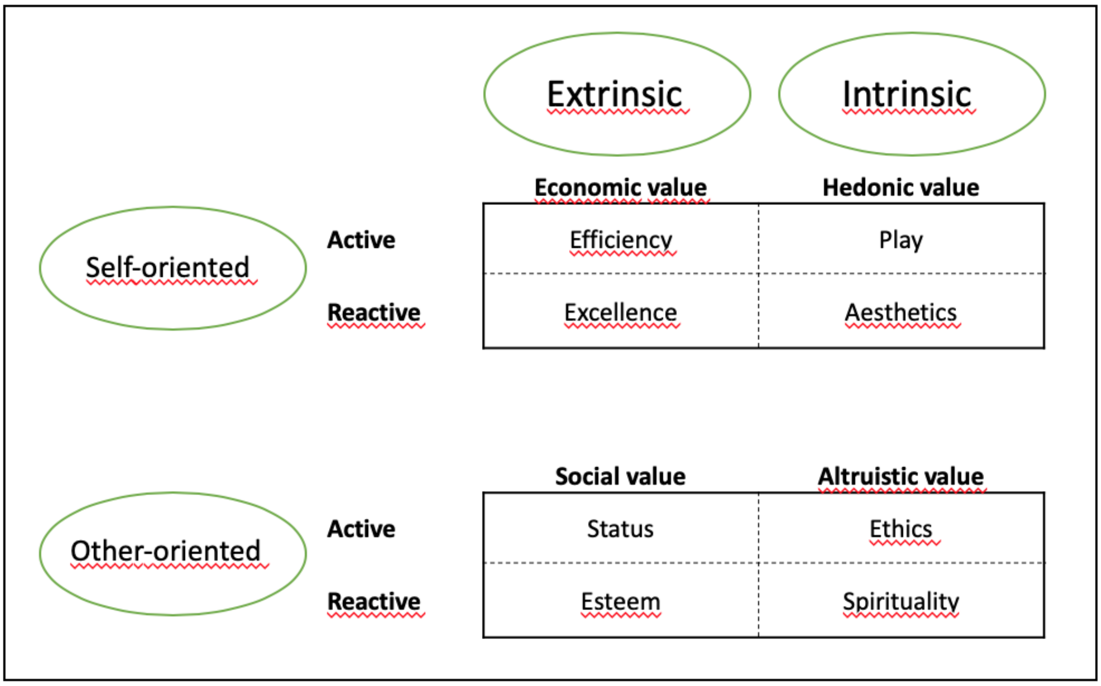

Figure 8. Holbrook's typology of consumer value.

In Holbrook's studies (1999) he has identified four different characteristics of consumer value which are summarized in his quotation:

"Value is an interactive relativistic preference experience"

First, consumer value is *interactive* because it can only be obtained through an interaction between the consumer and the product. A product can have many different qualities, but they only come to represent consumer value when they are appreciated within the context of a consumption experience (Smith 2002).

Value is also *relativistic*, because it can never be absolute when it is the result of consumers who differ amongst themselves and also who make comparisons among alternative possible sources of value in a multitude of different situations (Smith 2002). Consumers' tastes and opinions differ and may change over time or in response to the arrival of new styles and products, for example in fashion-clothing where the whole business is based on all the time changing styles. Therefore, a judgement of *preference* is the third characteristic that value. The fourth value is *experience* of consumption, not only the purchase process of a product. The purchase process of a product doesn’t end to the purchase, but continues also after the actual purchase. (Smith 2002)

3.7 Motives and barriers towards prosumption

PV systems are high-involvement decisions for households and require usually a lot of time and consideration on beforehand (Palm 2018). Earlier research (e.g. Palm 2018) has shown that most important drivers that have been identified, have been among other things; environmental concerns, saving money and technical interests and desires to try out PV technology. In Palm’s research the most often mentioned motivational factor was environmental concerns, however consumers are not always willing to pay extra in case of environmental benefits of PV systems.

Besides motivational factors, some barriers have also been found in the earlier studies. Most occurred barriers were finance (e.g. investment cost and long pay-off time), lack of subsidies and uncertainty and mistrust that the system will perform as desired. The most discussed barrier has been the financial costs of the installation of PV systems, even though the analysed pay-off time for the microgeneration is 3-5 years according to Scarpa and Willis (2010).

One motive worth of discussion is the public acceptability of energy projects, which can be seen as a motive for consumers to become prosumers. Without the public acceptability and support for changes, a sustainable energy transition is unlikely to be viable (Perlaviciute, Schuitema, Devine-Wright & Ram 2018). Olkkonen, Korjonen-Kuusipuro & Grönberg (2016) found in their study, that prosumers often lack information and support from the side of the energy companies, which may occur as a barrier when considering prosumption. Perlaviciute et al. (2018) state that energy projects cannot be adopted and adequately used if the policies surrounding a sustainable energy transition are not accepted. Yet many energy projects proposed are strictly opposed, especially from the communities where these projects are to be deployed.

Balcombe, Rigby and Azapagic (2013) found out in their studies that environmental benefit appears to be a major motivation to install PV panels, but consumers may not be willing to pay extra for the installation. Besides motivations and barriers tend to differ between segments of the population, especially with age; younger consumers are more willing to consider installing of PV panels but less frequently reach the final point of installation, because they might meet other barriers such as costs preventing them from installing. (Balcombe et al. 2013)

According to Balcombe et al. (2013) previous studies have found different motivations and barriers that can be divided into six different categories; finance, environment, security of supply, uncertainty and trust, inconvenience and impact of residence. These motivations and barriers are summarized in table 1 below as found in the literature.

Table 1. Summary of motives and barriers with adopting microgeneration as found in the literature. (Balcombe et al. 2013)

	Motivation	**Barrier**
Financial	Save money or earn money from lower fuel bills and government incentives	Costs too much to buy or install
	Increase the value of my home	Cannot earn enough or save money enough
		Loss of money when moving out
		High maintenance costs
Environmental	Help improve the environment	Environmental benefits are not big enough
Security of supply	Protect against future higher energy costs	Would not make much more self-sufficient or independent
	Make the household more self-sufficient	

	Protect the household against power cuts	
Uncertainty and trust	Use an innovative/high-tech system	Home or location is not suitable
		System performance or reliability not good enough
		Energy not available when I need it
		Hard to find trustworthy information
		Hard to find any information
Inconvenience	None	Hassle of installation
		Disruption or hassle of operation
		Potential requirement for planning permission
Impact on residence	Improve the feeling or atmosphere within my home	Take up too much space
	Show my environmental commitment to others	The installation might damage my home
		Would not look good
		Neighbour disapproval

Generally, costs are the largest barrier to microgeneration adoption. According to Balcombe et al. (2013) the capital costs are too high for the majority of potential adopters and the payback times are too long to warrant the large investment. Along with the capital costs, consumers were also concerned about the resale value of the home in future. In 2013 as Balcombe et al. made their research in barrier and motives, some survey respondents had expressed their concern that potential future house buyers would be put off by a microgeneration installation which could lead to a decrease in house price. The situation might have changed over the years, as consumers are seeing solar panels and other microgeneration technologies as an advantage in house markets. Balcombe et al. (2013) also notes that in other countries than UK, house prices have tended to increase after PV panels were installed.

Along with the financial barriers, also environmental barriers exist. Although, they are seen having only a small impact when considering to adopt microgeneration. As seen in the table 1, consumers feel that environmental benefits that are gained through microgeneration are not big enough. Environment is seen more as a motivational factor than barrier. Also, Balcombe et al. (2013) state that microgeneration is generally seen as environmentally friendly way to produce ‘low-carbon’ energy. Environmental benefits can also be drivers for the consumers, as some of the potential adopters are driven by the desire to reduce greenhouse gas (GHG) emissions by using the microgeneration technologies. This desire may not be enough though, as many studies suggest that desire to reduce GHG emissions doesn’t mean that consumers are willing to pay extra for it. Another motivational factor is promoting one’s ‘green’ image that can be achieved by installing a publicly visible system of PV panels. In Palm & Tengvard’s (2011) study they found out that for some consumers ‘to set an example for others’ was seen as a motivational factor. Consumers that are motivated to visibly demonstrate their environmental commitment may want to identify themselves with a low-carbon green image. (Balcombe et al. 2013)

Security of supply is also seen as a motive for consumers to become prosumers. Being independent or having security of supply reduces the reliance on the electricity grid in the future. It has been found in many studies that a motive for PV system installation, is often the independence from centralised energy generation. Uncertainty and trust relate to the security of supply, but is seen as barrier for the adoption. Consumers tend to have a lack of confidence that the system will perform as desired. (Balcombe et al. 2013)
Inconvenience of major modifications to electrical systems is seen as a significant barrier to adoption as well as are the space issues. Some microgeneration technologies require a significant amount of space within a home. Although some of these are barriers and some are motivational factors, they might not be the same for everyone. Previous studies have found some major differences in the attitudes across the world. (Balcombe et al. 2013)

3.8 Chapter summary

To be able to continue to the empirical part of this study, it is necessary to summarize the theoretical part of this thesis and to answer to the first objective. The first objective was to chart from the previous literature, the common motives and barriers for households to become an electricity prosumer and also to find out how aggregators and electricity companies could motivate the households to take part of the energy production. In order to answer these research questions, it was necessary to deepen the knowledge of what prosumers are and what drives them to prosumption.

As discussed in the chapter 3.4 energy behaviour, including pro-environmental behaviour, values and environmental self-identity, have a huge impact on creating the interest towards energy-related technology and prosumption. These factors together with the interest create motives for consumers to start prosumption in their households.

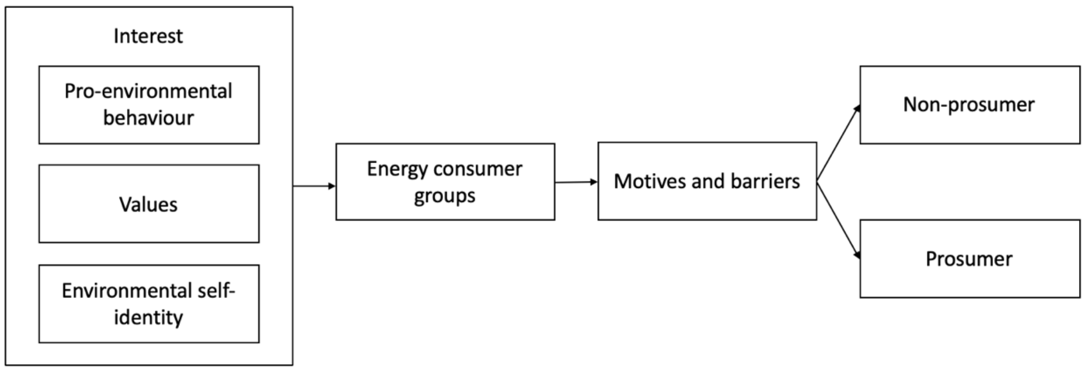

Figure 9. Theoretical framework.

Figure 9 shows the created theoretical framework for this study that is based on pro-environmental behavior, environmental self-identity and different values, such as consumer value. These factors are involved in both sustainable energy consumption and production and also in prosumption. Based on this framework it is possible to identify different energy consumer groups (such as different prosumer groups) from the research material of this study which helps along to find out what could motivate consumers to begin the prosumption.

The chapter gave also an insight to how households and more over the consumers, consume energy in everyday life and which factors impact the way they consume energy. In this chapter used literature will be reflected to the findings in later chapters.

4 METHODOLOGY

Methodological choices of the research will be examined in this chapter along with the theories of the study. Research approach is a plan of how the data of this research is collected and analyzed. Data analysis will be taken into closer look in this chapter. In the end also the reliability of the study will be discussed.

4.1 Research approach and design

Research design of this study is quantitative and it is implemented by using an online survey strategy. The reason why quantitative research was chosen for this study is that the quantitative approach emphasizes numbers and closed-ended questions, which is more suitable for survey strategy than qualitative approach that uses words and open-ended questions to identify different themes. (Cresswell 2014: 31) The research approach to this study is deductive and the focus is on using the collected data to test the theory. The quantitative research shows a relationship between different variables which are measured numerically and analyzed by using a range of statistical techniques. The aim of quantitative research is to predict, generalize and find connections between different topics, variables, whereas quantitative research demands economical resources where qualitative approach would be more time consuming. The aim of qualitative approach is to explore and understand a certain phenomenon. An online survey is a generally used method in quantitative research strategy as it is easy to build and it reaches many people no matter the location. (Saunders, Lewis & Thornhill 2016; Cresswell 2014: 68; Easterby-Smith, Thorpe & Jackson 2012: 27-34)

As mentioned above, this study uses deductive approach. Deductive approach is more suitable for this study as it uses existing literature and theories to identify different theories that will be tested by data, whereas inductive approach explores the data developing theories out of them. (Saunders et al. 2016: 61) In this research pre-existing literature is collected together and the theories are used deductively as a framework for the research questions. The aim is to use literature to advance the research questions. According to Cresswell (2014: 92) “objective of testing or verifying a theory rather than developing it, the researcher advances a theory, collects data to test it, and reflects on its confirmation or disconfirmation by the results”.

4.2 Research method

According to Yin (2014: 1-4) several ways of doing research have been identified, for example case study, survey research, experiments and achieve analysis. This research adopts survey strategy. According to Easterby-Smith et al. (2012: 142-144) there are three types of surveys; factual, inferential and exploratory. Generally, factual surveys are market surveys and polls that are used by companies to collect fact-based data with structured interviews or questionnaires. Inferential surveys again identify possible connections between variables and concepts in order to that inferences can be generalized from sample to population. Exploratory surveys are used to develop different models. (Easterby-Smith et al. 2013: 142-144)

In this research the collected data is factual and the main research method is online questionnaire that provides a quantitative description of attitudes and opinions amongst the certain population. Data from questionnaires could also be collected through e-mail, telephone or personal face-to-face interviews (Cresswell 2014: 201), but here the used method is through online questionnaires. Questionnaire is used as a universal term for data collection methods in which respondents can answer pre-determined set of different questions in pre-determined order. (Cresswell 2014) The data collected by the survey strategy is improbable to be as extensive as those collected by other research strategies. The data collection techniques included to the survey are questionnaire, structured observation and structured interviews (Saunders et al. 2011, 162-178).

4.3 Data, Data Gathering and Data Analysis

Online survey was chosen as a research strategy for this particular study. Data was gathered from all the responders with standardized online survey in the Facebook group called

Tuuli-, aurinko- ja pienvesivoiman itserakentajat[3], of which focus is on micro-scale production of energy with/or wind power, solar power or hydropower. The group is meant for people who are interested in micro-scale energy production either at home or at summer cottage as well as for people who are just generally interested in micro-scale energy production. The purpose of the group is to discuss about the theme and share information and thoughts. This group was chosen for the survey data collection because the theme matches the theme of the survey.

67 members of 6 182 members in the group answered to the survey, which is about 1 % of all the members in the group. The survey answers were collected in Spring 2019, specifically in April-May 2019. In this study the questionnaire was constructed by using Finnish language and Webropol 2.0 online survey platform. The background information, such as the purpose of the survey and also some information of micro-scale electricity production and the time that it takes to answer the survey, were included to the message that was posted in the Facebook group. The results were transferred directly from Webropol to the used IBM SPSS Statistics 26 program. Quantitative analyses were operated with SPSS program.

The online survey was chosen for this study as a method of data collection, because it is the best way to gather information from a large sample of individuals and it was easy to create with help of often used question packages.

Three different analysis methods were chosen for the analysis of the survey. First the data will be analyzed with factor analysis that results different summated scales. With these summated scales it is possible to do other analyses for the material: cluster analysis and regression analysis. Cluster analysis results different clusters that in this study are the different energy consumer identities and with regression it is possible to test out how much one variable effects on another. These analysis methods are better introduced with the results in chapter 5.

[3] Link to the Facebook group *Tuuli-, aurinko- ja pienvesivoiman itserakentajat*: https://www.facebook.com/groups/169305633185347/

4.3.1 Questionnaire

The questionnaire consisted of 6 different question groups, including the total of 31 potential questions or claims. The last question, question number 32, asked for an email address in case of interest for further interviews or information. The questionnaire items, as shown in Appendix 1 and 2, were mostly close-ended multiple choice questions apart from the questions number 2 (age), 28 (would recommend prosumerism), 29 (would not recommend prosumerism) and 31 (other notices). These four items required more specific answers as they were open-ended questions. Some of the closed-ended questions also had the choice for open-ended question if none of the choices were suitable for the respondent.

The item groups included demographic and background questions in the beginning, continuing with questions of energy consuming and producing. The third item group was about energy investments, including questions whether the respondents have made any or are about to make some energy investments. The fourth group included questions for respondents who have already made some energy investments and the fifth question group included questions for anyone who is interested in micro-scale energy production, and if the respondents did not have done any energy investments, the survey continued from question 24 straight to the question 29. The questionnaire was created mostly by using structured claims, but included also open questions such as further opinions.

Some of the questions were in a form of multi-item scale that ensures the reliability. A multi-item scale consists of number of closely related individual statements, whose responses are combined into a composite score or summated ratings to measure a concept (Hair et al. 2015: 247). All of the items are listed below of this study, from the last page on. First in the initial language of the survey, in Finnish (APPENDIX 1.) and then translated into English in APPENDIX 2.

The multiple-indicator items were measured using an unbalanced five-point Likert scale to the positive and negative ends:

1 = strongly agree

2 = agree

3 = neither agree nor disagree

4 = disagree

5 = strongly disagree

6 = I cannot say

With Likert scale it is possible to measure variables that meter an internal subjective feeling of the respondent. Likert scale is suitable for measuring whether person is more or less agreeing with the statement.

The table 3 shows some of the detailed items to the concepts (see table 2). To see the remaining items, see APPENDIX 1 and 2 in the end of this thesis.

Table 2. Example questionnaire items in relation to the concepts.

Concept:	**Question asked:**
Environmental self-identity	For example, acting environmentally friendly is an important part of who I am; I am the type of person who acts environmentally friendly; I see myself as an environmentally friendly person
Pro-environmental behavior	Try to reduce water consumption by taking short showers; Cycling short trips instead of driving; Lower the temperature of the apartment while I am away
Energy literacy	I would like to get more information about how to save energy at home; I would like to get more specific information about how to save energy at home;

	I would like to get information on my energy consumption compared to the consumption of other similar households
Motivation	Possibility to produce electricity in an environmentally friendly way; Possibility to save money in the long run; Possibility to order panels on a turnkey basis; Increasing indigenous energy self-sufficiency

4.4 Reliability and validity

Reliability and validity are issues that need to be discussed and analyzed carefully, as the credibility and the quality of this thesis are proven by them. According to Burns & Burns (2008) "reliability refers to the consistency and stability of findings that enables findings to be replicated". "Validity again refers to whether an instrument measures what it was designed to measure " according to Field (2009: 12).

The reliability of this study is tested with Cronbach's alpha α which is the most commonly used measure of scale reliability. Cronbach's alpha measures the similarity of the items. High value shows that the items do correlate strongly and measure the same concept. If the value is low, it tells that the respondents experienced the items (questions) differently and thus the item is not reliable and cannot be used to measure the concept. (Field 2009: 709) When Cronbach's alpha is calculated for every factor, the generally accepted value for the Cronbach's alpha is over .7, but in explorative analyses the commonly accepted value is > .6 (Hair et al. 2015: 140).

The validity refers to the question: if the instrument is really measuring what it was meant to measure? The validity of this study is strengthened by the used data collection and analyzing methods and also by the measurement instruments. The measurement instruments have been collected from different scientific literature sources and they are previously tested and accepted by the scientific community. The reliability of the questionnaire was enhanced by making it compulsory for the responders to answer all the questions to be able to send their answers for the questionnaire.

5 RESULTS

This chapter starts with an introduction to the research material, mainly with demographic and background information. Along with the background information, the results of this study will be presented. Results were found by using two different analysis methods: factor analysis and cluster analysis. Factor analysis results summated scales that can be used in further analyses, such as in cluster analysis in this study. Factor analysis is used in this study to decrease the size of the dataset and to reduce it to an actual underlying dimensionality. With the summated scales from the factor analysis, the cluster analysis will be done in the chapter 5.3. The cluster analysis is used to form different consumer groups that include survey respondents that are as similar as possible, but the groups differ from each other as much as possible. With these groups it is possible to understand better what consumers value, for example in prosumption. After the analyses are driven and opened up, the results are interpreted.

5.1 Demographic and background information

The most of the respondents were men 58 (86,6 %) whereas female respondents were total of 9 (13,4 %). Most of the respondents were between the age 40 and 59 which makes 59,7 % of the respondents. The largest age group was 40 – 49 years old (31,3 %) and second largest 50 – 59 with 19 respondents (28,4 %). Also 36 of the respondents were married (53,7 %), which is not so relevant for the analysis, thus, it relates to the question of how many people are living in the house of the respondent. These results are presented in table 3 below.

Table 3. Demographic information.

	N	%
Gender		
Male	58	86,6
Female	9	13,4
Total	67	100,0

Age		
18-29	5	7,5
30-39	8	11,9
40-49	21	31,3
50-59	19	28,4
60-69	11	16,4
Over 70	1	1,5
Unknown	2	3,0
Total	67	100,0

From the educational background, over the half of the respondents have college or university degree (56,7 %), mostly in engineering (59,7 %) and they work as employees (31,3 %). 13,4 % have their own firm or are self-employed and 14,9 % have already retired from work life. As the theme of the survey is technology-related as well as the group where the survey was deployed, it is not surprising that most of the respondents have also technological background.

Table 4. Background information about respondents' education.

Educational background	**N**	**%**
Comprehensive school	2	3,0
High school or professional degree	23	34,3
College or university degree	38	56,7
Licentiate or doctorate degree	4	6,0
Total	67	100,0
Field of study		
Education or teacher	5	7,5
Humanities or arts	1	1,5
Business or social sciences	6	9,0
Natural sciences	5	7,5
Engineering	40	59,7
Agriculture and forestry	1	1,5
Health and welfare	5	7,5
No education of my field	1	1,5
Other	3	4,5
Total	67	100,0

Most of the respondents have owner-occupied flats 61 (91,0 %), mostly detached houses 52 (77,6 %), which is essential for PV panels. The Facebook group where the survey was deployed, is meant for all who are interested in producing energy in general by themselves, and that explains why they all do not have detached houses where solar panels can be used. Some of the respondents can also live generally in a high-rise, but have cottage in countryside and have micro-scale electricity production for own consumption there. Most of the respondents also live in a house that is built in 2000s, as 40,3 % (27 out of 67) have answered that they live in either in a house that was built between 2000 and 2009 or after 2010 (See APPENDIX 3 for more information).

Table 5. Demographic information about respondents' housing situation.

Housing situation	N	%
Owner-occupied flat	61	91,0
Residential or fractional dwelling	1	1,5
Rented flat	4	6,0
Other	1	1,5
Total	67	100,0
Type of housing		
Detached house	52	77,6
Farm	2	3,0
Semi-detached house	4	6,0
Rowhouse	2	3,0
High-rise	7	10,4
Total	67	100,0

Respondents' income has divided more evenly, as 13 (19,4 %) earned between 20 000 and 39 999€ in year 2017, 16 (23,9 %) of the respondents earned between 40 000 and 69 999€ and again 13 (19,4 %) between 70 000 and 89 999€. Rest of the respondents earned either less than 20 000€ (9,5 %) or more than 90 000€ (23,8 %). Also 2 (3,0 %) of the respondents didn't know how much their gross income was in 2017. These results are presented below in the table 6.

Table 6. Respondents' gross income in 2017.

Gross income 2017	N	%
under 15 000€	4	6,0 %
15 000 - 19 999€	3	4,5 %
20 000 - 39 999€	13	19,4 %
40 000 - 69 999€	16	23,9 %
70 000 - 89 999€	13	19,4 %
90 000 - 119 999€	7	10,4 %
120 000 - 139 999€	2	3,0 %
140 000€ or more	7	10,4 %
I don't know	2	3,0 %
Total	67	100,0 %

The survey also asked as demographic information about respondents' households' heating systems. Three most mentioned main heating systems were geothermal or air-source heating with 22 responses (32,8 %), direct electrical heating 16 (23,9 %) and district heating 12 (17,9 %). Other mentioned main heating systems were wood or pellet heating, oil heating and reserve electric heating.

As secondary heating systems 27 of the respondents' mentioned wood or pellet heating which makes over 40 % of all. 19,4 % (13) of the respondents don't have any other heating system.

Table 7. Households' main and secondary heating systems.

	N	%
Main heating system		
Direct electrical heating	16	23,9 %
Reserve electric heating	1	1,5 %
District heating	12	17,9 %
Wood or pellet heating	9	13,4 %
Oil heating	4	6,0 %
Geothermal or air-source heating	22	32,8 %
Something else, what?	3	4,5 %
Total	67	100,0 %
Secondary heating system		
Nothing	13	19,4 %
Wood or pellet	27	40,3 %
Solar panel	8	11,9 %

Geothermal or air-source heating	7	10,4 %
Electric heating	6	9,0 %
Something else, what?	5	7,5 %
I don't know	1	1,5 %
Total	67	100,0 %

One of the items also asked if the respondents already produce electricity or here energy in their households. 35 of all of the respondents did not produce energy in their household and 32 already produced energy. So almost the half are already prosumers and a little over the half of the respondents are not (see figure 10).

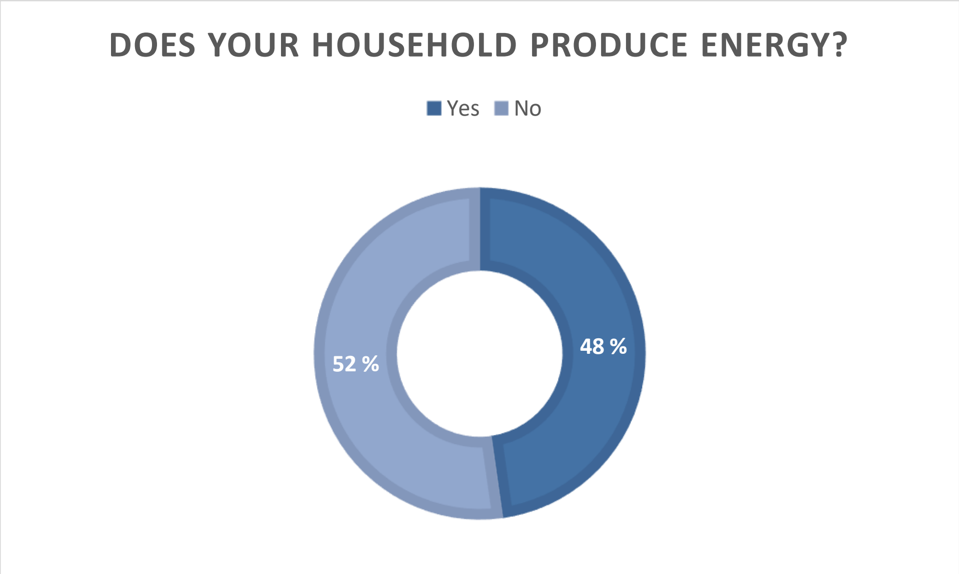

Figure 10. Number of respondents who already produce energy in their household.

5.2 Factor analysis

There are two types of factor analysis: exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). Exploratory factor analysis is used term for a group of multivariate analysis techniques that aim to decrease the size of a dataset and to reduce it to an actual underlying dimensionality whereas confirmatory factor analysis makes priori statements about the expected number of underlying dimensions and their nature. (Janssens et al. 2008: 245; Burns & Burns 2008: 440) In this research the used factor analysis method is the exploratory factor analysis. According to Janssens, Wijnen, De Pelsmacker and Van Kenhove (2008: 245) factor analysis involves the preparation of the data material for further analysis such as cluster analysis.

It is important to pay attention to communalities when interpreting factor analysis. Communalities means that how much variation a single variable can describe with factors. (Nummenmaa 2004: 339) Originally variables are standardized and that is why the variance for each of the variables is equal to 1. The nearer the value 1 the variable is, the better factor model explains the variation of a single variable. (Janssens et al. 2008: 256) In this study the communalities value must be over .5 when following the general standard. If the value is smaller, it shows that the factor model cannot explain the variation of a single variable well enough. (Hair et al. 2015: 134)

For the interpretation of the factor analysis it is worthwhile to perform rotation. According to Field (2009) “Rotation is used to discriminate between factors”. The meaning of rotation is to clarify the factor analysis and so the loadings of a single variable to one factor are tried to maximize. There are two types of rotation; orthogonal (varimax) rotation and oblique rotation. (Nummenmaa 2004: 346; Field 2009: 701-702) In this study the used rotation is orthogonal to ease out the interpretation of the factor analysis. The factor loading, according to Janssens et al. (2008: 260), should be over .70 before a variable can be assigned to a single factor, when the sample size is 60.

The first step of the factor analysis was to test out if factor analysis was even possible to drive for the research material. This was measured with Bartlett’s test and Kaiser-Meyer-Olkin’s test (KMO). The suitability of factor analysis for the data can be measured with Bartlett’s test or Kaiser-Meyer-Olkin’s test (KMO). With Bartlett’s test, it is possible to confirm the null hypothesis, which means that the variables that don’t correlate with each other, can be discarded. KMO should be at least .5 or the variable can be discarded from the analysis. (Janssens et al. 2008: 256) Bartlett’s test was statistically significant ($p = .000$) and so the null hypothesis can be discarded. The KMO value was .717 which is good, as it is higher than the generally accepted value .6. Because of these two values, factor analysis is suitable for this material.

After KMO and Bartlett's test, the Cronbach alphas were tested. These tests measure the reliability of the measured scale. The Cronbach alphas are presented in the table 9 below. The factor analysis revealed a four-factor solution with item loadings exceeding .70, except one item loading was .533. Most of the items had loadings over .80 "Latent root criterion" –technic was used to take into consideration only the factors which eigenvalue is over value 1. The four factors were named as ENVIR (*environmental self-identity*), ENLIT (*energy literacy*), INCOM (*information about energy consumption*) and GENER (*general interest in energy-related subjects*) (see table 8). Eigenvalues tell how much a single factor explains variation in material. The bigger the eigenvalue the more it explains the variation. (Nummenmaa 2004: 339) The factors that are insignificant for the analysis can be discarded if the factor explains the variation only poorly. (Janssens et al. 2008: 257) In table 8 is the total variance explained. This four-factor model explains 78,23 % of the total variation.

Table 8. Factor variance explained.

Factor	Concept	Eigenvalue	Initial Eigenvalues % of Variance	Number of Items
F1	Environmental self-identity (ENVIR)	4,452	34,243	3
F2	Energy literacy (ENLIT)	2,956	22,736	3
F3	Information about energy consumption (INCOM)	1,519	11,686	3
F4	General interest in energy-related subjects (GENER)	1,046	8,043	2

In table 9 are the final results of the exploratory factor analysis presented. Item descriptions, communalities and Cronbach's alphas are also presented in this table below.

Table 9. Final results of the exploratory factor analysis.

Factor	Item	Description	Item loading	Communality	Cronbach's alpha α
F1	ENVIR1	I see myself as an environmentally friendly person	.861	.799	.890
	ENVIR2	I am the type of person who acts environmentally friendly	.859	.781	
	ENVIR3	Acting environmentally friendly is an important part of who I am	.835	.780	
F2	ENLIT1	I would like to get exact information about the operating costs of my electrical devices	.877	.844	.864
	ENLIT2	I would like to get information about my current energy consumption compared to my previous energy consumption	.806	.802	
	ENLIT3	I would like to get more specific information about how to save energy at home	.677	.751	
F3	INCOM1	I would like to get information on my energy consumption compared to the consumption of other similar household in my area	.904	.880	.863

	INCOM2	I would like to get information on my energy consumption compared to the consumption of other similar households	.874	.843	
	INCOM3	I would like to get more information how to save energy at home	.614	.767	
F4	GENER1	I follow conversations about energy subjects	.895	.861	.831
	GENER2	Energy-related subjects interest me	.893	.842	

Different measurement scales were combined in this survey, so it was assumed that some items would load on some factors more strongly. Noticeable is that Cronbach's alphas for all of the factors are higher than the targeted values > .7, so it can be stated that these items measure the concept reliable. 11 items in total loaded for four different factors. The items in the first factor have common environmental self-identity. All of the items measure the same quality. In the second factor this quality is energy literacy, how well the respondents understand their energy bills, for example, or do they want to have more information how to save electricity at home. The third factor measured that how much information and what kind of information the respondents would want to get about their energy consumption. Fourth factor measured the general interest in energy-related subjects.

After the factor analysis and reliability analysis the items were combined into summated scales. Summated scales are summaries of functional items and they represent one concept, as here ENVIR (*environmental self-identity*), ENLIT (*energy literacy*), INCOM (*information about energy consumption*) and GENER (*general interest in energy-related subjects*). With these summated scales it is possible to do further analysis, like in the next chapter cluster analysis.

5.3 Cluster analysis

In cluster analysis the aim is to sort cases such as individuals, products or brands, into groups so that a high degree of similarity exists between cases in the same group (Janssens et al. 2008: 317). In the context of this research with cluster analysis different energy consumer identity groups (or in other words possible prosumer identity groups) are tried to found among the respondents. In these groups the respondents are similar as possible but the groups will be as different from each other as possible.

Cluster analysis in marketing is generally used for segmenting consumers or customers. Cluster analysis enables material categorization based on data, what for the results of the analysis will be less subjective. (Mooi & Sarstedt 2011: 237) There are two commonly used types of cluster analysis; K-means and hill-climbing. The used cluster analysis method in this research is the K-Means method. According to Janssens et al. (2008: 319) “K-means method is most efficient when the same optimum criterion is used as that used to generate the initial configuration”. In this method the criterion minimizes the distances within each cluster to the center of that cluster. In other words, this method classifies the data so that the variation in each of the groups is as small as possible. (Mooi & Sarstedt 2011: 256)

With cluster analysis in this study it is possible to answer to the research question: *What kind of consumer/prosumer groups can be found by means of a survey made for consumers about their energy consumption and willingness to become an energy prosumer?* Cluster analysis also gives prediction about what kind of values and environmental self-identity the respondents might have. The aim is to find groups from the material that are similar but differ from other groups as much as possible. After the factor analysis, summated scales were formed and the cluster analysis was performed for the summated scales.

The used method for this study was K-means which is non-hierarchical method where SPSS creates predestined number of clusters. K-means method classifies observation units with the predestined number of clusters and in the end, clusters are formed so that the inner variation is as small as possible and the outer variation as big as possible. For this study the cluster analysis was tried to drive with 2-6 predestined clusters. 5 cluster model was chosen because it describes the data best and makes the interpretation of the results easier. In this model the cluster sizes were best suitable, but the variation was still high and does not give the best possible result of the cluster analysis. This happened because there were such a small number of respondents in the measured survey. The results of cluster analysis are presented below in table 10. Cluster means are presented in the table first and in parenthesis the standard deviation. Cluster sizes (N) are presented in the end.

Table 10. Cluster centers.

	Cluster 1 ($N = 8$)	Cluster 2 ($N = 17$)	Cluster 3 ($N = 6$)	Cluster 4 ($N = 35$)	Cluster 5 ($N = 1$)
Environmental self-identity	1.88 (1.231)	1.75 (1.519)	3.39 (1.202)	1.67 (1.101)	4.00 (.000)
Energy literacy	4.33 (.332)	2.47 (.166)	2.28 (.364)	1.60 (.070)	1.67 (.000)
Information of energy consumption	4.33 (.000)	2.47 (.123)	2.28 (.369)	1.60 (.000)	1.67 (.000)
General interest in energy-related subjects	1.50 (.000)	1.47 (.000)	1.33 (.177)	1.07 (.000)	5.00 (.000)
Cluster name	*Passive consumers*	*Green consumers*	*Engineers*	*Expert engineers*	*Unknown consumers*

Another important part of the cluster analysis is to examine the ANOVA table. With ANOVA table it can be examined if to the clusters placed respondents differ statistically significant in every variable that was chosen to the model. If all p values are $< .05$ and clusters are divided relative evenly, can be assumed that the cluster model has succeeded. (Nummenmaa 2004: 367) All p values were .000, so it can be stated that cluster model has succeeded. The whole ANOVA table is presented in the APPENDIX 4.

With crosstabulation was examined the demographic features of different clusters based on background variables such as age, gender and educational background. The results of crosstabulation are presented in table 11 below.

Table 11. Background variables of the clusters.

	Cluster 1 (*passive consumers*)	**Cluster 2** (*green consumers*)	**Cluster 3** (*engineers*)	**Cluster 4** (*expert engineers*)	**Cluster 5** (*unknown consumers*)
Gender					
Female	1 (12,5 %)	2 (11,8 %)	0 (0,0 %)	5 (14,3 %)	1 (100 %)
Male	7 (87,5 %)	15 (88,2 %)	6 (100 %)	30 (85,7 %)	0 (0,0 %)
Total	8	17	6	35	1
Age					
18-39	1 (12,5 %)	2 (12,5 %)	3 (50,0 %)	6 (17,6 %)	1 (100 %)
40-59	6 (75,0 %)	9 (56,3 %)	3 (50,0 %)	22 (64,7 %)	0 (0,0 %)
over 60	1 (12,5 %)	5 (31,3 %)	0 (0,0 %)	6 (17,6 %)	0 (0,0 %)
Educational background;					
Education or teacher	0 (0,0 %)	3 (17,6 %)	0 (0,0 %)	2 (5,7 %)	0 (0,0 %)
Humanities or arts	0 (0,0 %)	0 (0,0 %)	0 (0,0 %)	1 (2,9 %)	0 (0,0 %)
Business or social sciences	1 (12,5 %)	0 (0,0 %)	1 (16,7 %)	3 (8,6 %)	1 (100 %)
Natural sciences	0 (0,0 %)	1 (5,9 %)	0 (0,0 %)	4 (11,4 %)	0 (0,0 %)
Engineering	6 (75,0 %)	11 (64,7 %)	5 (83,3 %)	18 (51,4 %)	0 (0,0 %)
Agriculture and forestry	0 (0,0 %)	0 (0,0 %)	0 (0,0 %)	1 (2,9 %)	0 (0,0 %)
Health and welfare	0 (0,0 %)	2 (11,8 %)	0 (0,0 %)	3 (8,6 %)	0 (0,0 %)
I have no education of my field	0 (0,0 %)	0 (0,0 %)	0 (0,0 %)	1 (2,9 %)	0 (0,0 %)

Other	1 (12,5 %)	0 (0,0 %)	0 (0,0 %)	2 (5,7 %)	0 (0,0 %)
Prosumer household					
Yes	5 (62,5 %)	10 (58,8 %)	2 (33,3 %)	15 (42,9 %)	0 (0,0 %)
No	3 (37,5 %)	7 (41,2 %)	4 (66,7 %)	20 (57,1 %)	1 (100 %)

Cluster 1. – *Passive consumers*

Passive consumers are consumers who do not think much about environment or act environmentally friendly way in their everyday life. Passive consumers are also not so interested in energy-related technology or have not considered of making any energy investments such as buying PV panels of wind turbines. They are not against new energy-related technology though, as 50,0 % of them already own digital electricity meter and 87,5 % have air-source heat pump. Most of the members in this group are aged between 40 and 59 and their gender is male.

Cluster 2. – *Green consumers*

Green consumers are very interested in energy-related subjects as well as in energy consumption information. They would like to get more information about their energy consumption in general but also compared to other households. Green consumers would also like to get more information about how to save energy at home. They also already have PV panels or have considered of buying some. 58,8 % of this groups' members already produce energy in their household, but only with PV panels as 70,6 % of them have not considered of buying a wind turbine. Before green consumers have begun their prosumption the most important thing for them was to produce electricity in an environmentally friendly way. Somewhat important for them was to save money on electricity in a long run.

Cluster 3. – *Engineers*

This group is pretty similar as expert engineers in cluster 4 as all of the member are relatively young men as 100,0 % of the members are men and they are all under 59 years old. The different factor between engineers and expert engineers is though, that engineers do not find environmental friendliness and information about energy consumption as important as expert engineers, even though they do find it somewhat important. They are interested in wind power as 66,7 % have considered of buying a wind turbine.

Cluster 4. – *Expert engineers*

Engineers are more interested in energy-related technology than other groups and are also very interested in producing electricity in their households for either own consumption and also for selling. Engineers are mostly men (85,7 %) and 42,9 % of them already produce energy and 51,49 % have planned to buy some PV panels. 37,19 % would also consider getting wind turbines. As engineers have bought their PV panels, the interest in new technology was high as 86,7 % thought that it was very important factor as buying the PV panels.

Cluster 5. – *Unknown consumers*

This group has only one member which makes the describing difficult. This cluster could have been deleted from the final analysis and that is why it is named unknown consumers.

5.4 Summary of results

As mentioned in the chapter 3.6 that earlier studies have found numerous motivational factors and also barriers that households face while considering prosumption. Financial factors have been found to be one of the most important factors in both motives and barriers. In this study was found that 93,5 % of all the respondents who already own PV panels and are prosumers think that the possibility to save money in the long run is either very important or pretty important. 91,5 % of respondents who are not prosumers yet think that the possibility to save money in the long run with PV panels is either very important or pretty important. Only 5 respondents said that saving money is not important. The survey also asked respondents if environmental concerns were important to them. In previous studies, for example, in Palm’s (2018) the most important motivational factor was environmental concerns as mentioned also in the chapter 3.6. Respondents who already own PV panels the possibility to produce electricity in an environmentally way was pretty important, as 83,9 % (26 out of 31) of the respondents said it is important. For the rest 5 respondents environmental concerns were not that important. For the respondents who are not prosumers yet, the environmentally concerns were also important as 88,6 % (31 out of 35) answered that the possibility to produce electricity in an environmentally friendly way would be a motivational factor when considering to buy PV panels.

Interest in new technology was very important for 71,0 % of the respondents who already produce electricity. As the survey was executed in a Facebook group where the members are kind of trial users and have mostly technological background, this finding was not surprising. Also 62,9 % of the respondents who are not producing electricity yet, answered that the interest in new technology is a very important factor while considering to begin prosumption. The desire to learn something new was also very important for 51,4 % of the respondents who do not produce electricity already. 61,3 % of the already prosumers answered that to learn something new is very important. 32,3 % said it is somewhat important.

Barriers towards prosumption were charted with open questions. Barriers that were mentioned amongst respondents have also came up in earlier research. Financial barriers such as the pay-off time is too long and the actual installation of the PV panels is too expensive. Some of the barriers were not really barriers but obstacles that can be crossed. The survey respondents also pointed out that the lack of information from electricity companies and authorities is hindering the adoption of prosumption in households. Consumers do not get enough information about their energy consumption neither compared to their previous consumption habits nor compared to other consumers. Another important barrier that came up was net metering or in other words the lack of net metering in Finnish electricity markets. This barrier was found to be very annoying amongst the survey respondents.

The first part of the empirical part was to do a factor analysis that will result different factors that can act as a base for summated scales for further analyses. Factor analysis resulted four different factors (see table 8 and 9) that were used to form summated scales that are summaries of functional items and represent one concept. The summated scales that were found were named as followed: ENVIR (*environmental self-identity*), ENLIT (*energy literacy*), INCOM *(information about energy consumption*) and GENER (*general interest in energy-related subjects*). Based on these summated scales it was possible to drive a cluster analysis that resulted five different consumer groups. These groups were named as followed: *passive consumers*, *green consumers*, *engineers*, *expert engineers* and *unknown consumers*. The five-cluster model was chosen because the consumers were most evenly divided to five different groups, although, one group included only one consumer. This group was named as *unknown consumers* because based on the measured items and the respondent's answers it could have been discarded from the analysis. The answers were not constant and they differed from other respondents' answers tremendously. If this respondent's answers were discarded from the survey, the cluster analysis would have resulted four groups that were more evenly divided.

As already mentioned in chapter 5.3 the *engineers* and *expert engineers* do not differ from each other that much which is due to the place where the survey was executed. The group is meant for people who have general or deeper interest in self-made wind, solar and hydro power. If the survey would have been executed in somewhere else, the results would have differed even more as the cluster analysis could have resulted more groups that differ from each other and the sampling of responders would have been bigger and diverse. However, the survey was executed in this kind of place for a reason, as it was important to find out what kind of motives and barriers the already existing prosumers might have and also what consumers who are considering prosumption might think as motives and barriers. It was also found that consumers who already have a common interest towards new technology are more willing to try out new energy-related technologies such as PV panels.

6 CONCLUSIONS

The purpose of this research was to find out what kind of motives and barriers consumers might have towards prosumption. The intention was to examine and to clarify the situation of the energy markets and energy transition. Consumers' role in the energy markets has become even more important as electricity companies, authorities and consumers are fighting against the climate change by reducing the fossil-based energy consumption and shifting towards renewable energy consumption. One way to ease this shift is the prosumption. The motives and barriers of prosumption have been studied a lot in the last decade (for example Balcombe et al. 2013, Olkkonen et al. 2016 and Palm 2018), but first now prosumption has become a more common way to produce energy. As mentioned in chapter 2, the installed capacity of solar energy has grown enormously between 2016 and 2018. In only two years the capacity has grown 500 %. In this research the energy transition and prosumption were studied from the aspect of a consumer and the aim was to find answers to the following research questions: *What are the motives and barriers for households to become an electricity prosumer? What kind of consumer/prosumer groups can be found by means of a survey made for consumers about their energy consumption and willingness to become an energy prosumer?*

With the research results it can be stated that the most common motives and barriers towards electricity prosumption are financial and also the need of information. Financial motives were for example the possibility to save money in the long run, but there were also financial barriers, such as high installation costs of PV panels. Besides motives and barriers also environmental self-identity of the respondents was examined. Environmental self-identity acted as a one factor towards prosumption through the interest. It was found out that pro-environmental behaviour, values and environmental self-identity together help the creation of interest towards new energy-related technology and therefore also create the interest towards prosumption (see also figure 9). With questions about respondents interests that include pro-environmental behaviour, values and environmental self-identity it was possible to create a cluster analysis that resulted different energy consumer groups. These groups combined with motives and barriers resulted two different groups: non-prosumers and prosumers.

It can be hereby stated that consumers are driven by individual factors, such as their behaviour and habits that include also values and environmental self-identity. In this research was found that biospheric values that act in the background of one's environmental self-identity might act as a motivator for consumers to begin prosumption. Awareness of nature's condition and future can make consumers to consider decreasing their energy consumption or even to replace fossil-based energy consumption with consumption of renewable energy which is produced, for example, on the roof of a detached house.

In this research was examined what kind of consumer groups can be classified based on consumers' environmental self-identity, energy literacy, need of information about energy consumption and general interest towards energy-related technology. Five groups were found in which the consumers are as similar as possible but the groups differ from each other as much as possible. These groups were formed with K-Means cluster analysis and with background variables. The groups were named as *passive consumers*, *green consumers*, *engineers*, *expert engineers* and *unknown consumers*. With K-Means cluster analysis it was possible to find statistical differences between the groups and with different background variables it was possible to highlight these differences.

These results can be used in marketing for example for segmenting and in target marketing. These could help electricity companies to find the consumers who are considering to begin prosumption, but need for example more support from the side of the electricity company. As one of the mentioned barriers was the lack of net metering on the electricity markets, for consumers that are not interested in prosumption and also for already existing prosumers the enabling of net metering would motivate them more. Net metering would credit prosumers for sending back to the electricity grid the excess electricity that they have produced.

This research had also some major limitations that hindered the final results essentially. The first one was the size of the sampling. It was noticed that without a reward of participating in this survey, not many respondents were reached, although some respondents were more than happy to help with this survey as they had a lot to comment about the state of today's prosumption. The second limitation was the survey itself as there were not enough variables about important factors such as environmental self-identity and energy literacy. Also, the motives and barriers of prosumption were only slightly examined in the survey.

The size of the sampling and also the place where this survey was exploited had a huge impact on the results. With a bigger sampling there might have been more consumer groups and the differences between them might have been bigger. Also, the place could have been for example the website of a certain electricity company, but it was not possible at the time of the execution of the survey. These two things can be changed in the further researches. Further researches can also focus on examining the correlations between different variables such as, if an already existing prosumer and a certain motive has correlation. This could be exploited with a regression analysis, but it would be better if the survey variables were perfected and the sampling would be bigger.

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APPENDICES

APPENDIX 1. Questionnaire for the Facebook group Tuuli-, aurinko- ja pienvesivoiman itserakentajat in Finnish

Energiakysely sähkön pientuottajille ja sitä suunnitteleville kotitalouksille
Taustatiedot

1. Mikä on sukupuolesi?

Nainen
Mies

2. Mikä on ikäsi?

3. Mikä on siviilisäätysi?

Naimaton
Avioliitossa
Avoliitossa
Asumuserossa
Eronnut
Leski
Muu

4. Kuinka monta aikuista ja lasta kotitalouteesi kuuluu seuraavilla ikähaarukoilla?

Yli 55-vuotiasta
36-55 vuotiasta
18-35 vuotiasta
Alle 18-vuotiasta

5. Mikä on ammattiasemasi?

Johtavassa asemassa (toisen palveluksessa)
Ylempi toimihenkilö
Alempi toimihenkilö
Työntekijä
Yrittäjä tai yksityinen ammatinharjoittaja
Maatalousyrittäjä
Opiskelija
Eläkeläinen
Kotiäiti tai -isä
Työtön
Muu

6. Mikä on koulutustaustasi?

Peruskoulu
Lukio, ylioppilas- tai ammatillinen tutkinto
Opisto- tai korkeakoulututkinto
Lisensiaatin tai tohtorin tutkinto
Ei mitään näistä
Muu

7. Mikä on koulutusalasi?

Kasvatustieteellinen tai opettajankoulutus
Humanistinen tai taidealankoulutus
Kaupallinen tai yhteiskuntatieteellinen koulutus
Luonnontieteellinen koulutus
Tekniikan koulutus
Maa- ja metsätalousalan koulutus
Terveys- ja sosiaalialan koulutus

Palvelualojen koulutus

Minulla ei ole alaani liittyvää koulutusta

Muu

8. Mikä on asumismuotosi?

Omistusasunto

Asumisoikeus- tai osaomistusasunto

Vuokra-asunto

Muu

9. Minkälaisessa talossa asut?

Omakotitalo

Maatila

Paritalo

Rivitalo

Kerrostalo

Muu

10. Milloin kotitalosi on rakennettu?

Ennen vuotta 1919

1920-1929

1930-1939

1940-1949

1950-1959

1960-1969

1970-1979

1980-1989

1990-1999

2000-2009

2010 tai sen jälkeen

En osaa sanoa

11. Mitkä olivat kotitaloutesi yhteenlasketut bruttotulot vuonna 2017 (ei veroja vähennetty)?

Alle 15 000€

15 000 – 19 999€

20 000 – 39 999€

40 000 – 69 999€

70 000 – 89 999€

90 000 – 119 999€

120 000 – 139 999€

140 000€ tai enemmän

En osaa sanoa

12. Mikä seuraavista pääasiallisista lämmitysjärjestelmistä sinulla on kotonasi?

Suora sähkölämmitys

Varaava sähkölämmitys

Kaukolämpö

Puu tai pelletti

Öljylämmitys

Maa-/ilmalämpö

Maa-/biokaasu

Jokin muu, mikä?

En osaa sanoa

13. Mitä seuraavista toissijaisista lämmitysjärjestelmistä sinulla on kotonasi?

Kotitaloudellani ei ole toissijaista lämmitysjärjestelmää

Puu tai pelletti

Aurinkopaneeli

Maa-/ilmalämpö

Sähkölämmitys

Jokin muu, mikä?

En osaa sanoa

Energian kulutusta ja tuottamista koskevat kysymykset

14. Kuinka paljon sähköä kotitaloutesi kuluttaa keskimäärin vuosittain?

Noin 30 000 kWh

Noin 18 000 kWh

Noin 10 000 kWh

Noin 5 000 kWh

Noin 2000 kWh

En osaa sanoa

15. Kuka maksaa yleensä sähkölaskun taloudessasi?

Minä

Puolisoni

Joku muu

Minä yhdessä puolisoni tai jonkun muun kanssa

En osaa sanoa

16. Kuinka suuri oli kuukausittainen sähkölaskusi keskimäärin viime kesän (kesäkuu 2017 – elokuu 2017) aikana?

Alle 30€

30-59€

60-89€

90-119€

120-149€

150-179€

180-209€

210-239€

240-269€

270-299€

300€ tai enemmän

En osaa sanoa

17. Kuinka suuri oli kuukausittainen sähkölaskusi keskimäärin viime talven (joulukuu 2017 – helmikuu 2018) aikana?

Alle 30€

30-59€

60-89€

90-119€

120-149€

150-179€

180-209€

210-239€

240-269€

270-299€

300€ tai enemmän

En osaa sanoa

18. Kuinka hyvin seuraavat väittämät pitävät paikkaansa?

Täysin samaa mieltä

Jokseenkin samaa mieltä

Ei samaa eikä eri mieltä

Jokseenkin eri mieltä

Täysin eri mieltä

En osaa sanoa

Väittämät:

Ympäristöystävällinen käytös on tärkeä osa minua

Olen henkilö, joka käyttäytyy ympäristöystävällisesti

Koen itseni ympäristöystävälliseksi henkilöksi

Energia-asiat kiinnostavat minua

Seuraan energia-asioihin liittyvää keskustelua

Ilmastonmuutos johtuu pääosin ihmisen toiminnasta

Voin omalla käytökselläni ja valinnoillani vaikuttaa ilmastonmuutokseen

19. Kuinka usein teet seuraavia asioita?

En koskaan
Joskus
Usein
Aina
En osaa sanoa

Väittämät:

Pyrin vähentämään veden kulutusta ottamalla lyhyitä suihkuja
Pyöräilen lyhyet matkat autoilun sijaan
Alennan huoneiston lämpötilaa ollessani pois kotoa
Laitan pesukoneen päälle vasta sen ollessa täynnä
Sammutan valot, kun kukaan ei käytä huonetta
Ostan kausituotteita
Lajittelen muovijätteen
Ostan biohajoavia pesuaineita

20. Millainen arvioit oman kuukausittaisen energiankulutuksesi olevan verrattuna kotitalouksiin, jotka ovat samanlaisia tulotason, kotitalouden koon ja asuntotyypin suhteen?

Energiankulutukseni on huomattavasti suurempi

Energiankulutukseni on suurempi
Energiankulutukseni on keskitasoa
Energiankulutukseni on vähäisempi
Energiankulutukseni on huomattavasti vähäisempi

21. Kuinka hyvin seuraavat väittämät pitävät paikkansa?

Täysin samaa mieltä

Jokseenkin samaa mieltä

Ei samaa eikä eri mieltä

Jokseenkin eri mieltä

Täysin eri mieltä

En osaa sanoa

Väittämät:
Haluaisin saada tarkempaa tietoa siitä, kuinka säästän energiaa kotonani
Haluaisin saada yksilöidympää tietoa siitä, kuinka säästän energiaa kotonani
Haluaisin saada tietoa energian kulutuksestani verrattuna muiden samanlaisten kotitalouksien kulutukseen
Haluaisin saada tietoa energian kulutuksestani verrattuna muiden alueeni kotitalouksien kulutukseen
Haluaisin saada tietoa nykyisestä energian kulutuksestani verrattuna aikaisempaan energian kulutukseeni
Haluaisin saada tarkkaa tietoa sähkölaitteiden käyttökustannuksista

22. Mille seuraavista tahoista ja mihin käyttötarkoitukseen olisit valmis luovuttamaan tietoa kotitaloutesi energian kulutuksesta?

Energiayhtiöt
Yliopistot/tutkimuslaitokset
Kunta
Palveluntarjoajat
Yhdistykset

Energiainvestoinnit
23. Mitä energiainvestointeja kotitaloutesi on jo tehnyt tai on aikeissa tehdä?

Omistan jo
Olen suunnitellut hankkivani
En omista, enkä ole suunnitellut hankkivani
En osaa sanoa

Aurinkopaneelit
Tuuligeneraattori
Sähköauto
Hybridi tai lataushybridi
Digitaalinen sähkömittari
Ilma-/maalämpöpumppu
Bioreaktori

24. Tuottaako kotitaloutesi itse energiaa?

Kyllä
Ei

25. Tuotatteko sähköä vain kotitaloutenne omaan käyttöön vai myös myyntiin?

Vain omaan käyttöön, en ole kiinnostunut myymisestä
Vain omaan käyttöön, mutta olisin kiinnostunut myymisestä
Omaan käyttöön sekä myyntiin

26. Arvioi, kuinka tärkeitä seuraavat kriteerit olivat ostaessasi aurinkopaneeleita.

Erittäin tärkeää
Jokseenkin tärkeää
Ei kovin tärkeää
Ei lainkaan tärkeää
En osaa sanoa

Mahdollisuus tuottaa sähköä ympäristöystävällisesti
Mahdollisuus säästää rahaa pitkällä aikavälillä
Mahdollisuus tilata paneelit avaimet käteen -periaatteella
Kotimaisen energiaomavaraisuuden lisääminen
Halu vähentää riippuvuutta sähköyhtiöistä

Kiinnostus uutta teknologiaa kohtaan
Halu toimia edelläkävijänä
Lähipiiriltä saatu kannustus
Asuinalueeni muiden asukkaiden pientuottajuus
Halu harrastaa
Halu oppia uutta
Kotimaisen energiatuotannon ja työn tukeminen
Vaasan seudun energiatuotannon ja työn tukeminen

27. Arvioi, kuinka hyvin seuraavat väittämät pitävät paikkansa.

Täysin samaa mieltä

Jokseenkin samaa mieltä

Ei samaa eikä eri mieltä

Jokseenkin eri mieltä

Täysin eri mieltä

En osaa sanoa

Väittämät:
Keskustelen energian pientuottajuudesta usein ystävieni/tuttavieni kanssa
Usealla tuttavallani on jo aurinkopaneelit
Suosittelisin aurinkopaneeleita myös tuttavilleni
Olen ylpeä energian pientuottajuudestani

28. Miksi et suosittelisi pientuottajuutta ystävillesi ja tuttavillesi?

Avoin vastaus

29. Miksi suosittelisit pientuottajuutta ystävillesi ja tuttavillesi?

Avoin vastaus

30. Arvioi, kuinka tärkeitä seuraavat kriteerit olisivat, jos kotitaloutesi ryhtyisi sähkön pientuottajaksi?

Erittäin tärkeää

Jokseenkin tärkeää
Ei kovin tärkeää
Ei lainkaan tärkeää
En osaa sanoa

Väittämät:

Mahdollisuus tuottaa sähkö ympäristöystävällisesti
Halu vähentää riippuvuutta sähköyhtiöistä
Mahdollisuus säästää rahaa pitkällä aikavälillä
Mahdollisuus tilata paneelit avaimet käteen -periaatteella
Kotimaisen energiaomavaraisuuden lisääminen
Kiinnostus uutta teknologiaa kohtaan
Halu toimia edelläkävijänä
Lähipiiriltä saatu kannustus
Asuinalueeni muiden asukkaiden pientuottajuus
Halu harrastaa
Halu oppia uutta
Kotimaisen energiatuotannon ja työn tukeminen
Vaasan seudun energiatuotannon ja työn tukeminen

31. Mitä muita huomioita, kerrottavaa tai kommentoitavaa sinulla on aihepiiriin liittyen?

Avoin vastaus

APPENDIX 2. Questionnaire for the Facebook group Tuuli-, aurinko- ja pien-vesivoiman itserakentajat in English

Energy survey for small-scale electricity producers and for households planning it
Background information

1. Gender?

Female
Male

2. Age?

Open

3. Marital status?

Single
Married
Domestic partnership
Separated
Divorced
Widowed
Else

4. How many adults and children are living in the household in the following age ranges?

Over 55 years old
36-55 years old
18-35 years old
Under 18 years old

5. Employment status. Are you currently…?

Leadership (employed by another)
Senior officer

Junior officer
Employee
Entrepreneur or self-employed
Farmer
Student
Pensioner
Housewife or -husband
Unemployed
Other

6. What is your educational background?

Comprehensive school
High school or professional degree
College or university degree
Licenciate or doctorate degree
None of the above
Other

7. What is your field of study?

Education or teacher
Humanities or arts
Business or social sciences
Natural sciences
Engineering
Agriculture and forestry
Health and welfare
Services
I have no education of my field
Other

8. Which of the following best describes your current housing situation?

Owner-occupied flat
Residential or fractional dwelling
Rented flat

Other

9. In which type of housing do you live?

Detached house
Farm
Semi-detached house
Rowhouse
High-rise
Other

10. When was your house built?

Before the year 1919
1920-1929
1930-1939
1940-1949
1950-1959
1960-1969
1970-1979
1980-1989
1990-1999
2000-2009
2010 or after
I don’t know

11. What were your household’s gross income in 2017 (no tax deduction)?

Under 15 000€
15 000 – 19 999€
20 000 – 39 999€
40 000 – 69 999€
70 000 – 89 999€
90 000 – 119 999€
120 000 – 139 999€
140 000€ or more
I don’t know

12. Which of the following <u>main</u> heating systems do you have in your home?

Direct electrical heating
Reserve electrical heating
District heating
Wood or pellet heating
Oil heating
Geothermal or air-source heating
Natural gas or biogas
Something else, what?
I don't know

13. Which of the following <u>secondary</u> heating systems do you have in your house?

My household does not have a secondary heating system
Wood or pellet heating
Solar panel
Geothermal or air-source heating
Electrical heating
Something else, what?
I don't know

Questions about using and producing energy

14. What is on average the energy usage of your household per annum?

Ca. 30 000 kWh
Ca. 18 000 kWh
Ca. 10 000 kWh
Ca. 5 000 kWh
Ca. 2 000 kWh
I don't know

15. Who pays usually the electricity bill in your household?

Me

My spouse
Someone else
With my spouse or someone else together
I don’t know

16. How much was your monthly electricity bill on average last summer (June 2017 – August 2017)?

Under 30€
30-59€
60-89€
90-119€
120-149€
150-179€
180-209€
210-239€
240-269€
270-299€
300€ or more
I don’t know

17. How much was your monthly electricity bill on average last winter (December 2017 – February 2018)?

Under 30€
30-59€
60-89€
90-119€
120-149€
150-179€
180-209€
210-239€
240-269€
270-299€
300€ or more
I don’t know

18. How would you respond to the following statements?

Strongly agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree
I can not say

Acting environmentally friendly is an important part of who I am
I am the type of person who acts environmentally friendly
I see myself as an environmentally friendly person
Energy subjects interest me
I follow conversations about energy subjects
Climate change is mainly due to human activity
I can influence climate change through my behavior and choices

19. How often do you do these things?

Never
Occasionally
Often
Always
I don’t know

Try to reduce water consumption by taking short showers
Cycling short trips instead of driving
Lower the temperature of the apartment while I am away
Turn the washing machine on first when it is full
Turn off the light when no one is using the room
Buy seasonal products
Sort plastic waste
Buy biodegradable detergents

20. How do you estimate your monthly energy consumption compared to households that are similar in terms of income, household size and type of housing?

My energy consumption is much higher
My energy consumption is higher
My energy consumption is average
My energy consumption is lower
My energy consumption is much lower

21. How would you respond to the following statements?

Strongly agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree
I can not say

I would like to get more information about how to save energy at home
I would like to get more specific information about how to save energy at home
I would like to get information on my energy consumption compared to the consumption of other similar households
I would like to get information on my energy consumption compared to the consumption of other similar households in my area
I would like to get information about my current energy consumption compared to my previous energy consumption
I would like to get exact information about the operating costs of my electrical devices

22. Which of the following and for what purpose would you give information about your household's energy consumption?

Scientific research
Market research
Production of additional services
Other

Energy investments

23. What kind of energy investments has your household already done or will do in the future?

I already own
I am planning to get
I don’t own and haven’t planned to get
I don’t know

Solar panels
Wind generator
Electric vehicle
Hybrid or rechargeable hybrid
Digital electricity meter

24. Does your household produce energy?

Yes
No

25. Do you produce electricity only for your own household or also for sale?

For my own use, I’m not interested in selling
Only for my own use but I would be interested in selling
For my own use and for sale

26. Estimate how important the following criteria were when you were purchasing solar panels.

Very important
Somewhat important
Not very important
Not important at all
I don’t know

Possibility to produce electricity in an environmentally friendly way
Possibility to save money in the long run
Possibility to order panels on a turnkey basis
Increasing indigenous energy self-sufficiency
Desire to reduce dependence on electricity companies

Interest in new technology
The desire to be a pioneer
Encouragement from related parties
Other prosumers in my area
Desire to have a hobby
Desire to learn something new
Supporting domestic energy production and work
Supporting energy production and work in the Vaasa region

27. How would you respond to the following statements?

Strongly agree
Agree
Disagree
Strongly disagree
I don't know

I often talk about small-scale energy production with my friends / acquaintances
Many of my acquaintances already have solar panels
I would recommend solar panels also for my acquaintances
I am proud to be a small-scale producer

28. Why would you not recommend small-scale production for your friends and acquaintances?

Open

29. Why would you recommend small-scale production for your friends and acquaintances?

Open

30. Evaluate the importance of the following criteria if your household were to become a small-scale producer of electricity?

Very important
Somewhat important

Not very important
Not important at all
I don’t know

Increasing indigenous energy self-sufficiency
Desire to reduce dependence on electricity companies
Interest in new technology
The desire to be a pioneer
Encouragement from related parties
Other prosumers in my area
Desire to be into something
Desire to learn something new
Supporting domestic energy production and work
Supporting energy production and work in the Vaasa region

31. What other notices or comments do you have to the theme?

Open

APPENDIX 3. Background information and demographic information tables.

Employment status	N	%
Leadership (employed by another)	6	9,0 %
Senior officer	8	11,9 %
Junior officer	6	9,0 %
Employee	21	31,3 %
Entrepreneur or self-employed	9	13,4 %
Student	2	3,0 %
Pensioner	10	14,9 %
Unemployed	3	4,5 %
Other	2	3,0 %
Total	67	100,0 %
Marital status		
Single	12	17,9 %
Married	36	53,7 %
Domestic partnership	16	23,9 %
Divorced	1	1,5 %
Else	2	3,0 %
Total	67	100,0 %

The year the house was built		
Before 1919	1	1,5 %
1920-1929	1	1,5 %
1930-1939	1	1,5 %
1940-1949	3	4,5 %
1950-1959	5	7,5 %
1960-1969	9	13,4 %
1970-1979	4	6,0 %
1980-1989	9	13,4 %
1990-1999	6	6,0 %
2000-2009	17	25,4 %
2010 or after	10	14,9 %
I don't know	1	1,5 %
Total	67	100,0 %

APPENDIX 4. ANOVA table from cluster analysis.

ANOVA

	Cluster		Error			
	Mean Square	df	Mean Square	df	F	Sig.
Environmental self-identity	4,993	4	,302	61	16,538	,000
Energy literacy	12,569	4	,179	61	70,046	,000
Information of energy consumption	12,569	4	,179	61	70,046	,000
General interest in energy-related subjects	4,084	4	,147	62	27,706	,000

The F tests should be used only for descriptive purposes because the clusters have been chosen to maximize the differences among cases in different clusters. The observed significance levels are not corrected for this and thus cannot be interpreted as tests of the hypothesis that the cluster means are equal.