UNIVERSIDADE CATÓLICA PORTUGUESA

EXPLORING THE DETERMINANTS OF: PARTICIPATION AND PAYMENT REQUIREMENTS FOR PEER 2 PEER ELECTRICITY MARKETS IN COMBINATION WITH SMART ELECTRICITY MANAGEMENT DEVICES

Dissertation submitted to Universidade Católica Portuguesa to obtain a Master's Degree in: Master in Psychology in Business and Economics

By

Till Tinsahli

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November 2021

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Under the supervision of Professor Dr. Ian Scott

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Abstract

Using Peer-to-Peer electricity trading in combination with Smart Electricity Management Devices is a promising approach to use renewable electricity sources more effectively, while creating greater welfare for the market participants than current electricity markets do. The presented work investigates how the Willingness to Participate, the Minimum Savings for Participation, and the electricity prices in a Peer-to-Peer electricity market are shaped. Though investigating the relations of: Pro Environmental Behaviour, explanatory variables and control variables, with the Willingness to Participate, the Minimum Savings for Participation and the electricity prices on a Peer-to-Peer electricity market with Smart Electricity Management Devices. Therefore, the answers of 134 German residents to a questionnaire got evaluated, to determine the Willingness to Participate and the Minimum Savings for Participation in Peer-to-Peer electricity trading, Smart Electricity Management Device use and a combination of both. Furthermore, the buying and selling prices for electricity on a Peer-to-Peer market are determined. This work found that the Willingness to Participate in is fully mediating the relation between Pro Environmental Behaviour and the Minimum Savings for Participation. Also, the Willingness to Participate and the Minimum Savings for Participation are mediating the relation between Pro-Environmental Behaviour and the selling price for electricity. Additionally, simple linear relations and multiple relations of: Pro Environmental Behaviour, the explanatory variables and control variables, with: the Willingness to Participate, the Minimum Savings for Participation and the electricity prices are indicated. Finally, conceptual frameworks illustrate the most important relations and the mediation analyses with the respective effect sizes. The presented work found that a P2P electricity market could function effectively regarding the prices, and that Pro Environmental Behaviour is the most important external variable influencing the Willingness to Participate, the Minimum Savings for Participation and the electricity prices. Thus, this work provides valuable insights about what should be considered when setting up an actual Peer-to-Peer electricity market.

Keywords: P2P electricity trade; Smart Electricity Management Devices; Willingess to Participate; Minimum savings for participation; Electricity prices, Pro Environmental Behaviour

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Abbreviation Index

AEB .... Amount of electricity bill
ATI .... Affinity for Technology Interaction
CI .... Community Identity
CO2 .... Carbon dioxide
DV .... Dependent Variable
EIA .... Electricity independence aspirations
etc .... Et cetera
EU .... European Union
FRP .... Financial Risk Perception
GW .... Gigawatt
IV .... Independent Variable
KEB .... Knowledge about electricity bill
kWh .... Kilowatt-hour
MSP .... Minimum savings to participate
P2P .... Peer-to-Peer
PC .... Price Consciousness
PEB .... Pro Environmental Behaviour
PV .... Photovoltaics
RTP .... Real time pricing
SCS .... Sense of Community Scale
SEMD .... Smart Electricity Management Devices
TP .... Time Preferences
TWh .... Terawatt-hour
vs. .... Versus
WTP .... Willingness to participate

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Introduction

Climate change is unfolding at a fast pace. To counteract the worst outcomes and to achieve the goal of maximum 2°C of global warming, innovative approaches need to be considered. As the energy sector is the single biggest emitter of CO2 emissions with 75% of all EU CO2 emissions (European Commission, n. d.). This sector features the possibility of a significant reduction of the CO2 emissions. The European Union just announced its Green Deal, a plan how the EU should reach net zero emissions by 2050. With special attention to the energy sector and the energy transformation. The EU pledges that for this target they need to “develop a fully integrated, interconnected, and digitalised EU energy market” with “innovative technologies and modern infrastructure” (European Commission, n. d.).

Countries like Germany already started this energy transformation in the previous years, to change their electricity mix. The private photovoltaic (PV) electricity production in Germany reached 50,6 TWh, respectively 9,2% of the total energy supply of Germany in 2020. With a yearly growth of at least 5 GW per year (Wirth, 2021).

For now, the biggest disadvantage of renewable energy and PVs is the fluctuations and uncertainties of the electricity production and supply. The increase in private PV output combined with the innovative approaches of the EU holds a lot of potential. However, consumers and private producers of green electricity must manage the consumption and the distribution of the electricity more efficiently.

One promising approach for more effective electricity distribution and consumption is a Peer-to-Peer (P2P) electricity trading market for privately produced electricity. In a P2P electricity trading market, the participants can trade (buy and sell) self-generated electricity with each other. This comes with many advantages when compared to the current electricity market. First the prices on a P2P market aren’t fixed as it is the case on the current market setup. Participants on a P2P electricity market are exposed to changing prices, depended on the current electricity output (supply) and the demand of the market participants. This leads to a price-based electricity consumption management, as participants react to price signals and thus engage in demand response. (E. M. Mengelkamp, 2019)

Optimally participants that engage in this P2P electricity market should have Smart Electricity Management Devices (SEMD) which automatically control and adapt their electricity consumption. For agents that have SEMD and take part in a P2P electricity market their devices could automatically react to price changes on the P2P market and thus lower or increase the electricity consumption. This would enable a fast reaction to the fluctuations and uncertainties of the electricity production and therefore the produced electricity could be used more effectively. (Belton & Lunn, 2020; Washizu et al., 2019)

Consumers in this market profit from obtaining green energy from peers of their community at competitive prices. Producers profit from higher margins, as the selling price for electricity on the P2P market is assumed to be higher than the fixed feed-in tariffs paid in Germany. Those profits then might be reinvested in improving the private electricity infrastructure.

The use of this technologies can significantly reduce the electricity consumption, increase the efficiency of electricity use and further could increase investments in private PV systems (or storage systems). (E. Mengelkamp et al., 2019)

As P2P electricity markets are a completely new electricity market setup, many uncertainties are connected to the adoption, the willingness to participate and the willingness to pay for it. Consumers must be way more engaged in the electricity trade as it is the case in the current market setup. Further prices in a P2P market must be competitive enough to compete with ordinary electricity suppliers. And most importantly agents must be willing to offer privately generated electricity on the P2P market and others must be willing to buy it.

Concerning SEMD there are some uncertainties connected with it too. Participants must be willing to give up some control over the electric devices, as they'll be managed by the SEMD. Even though latest SEMD try to provide as much consumer convenience as possible, by trying not to interfere too much with the consumers habits, some consumer convenience would still have to be traded off for a better electricity consumption management.

At this point in time there is some research connected to the willingness to participate (WTP) in P2P electricity trading and SEMD use. So far only few studies tried to investigate monetary aspects connected with these technologies, like the minimum savings participants would have to realize for using the respective technology and the prices participants would demand/pay for self-generated electricity. Even though monetary aspects are key in determine if participants would engage in the respective technology use, and especially if a P2P electricity market could function efficiently. Also, no study built a conceptual framework, that describes the dynamics that shape the WTP, MSP and the final electricity prices. This research aims to investigate the relations concerning WTP, MSP and the final electricity prices. Respectively for a P2P electricity market, SEMD and a combination of a

P2P electricity market with SEMD use. This research will provide valuable insights why participants would engage in the respective technology use and what dynamics shape the monetary aspects connected with the technology use to finally build a conceptual framework. This study will provide insights if a P2P market could function, and which participants could be the most valuable to build a healthy P2P electricity market. This will help policy makers, energy companies and other stakeholders to identify the most important determinants of the engagement in the respective technology use. So, if a P2P electricity market should be developed in the future, main target groups can be identified and researched based intervention can be carried out.

I Theoretical Framework

This part will provide technical and theoretical insights about a P2P electricity market and the SEMD use. First, the technical requirements and functionalities will be explained. Following, behavioural and attributable insights that determine the acceptance, engagement, and willingness to pay, connected to the respective technology use, will be pointed out.

The final part of the theoretical framework will then focus on the concepts that are used in the study to explore different predictors.

1.1. P2P Electricity Trading

1.1.1. P2P Technical Requirements & Functionalities

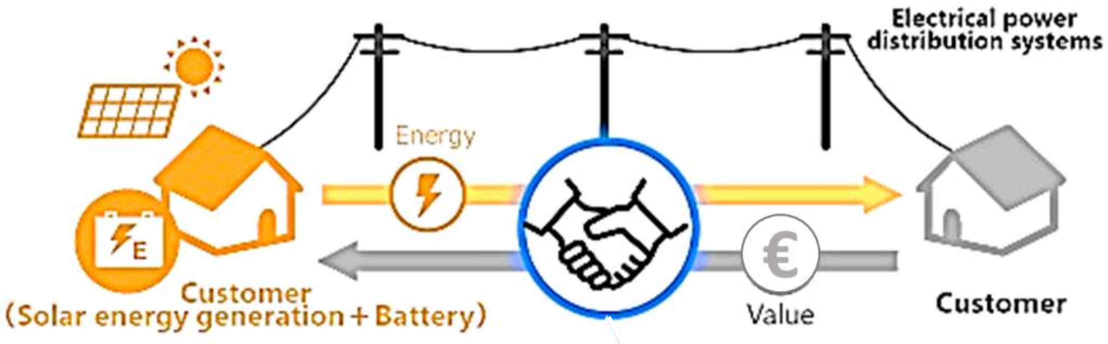

Figure 1 P2P Electricity Trade (Toshiba, 2019)

P2P electricity trading is a direct energy trading mechanism that allows participants to trade self-produced electricity from renewable sources in a small scale with each other over the grid. The area in which the P2P electricity trade can be implemented are multiple households in a neighbourhood, one or several cities, a federal state, or a state, respectively a locally defined area. Different regions/counties have different market rules, languages, and legislative regulations, but a P2P community must be able to constructively interact. Participants in a P2P electricity trading community must be all connected over a physical distribution grid that connects all consumers and producers of the trading community. Further, trading agents do have to be connected in a community over an online platform at which they can trade electricity with each other. Thus, P2P electricity trade is a tool for a multidirectional energy trading within a community in local geographical area. (Burmester et al., 2017; Perger et al., 2021)

The key agents in this market are consumers (only consume energy) and prosumers (produce and consume energy). Additionally, there might be other agents, or suppliers involved in the P2P electricity trade.

Agents in the P2P electricity market do not have to actively sell and buy energy. This is managed through a demand and supply aggregator that acts according to the consumer's and produces needs, using historical energy consumption and energy production to predict current and future energy demand and supply. (Alam et al., 2016, 2017; E. Mengelkamp, Staudt, Garttner, & Weinhardt, 2017)

The amount of tradable electricity in a P2P electricity market is limited to the current production level of the market agents. If demand in a P2P electricity market cannot be satisfied, the system operator must either buy the remaining demand on the external market. Or consumers must engage in multihoming and acquire the remaining electricity on the external electricity market themselves (E. Mengelkamp, Staudt, Garttner, & Weinhardt, 2017).

1.1.2. Dynamic Pricing

There are several possible pricing mechanisms for a P2P electricity market. One pricing mechanism is trough bidding. In this process consumers and producers set bis for how much they would sell/buy one kWh of electricity and what amount of electricity they require. Timeslots are set (every 10-15 min). Each timeslot starts with a trading period. In which consumers and producers are matched according to the prior set prices and amounts of electricity. The trades are carried out subsequently and the electricity is traded for the minimum price the producer set and the matched consumer is willing to pay. The bids are fixed for a timeslot. They can be change from timeslot to timeslot. Individual prices for each electricity trade are the outcome. Nevertheless, average prices can be indicated for each time slot. This mechanism is managed automatically by matching algorithm.

Alternatively, a market clearing price can be computed for the respective timeslots. The market clearing price is automatically and dynamically calculated based on the marginal of all bids of the respective timeslots combined with data about historical (previous) trading behaviour. This aims to create a price at which a maximum of trades can be carried out at a smallest possible price. The market clearing price would be computed by a dedicated algorithm.

Both approaches are classified as real time pricing (RTP). RTP is based on the actual demand and supply of electricity at a given moment. This relates to cost minimization, as with a low selling price bigger margins are sold. Producers of electricity will therefore try to minimize production costs. This mechanism differs strongly from the current electricity pricing mechanism, as prices are usually fixed for at least one year. Consumers in the current market have no incentive to react to changes in supply. So, all the fluctuations and the related balancing of the electricity supply must be carried out by the supplier. With RTP consumers take part in balancing. Thus, in an electricity market with RTP consumers actively response to changing electricity quantities on the market.

This balancing leads to a more efficient interaction of supply and demand and reduces the total amount of electricity needed and consequently the CO2 emissions. (Zhang et al., 2018)

There are several ways how dynamic pricing can be implemented in the electricity market. The most recent are: Critical Peak Price, Time-of-Use tariffs, Peak Time Rebate and Real Time Pricing. A meta-analysis of 24 studies investigating the impacts of the dynamic pricing models on peak time consumption, found that all mentioned dynamic pricing models reduce the peak electricity consumption. Combining dynamic pricing models with supporting technology leads to an even higher reduction during peak times.

Consumers respond to price changes. They lower their demand when prices are high. All of the dynamic pricing models influence consumers behaviour through price signals and thus lower consumption during peak times. (Faruqui & Palmer, 2012)

1.1.3. Behavioural & Attributable Insights

The current setup of the electricity markets, with fixed prices, ensures a high consumer satisfaction through an ease of use. Thus consumer consider electricity to be a low involvement product (Paladino & Pandit, 2012). Nevertheless, active involvement and action is crucial for a P2P electricity market to operate effective. Therefore, behavioural insights about attributes and attitudes of possible participants in such a market are crucial.

A main driving factor for agents to participate in a P2P electricity trade is cost reduction. In a study over 50% of participants stated that they would participate in local electricity projects, if they can save money. This indicates that price consciousness is a possible driving factor behind the participation in a P2P electricity market (Wiyono et al., 2016).

Assigning high importance to green products increases the preference for local produced electricity of participants. Further a high valuation of regional products and sustainability as well as a perceived dependence on the energy provider increase the preference for local produced electricity (Kaenzig et al., 2013; Klein & Coffey, 2016).

P2P electricity trade takes place with other members of the community. The profits are generated and shared within the community. Generated profits can be reinvested in PV systems and storage units to further improve efficiency and effectivity of the trading community. This might lead to higher profits for all agents in the market. Thus, utility is always created in a cooperative form. In line with this, high community identity of individuals was found to increase the willingness to act in support of a P2P electricity trading community. The identification with a community has a positive impact on participation and acceptance of pro environmental projects in a community (Lantz & Loeb, 1998). Thus individuals that identify strongly with their community might be more willing to participate in a P2P electricity trading community. (E. Mengelkamp et al., 2018) (Cowell et al., 2011)

In general, focusing on aspects that explain the willingness of agents to participate, provides valuable insights about the driving factor that shape the decision process of participants. A survey carried out in Germany investigated the WTP in a P2P electricity market, possible behavioural insights and motivations connected with it. Data of 195 German electricity customers was analysed. They checked the impact of community identity, affinity towards technology, product regionality, price consciousness and importance of green products on the WTP in a P2P electricity market. Affinity for technology, community identity and importance of green products had a positive relationship with the WTP of the participants. The strongest relations were found for, affinity for technology and importance of green products. Price consciousness had no significant relation with the WTP. (E. Mengelkamp, Staudt, Garttner, Weinhardt, & Huber, 2017).

A following survey investigated attributes of the P2P electricity market settings and household preferences regarding the willingness to pay. 417 German and 239 regional German participants took part in the study. A status quo for green electricity costs was set at 80€ per month and the willingness to pay was defined as deviations from the status quo. Overall, green electricity was valued high. For a 19€ decrease in the monthly electricity bill participants would participate in a P2P trading. Also, the higher the investments of participants in supporting systems (PV, storage), the higher is the expected decrease in the monthly bill. Most participants stated that economic aspects are most important when deciding to take part in a P2P electricity trading community.

Concerning socio-demographics and the willingness to pay, younger people were found to have a lower utility threshold for participating in a P2P electricity market. Also, small households have a smaller willingness to pay for P2P electricity. This could be the case, because bigger households have a higher potential to save costs, as their consumption is higher. Having a green electricity contract didn't indicate a significate difference to not having a green electricity contract (E. Mengelkamp et al., 2019).

Hackbrath et.al. found significant relations of socio-demographic factors with a high WTP in P2P electricity trading in the subgroup of 40–69 years old, well educated, with a lower income, and participants that already own a PV. Further, previous knowledge about P2P electricity trading, interest in technology, a pro environmental attitude, the valuation of regionality and transparency, home ownership and a high aspired independence from the energy provider had positive relations with the WTP. The greatest influence on the WTP in P2P trading were detected for; pro environmental attitude, the ownership or planning of a PV unit, technical interests, the ownership of a home, and the independence aspiration from the energy supplier. Another important motivation for participants to engage in a P2P trade is the possibility to share electricity and the benefits coming along with it. Price consciousness was indicated to be a significant factor but with little impact on the WTP. (Hackbarth & Löbbe, 2020)

Gstrein et. al. launched a study in Switzerland investigating the value determination and perception of green energy in a P2P energy community and possible socio demographic connections. First, they indicate that participants give a high relevance to intelligent and decentralised energy managing systems, capable of producing and storing electricity like P2P electricity trading. 67% percent of the participants demand monetary compensation for sharing electricity. This indicates self-generated electricity as a possible object for trade. (Gstrein, 2016).

A survey by Reuter et. al. found a high willingness (around 80%) to sell self-produced energy. The same amount (79%) of participant also stated that its desirable to participate in a local electricity market. The key motivations for Germans to participate in such a market are balanced with 79% indicating environmental factors and 76% monetary factors (multiple selections were possible). Age and affinity for new technologies had a significant impact on the WTP. The younger the participant were, the higher the expected WTP. Energy consciousness, energy knowledge and the number of technological devices in the household had a positive relation with the WTP. They found no differences for gender, living area, ownership status or country of origin. (Reuter & Loock, 2017).

Ecker et. al found that emphasizing autarky benefits increases participants subjective value of self-generated electricity. They also determined the willingness to pay for self- and peer generated energy. Three conditions (groups) got tested. A neutral/control, an autonomy framed (not dependent on supplier) and an autarchy (complete self-supply) framed. The reported willingness to pay for buying electricity was lower than the reported willingness to pay for selling in the neutral and autarky condition. Only in the autonomy condition the reported price for selling electricity was lower than for buying. This outcome is concerning, as an efficient P2P market is only functional if the expected buying price is higher than the expected selling price. (Ecker et al., 2018)

1.2 Smart Electricity Management Devices

1.2.1. SEMD Technical Requirements & Functionalities

The market for smart homes is growing fast, and is expected to reach 53,45 $ billion by 2022 with an expected annual growth rate of 14,5% (Hargreaves & Wilson, 2017). This provides an opportunity to reduce electricity consumption through a more dynamic and automized electricity management in private homes.

SEMD are telecommunications, measuring and analysis devices combined with media output options. The main functions are output and visualization of previous actual and future electricity consumption and the automatic control and management of energy consumption, while trying not compromising the user's comfort and convenience. The most important functions of smart devices are to connect, control, monitor and visualize residential electricity consumption, with a special focus on electronic devices with a high consumption, such as: heaters, air conditioners, water heaters, freezers, electrical vehicles, etc. Two operation types of Smart Meters can be identified. Normal Smart Meters which only monitor the electricity consumption with the possibility for manual control and adoption. And SEMD which are more sophisticated so that they can perform automated consumption control, source of consumption control and output consumption information. Especially SEMD can perform demand side management, in order to balance the grid and manage applicants which loads can be shifted during peak loads or peak supply from PV (Alam et al., 2016).

Providing feedback over the consumed amount of energy can already lead to a reduction in overall consumption (Fischer, 2008). Thus, Smart Meters and especially SEMD can decrease electricity cost through a smart consumption management.

Further, they can manage the overall consumption on a macro grid level through smart demand side management of the electricity market, by lowering the electricity consumption of homes in times of peak electricity use. Or by increasing the consumption of for example storage units in time of peak electricity supply by renewable sources. This can lead to a more efficient electricity distribution and consumption and thus can reduce electricity costs for consumers. (Zipperer et al., 2013) (Hideo Ishii et al., 2016)

1.2.2. Behavioural & Attributable Insights

Li and colleagues conducted a study in the Netherlands investigating the perception of smart grids, WTP in SEMD use, and willingness to change electricity consumption behaviour with SEMD. The results indicate that most participants are unfamiliar with the technological concepts of SEMD. This unfamiliarity increases with age. Monetary aspects have been identified to have the biggest impact on the WTP in SEMD use. (Li et al., 2017)

A different study investigated time of use tariffs and SEMD regarding consumer preferences. Two conditions got tested, environmental impact and money saving condition. For the study participants got framed with a letter either stating the environmental benefits or monetary benefits of the technology. The environmental impact condition was found to have the bigger impact on the WTP in SEMD use. Younger participants have been more willing to use the technology. In terms of educational background, no relations got detected. (Belton & Lunn, 2020)

Further demographic and socio-economic factors regarding the acceptance and use of SEMD got detected. Positive relations for the adoption of SEMD in terms of income and home features (size, rooms number) were found. (Belton & Lunn, 2020)

Also, age, technology affinity and energy awareness were indicated to have a relation with the WTP in SEMD use. (Brown & Markusson, 2019).

The role of environmental attitude is of high importance for a successful use and implementation of SEMD by the consumer. In a study by Henn, participants with a higher environmental attitude saved more energy when compared to the control group. Also, money saving aspects might influence the consumption behaviour of consumers. (Henn et al., 2019)

The willingness to pay for SEMD got investigated with participants from Tokyo and New York with a questionnaire. They mainly focused on investigating how three conditions of SEMD: money saving, automatic control, and environmental impact, influence the willingness to pay for SEMD. Further, demographic and socio-economic factors that might influence the willingness to pay got investigated, using the marketing related contingent valuation method.

The money saving function enables the consumer to monitor the electricity use and warns the consumer in cases of excessive use or high prices. So, that the consumer can react accordingly. The automatic control function controls the consumption and production (PV, storage) of electricity automatically and thus, reduces electricity consumption and costs. The environmental impact function represents the implementation of smart grids to enable an effective demand response. This function is considered to have the biggest environmental impact.

Most of the participants indicted that they would use all three SEMD functions and are willing to pay for it. In the aspects of demographics, New York and Tokyo had different results. Where in New York the willingness to pay for the SEMD functions decreased with age, the willingness to pay in Tokyo increased with age. For New York, the following determinants were identified as having a positive significant influence on the willingness to pay of participants; Intention to use tele-medical services, a positive attitude towards SEMD, energy-saving behaviour, and house size. The most negative impact had the fact that the product would be available for a fee. In Tokyo, a positive attitude towards SEMD and a perceived dependence from the electricity supplier positively affected the willingness to pay, whereas technological anxiety had the biggest negative impact. The willingness to pay was the highest for the automatic control function in both towns, with just a small difference to the environmental impact function.(Washizu et al., 2019)

Research in related areas like smart homes or smart grinds, found insights that: concerns about new technology, privacy and data security and trust in the electricity supplier, have an impact on the consumer behaviour. Knowledge about and experience with new technologies was indicated to have a positive impact on the acceptance of those technologies (Balta-Ozkan et al., 2013; Berry et al., 2014). Further, the consumers motivation to save energy and pro environmental attitude have been indicated to influence the acceptance of SEMD positively (Oltra et al., 2013).

1.3 P2P & SEMD

Combing P2P electricity trading with the use of SEMD might create valuable synergies. SEMD smartly manage the electricity consumption on a micro and macro level and thus is an adequate technology to balance the grid and react to peak or low consumption phases to save electricity in private households. This can be reinforced by the dynamic pricing and the resulting price signals of a P2P electricity market. Also, the active interaction with peers on the electricity market increases the personal involvement with the electricity trade and thus might increase electricity awareness. Furthermore, a combination of both technologies could counteract the uncertainties and fluctuations coming with green electricity production. Thus combining P2P electricity trade with the use of SEMD can significantly reduce the electricity consumption of private homes. (Belton & Lunn, 2020)

1.4. Possible Related Concepts

The concepts that are used in this work are presented in the following paragraphs.

1.4.1. Pro Environmental Behaviour (PEB)

The Theory of Planned Behaviour aims to predict intentions to perform a certain behaviour. It uses attitudes toward the behaviour, subjective norms, previous behaviour, and perceived behavioural control to make predictions about intended future behaviour. Further, it takes into consideration that planned behaviour does not necessarily result in a performing of the planned behaviour. This theory is supported by many studies and often got replicated and used to determine PEB. It was often applied in connection with energy saving and renewable energy use.(Ajzen, 1991)

Also, connected with PEB is the NAM model. It aims to relate altruistic actions with the feelings of moral obligation and personal norms. The personal norms and feelings then are carried out in pro-social behaviour. Thus, if agents have moral norms and/or the feeling of a moral obligation to protect the environment, they're likely to act in a pro environmental way. Many studies used the NAM model to predict PEB. (Bamberg & Möser, 2007; Schwartz, 1977)

Findings indicate that the PEB is strongly related with the environmental attitude, the use of a new renewable energy technologies, subjective and descriptive norms and the perceived behavioural control. (Chen et al., 2016; Scott et al., 2014; Xu et al., 2015)

Research suggests that PEB is strongly related with environmental self-identity. This indicates that pro environmental actions of individuals high in environmental self-identity are not influenced by external factors. The driver for the pro environmental action is intrinsic motivated and acts as a moral obligation. (van der Werff et al., 2013)

PEB mostly is measured by previous performed pro environmental actions, as previous behaviours are a strong indicator for future pro environmental actions (Markle, 2013).

1.4.2. Affinity for Technology Interaction (ATI)

ATI is a construct that explains the relationship between individuals and the adoption of new technologies. New technologies require agents to learn new ways of interaction, new ways of data input and thus require a high level of adaptation and interest. A successful adoption of a new technology is therefore connected with the individual coping resources and requires cognitive and behavioural efforts of the individual. As all agents have different mental, physical, and personal resources to use, agents highly differ in the ease of adoption, the speed of adoption and willingness for adoption. Therefore, individuals have different coping strategies when it comes to new technologies. (Beaudry & Pinsonneault, 2005; Franke et al., 2019)

1.4.3. Community Identity (CI)

To describe associations of people that live in proximity with each other the construct of CI can be applied. Individuals have the intrinsic goal to have a positive self-identity and the desire to project this self-identity to peers in their groups to create a social identity with their social community. The CI theory assumes that the socially constructed self, mediates the relation between social structure and the individual behaviour. In this mediation process the CI is shaped. CI can be applied to describe what place an individual takes in the social community, what relation it has with other community members and how strong this relation is. (Hogg et al., 1995; Lantz & Loeb, 1998)

1.4.4. Price Consciousness (PC)

Prices represent the amount of money a consumer must give up, to make a trade happen. Prices are crucial for all marketplaces, purchases, negotiations, and all other trade related situations. Consumers are highly accustomed to make decisions based on price signals. Prices can have positive and negative effects on a purchase decision. Intuitively high prices relate to negative effects as more money must be given up. But high prices can also be interpreted as a sign of quality by consumers. Thus, prices can be interpreted differently by consumers and prices have different effects on consumers. The extend to what a consumer makes the purchase decision depended on a given price and how much effort a consumer takes upon himself to find low prices can therefore be described as PC. (Gabor & Granger, 1961; Lichtenstein et al., 1993)

1.4.5. Time Preferences (TP)

TP are an important economic construct when investigating financial decision-making. Knowledge about temporal discounting provide important insights about how agents trade off time vs financial pay-outs. Usually, TP is measured by making participants choose between different monetary payments in combination with different time frames for the monetary payments. Important in this context is the curvature of the utility function, both with respect to the time frame as well as the amount of the pay-outs (Andreoni et al., 2015). TP play a crucial role in the consumption behaviour of agents regarding financial products, always in context with temporal discounting. There is a crucial difference to Financial Risk Perception (Andreoni & Sprenger, 2012).

1.4.6. Financial Risk Perception (FRP)

Agents must make many decisions, most of them relate to uncertainty and risk. Individuals have a mechanism for how to assess the risk and how to decide. The outcome of a decision is mostly based on the available alternatives and on the likelihood each of these alternatives occur. Based on those two factors individuals' asses the most favoured alternative. Using the two factors (available alternatives and the likelihood) a utility function can be created to predict agents risk perception (Becker et al., 1964). Risk perception is mostly applied to predict financial decision making as the possible alternatives can easily be modelled with lotteries in which the outcome possibility and the outcome (payoff) as well as the time frame can be controlled. According to the respective answers, individuals then can be classified as: risk averse, risk neutral or risk seeking (loving). (Charness et al., 2013; Eckel & Grossman, 2008)

1.4.7. Electricity Consumption

Studies indicate that individuals high in electricity knowledge are more capable to react to changing electricity prices and are more engaged in adopting electricity consumption behaviour (Heberlein & Warriner, 1983). In dynamic electricity pricing schemes, the knowledge about the amount of the electricity bill (KEB) had a positive relation with a better adoption to changing prices and thus results in a lower electricity bill. (Mishra et al., 2012)

1.4.8. Willingness to Participate

A Study conducted in 2018 by Wei et. al. investigated the relations between the WTP and the price consumers are willing to pay for green products through a questionnaire. The results show that participants with a high engagement to purchase green products (WTP) are willing to pay a higher price for green products. (Wei et al., 2018).

A study from 2008 investigated the relations on the willingness to pay for green energy. The results show that the attitude towards green energy usage (WTP) is related to the willingness to pay meaning: that participants with a strong positive attitude towards green energy usage would be willing to pay higher prices for green energy. Also, the attitude towards green energy usage is positively related with environmental concern. Additionally, the willingness to pay for green energy was related with income and electricity costs. Further the study shows a full mediation of the relation between environmental concern and the willingness to pay for green energy over the attitude towards green energy usage. (Hansla et al., 2008)

1.5 Study Aims and Hypotheses

This work aims to build 3 conceptual frameworks that explain the relations with the minimum savings participant must reach to participate/use the respective technology. The technologies of interest are P2P electricity trading community, SEMD use and a combination of a P2P electricity training community with SEMD use. Therefore, first the relations with the WTP for each of the technology implementation will be determined. Following the relations with the MSP will be evaluated. To finally build a model that explains the relations and dynamics that determine the MSP, for the respective technology use. Therefore, all single direct relations of the IV, explanatory variables, and control variables on the WTP and the MSP will be investigated, followed by a multiple regression. To finally test a mediation of the relation between PEB and MSP for the respective technology over the WTP, as indicated by Hansla (Hansla et al., 2008). All mediation models will be checked for the control variables and the explanatory variables. The literature provides insights about relation of those with the WTP and the MSP.

For the MSP SEMD an additional mediation of the relation between ATI and MSP over WTP will be tested, as the literature indicates significant relations of ATI on the WTP as well as on the willingness to pay for SEMD (Brown & Markusson, 2019; Washizu et al., 2019).

This research will provide new insights in the relationships of the mechanisms that determine the acceptance, participation, and the MSP for the respective technology, as models which are explaining the relationships are missing so far.

Beyond the four models mention above, two more conceptual frameworks are developed, which explain the electricity selling and buying prices agents would pay or charge in a P2P electricity trading community, to explore if the prices allow a healthy market to function and to determine the relations that shape the prices. Therefore, first all direct relations of the IV, the WTP, the MSP, explanatory variables and control variables with the electricity buying and selling prices are evaluated. To finally test a sequential mediation between PEB and the buying/selling price for one kWh electricity, over the WTP in a P2P electricity trading community and the MSP. The sequential mediation will be checked for the control variables and the explanatory variables, as the literature provides insights about relation of those with the WTP, the MSP and the final prices.

This study only focuses on residents of Germany. As the electricity markets have different legal frameworks even in the European Union, the prices and the pricing methods also differ from country to country and a P2P electricity market can only be implemented in a strictly geographical defined area. The target population are all individuals over 18, as all natural legal persons over 18 can legally take part in P2P electricity trading community: either just buying or buying and selling electricity to their peers.

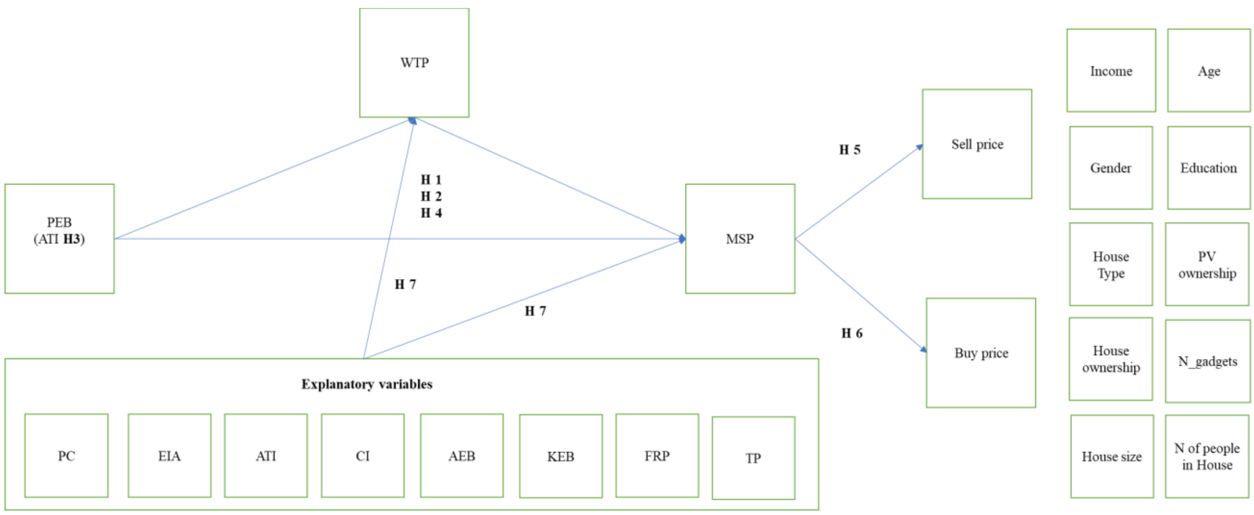

Figure 2 Hypothesis Framework

This graphic illustrates the approaches of this work in a simplified way. Its shows the mediation analysis connected to the hypothesis. The relation with the buy and sell price will only be tested for P2P electricity trade. All mediations will be checked for the control variables and the explanatory variables.

The literature provides insights that PEB predicts the WTP in a P2P electricity trading community (Hackbarth & Löbbe, 2020; Klein & Coffey, 2016; E. Mengelkamp, Staudt, Garttner, & Weinhardt, 2017). Also, literature connected to willingness to pay for green energy indicates that the WTP might mediate the relation between PEB and the MSP (Hansla et al., 2008; Wei et al., 2018).

H1: The link between PEB and the minimum savings to participate (MSP) in a P2P electricity trading community is mediated by the WTP in a P2P electricity trading community.

The literature provides insights that PEB predicts the WTP for SEMD use. Also, literature connected to willingness to pay for green energy indicates that the WTP might mediate the relation between PEB and the MSP. (Hansla et al., 2008; Wei et al., 2018).

H2: The link between PEB and the minimum savings to participate (MSP) in SEMD use is explained by the WTP in SEMD usages.

The literature provides insights that ATI predicts the WTP for SEMD use (Brown & Markusson, 2019). ATI also predicts the SEMD MSP (Washizu et al., 2019): Thus the WTP could mediate the relationship between ATI and the MSP

H3: The link between ATI and the minimum savings to participate (MSP) in SEMD use is explained by the WTP in SEMD usages.

The literature provides insights that PEB predicts the WTP in a P2P electricity trading community (Hackbarth & Löbbe, 2020; Klein & Coffey, 2016; E. Mengelkamp, Staudt, Garttner, & Weinhardt, 2017). Also, literature connected to willingness to pay for green energy indicates that the WTP might mediate the relation between PEB and the MSP (Hansla et al., 2008; Wei et al., 2018).

H4: The link between PEB and minimum savings to participate (MSP) in a P2P & SEMD combination is explained by the WTP in P2P & SEMD usages.

As there is no literature about the relations with the final prices in a P2P market, the following assumptions are of explanatory nature. If the P2P WTP mediates the relation between PEB and the P2P MSP, a sequential mediation will be applied to see if the final prices for electricity on a P2P market can be predicted from PEB on the buying/selling price, over P2P WTP and P2P MSP

H5: The link between PEB and the electricity selling price in a P2P trading market is explained by the WTP in a P2P electricity trading community and the minimum savings to participate (MSP) in a P2P electricity trading community.

H6: The link between PEB and the electricity buying price in a P2P trading market is explained by the WTP in a P2P electricity trading community and the minimum savings to participate (MSP) in a P2P electricity trading community.

The previous presented literature provides insights that the explanatory variables concerted to electricity use (KEB, AEB, EIA), financial decision making (PC, FRP, TP), ATI and CI have significant relations with the WTP or the MSP. To get insights about how these variables interact with the MSP, the WTP, the electricity buy/sell prices and finally with the mediation mode, the relations of the explanatory variables will be investigated. To finally map the relations in a conceptual framework.

H7: The explanatory variables KEB, AEB, EIA, PC, FRP, TP, ATI and CI will further have a significant influence on the mediation analyses.

II Research Design

2 METHODS

2.1 Participants

This study used a questionnaire to investigate the aspects of interest. The respective concepts were described in text form. The default questionnaire language was German, with the possibility to switch to English. The explanations for P2P electricity, SEMD use and P2P & SEMD use were simplified to increase understanding. No treatment or manipulation of the participants was applied: meaning that all participants answered the exact same questionnaire.

In average participants took 21,5 minutes to complete the survey. 43,3% of participants are male and 56,7% female. All participants have been living in Germany when they answered the questionnaire. The average age of participants is 34,12 years, with a SD of 14,69. In comparison the average age of German residence was 44,5 years in 2019 (Statista, 2021b). The average yearly net income of the participants households is 33.520 €, the German average household yearly net income is 42.960€ (Statista, 2021a). The highest educational qualification distribution of participants is the following: Secondary school diploma 16,4%, high school diploma 22,4%, university studies without a degree 6,7%, bachelor's degree 41%, master's degree 12,7% and a PHD 0,7%. Concerning the living conditions of participants, 66,4% live in an apartment house and 33,6% in a single-family house. The average size of participates households is 70-80m² and in average 2,4 persons share one household. 36,6% of participants live in a house/apartment that they own and 63,4% in a rented place. Further, 11,2 % of the participants own a PV (87,3% no PV) and 6% own an electricity storage unit, also 5 % own an electric car (95% no electric car). Concerning the number of electric appliances with large electricity consumption (electric car, washing machine, refrigerator, freezer, electronic heating, electronic water heater, air conditioner and dishwasher) participants have in average 4,05 of those in the household. Finally, 46,3% stated that they don't know the amount of the monthly electricity bill, and 53,7% knew the amount. The average amount of the monthly bill is 68,85€ with a SD of 53,16.

2.2 Instruments

WTP: The WTP was identified with a 5-point likert scale. Respectively for each of the main concepts of interest. In particular, the WTP for the P2P electricity trading community, the WTP for SEMD use and the WTP for a combination of P2P electricity trading community and SEMD. The participants could indicate their WTP by stating, how likely they would participate in such a technology use. From very likely, to very unlikely. The WTP in P2P electricity trading community mean was: 2,61, SD: 1,53. The WTP in SEMD use mean was: 2,43, SD: 1,63. The WTP P2P electricity trading community and SEMD mean was: 2,73, SD:1,59

P2P electricity trading community: To explain the concept of P2P electricity trading participants were presented with a text explaining the main aspects of P2P electricity trading. Some of the functionalities were simplified to increase the understanding. The corresponding text can be found in the appendix.

P2P electricity price: The prices for green grey and self-produced energy had to be anchored, as there are different electricity contracts for grey or green energy, which have different prices per kWh. Also, the feed in tariffs in Germany depend on the year the respective PV system got installed.

So that participants have a reference point when determining the prices for which they would like to buy and sell self-produced electricity. Information about average prices for green and grey electricity and the feed in tariffs were provided in an information box before answering the respective questions. The exact information can be found in the appendix.

P2P electricity selling price: To determine the possible price in € for which participants would be willing to sell their actual or hypothetical self-generated electricity by a PV or a related power generation unit, participants were asked to indicate a price in € Cent for which they would be willing to sell one kWh of electricity. Participants could choose a price between 0 and 50 cents. Additionally, participants could indicate that they would not sell electricity to peers. 16 responses got exclude from the analysis as those participants stated that they would not sell any electricity too peers. The average indicated selling price was 0,16 € with a SD of 0,8371€.

P2P electricity buying price: To determine the possible price in € for which participants would be willing to buy actual or hypothetical self-generated electricity by a PV or a related power generation unit from other individuals on the P2P electricity market, participants were asked to indicate the price in € Cent at which they would buy one kWh. Participants could choose a price between 0 and 50 cents. Additionally, participants could indicate that they would not buy electricity from peers. 16 responses got exclude from the analysis as those participants stated that they would not buy any electricity from peers. The average indicated buying price was 0,19€ with a SD of 0,9605.

P2P MSP: The monthly minimum savings participants would have to realize to participate in a P2P electricity market were determined. The participates could indicate the minimum monthly savings they had to realize to join a P2P electricity trading community on a scale from 0 to 35 €. The average minimum savings were 10,62€ with a SD of 9,01.

SEMD use: To explain participants the concept of SEMD and the functionalities of it, they got presented with a text before answering the respective questions. Some of the functionalities were simplified to increase the understanding. The corresponding text can be found in the appendix

SEMD MSP: The monthly minimum savings participants would have to realize to engage in SEMD usage were determined. Participants could indicate the minimum savings they had to realize to engage in SEMD usage on a scale from 0 to 35 €. The average minimum savings were 11,83€ with a SD of 9,74.

P2P & SEMD use: To explain participants the concept of P2P & SEMD and the functionalities connected with it, participants got presented with a text before answering the respective questions. Some of the functionalities were simplified to increase the understanding. The corresponding text can be found in the appendix.

P2P & SEMD MSP: The monthly minimum savings participants would have to realize in a P2P & SEMD program were determined. Participate could indicate the minimum savings they had to realize to use P2P and SEMD on a scale from 0 to 50 €. The average minimum savings were 14,37€ with a SD 14,14.

Time Preferences: Time Preferences were measured in a six-item likert scale, with six questions. The six-item likert scale consisted of six different pay-outs for “now” and “in five weeks”. Where the pay-out for “now” was always smaller than the in “five weeks”. The sum of the “now” and “in five weeks” pay-out was steadily increasing from item 1 to item 5. The sixth item always was a pay-out of 20 €. For the first item the entire pay-out was for “now” and for the sixth item the entire pay-out was for “in five weeks”. The participants were asked six times to choose a pay-out for “now” and “in five weeks”. From the first to the sixed question the sum of the “now” and “in five weeks“ pay-out was evenly decreasing, respectively from the first to the fifth item. This setup made it possible to control for temporal discounting. The scale was based on the model two of the paper “Measuring time preferences: A comparison of experimental methods” by Andreoni and colleagues (Andreoni et al., 2015). The internal consistency was measured for the six questions. The Cronbach’s Alpha is 0,90 (M: 4,97 ; SD: 1,40).

Community Identity: CI got measured with the Sense of Community Scale (SCS). It consisted of eight questions and a five-point likert scale. The SCS covered 4 dimensions. *Namely, Needs fulfilment, Membership, Influence and Emotional Connection*. For each dimension two questions got asked. The Sense of Community scale got adopted from: “Validation of A brief sense of community scale: Confirmation of the principal theory of sense of community” (Peterson et al., 2008). The Cronbach’s Alpha for all items of all dimensions is 0,87 (M: 2,56 ; SD: 0,95)

Pro Environmental Behaviour (PEB): Pro Environmental Behaviour was measured with a multiple item scale comprising of four dimensions (*Conservation, Environmental Citizenship, Food and Transportation*). The dimensions consisted of different numbers of questions. The dimension *Conservation* consisted of seven questions, *Environmental Citizenship* of six questions, *Food and Transportation* of three questions. The scale was adopted from Markle and colleagues (Markle, 2013). PEB got measured with a five-point likert scale in most of the dimensions. All items of the *Transportation* dimension were dropped from the analysis. Because of a low Cronbach’s Alpha and since the corona crisis had a significant impact on individuals transportation habits. Further the third item of the *Environmental Citizenship* dimension got dropped because of a low Cronbach’s Alpha. The Cronbach’s Alpha for all the remaining items combined, not regarding the dimensions is 0,80 (M: 3,39 ; SD: 0,82). The Cronbach’s Alpha for the *Conservation* dimension index is 0,64 (M: 3,70 ; SD: 0,68). The Cronbach’s Alpha for *Environmental Citizenship* dimension index is 0,56 (M: 2,50 ; SD: 0,92): As mentioned above the third item of the *Environmental Citizenship* dimension got dropped. The Cronbach’s Alpha for the Food dimension is 0,91 (M: 3,7 ; SD: 0,35). For the final analysis first an index for each dimension was created and based on them, an index from the dimension indexes was created. The Cronbach’s Alpha for the combined index of the three dimensions (*Conservation, Environmental Citizenship and Food*) is 0,52 (M: 3,36 ; SD: 0,75). With a Cronbach’s Alpha of 0,52 the reliability is not the best, but as all items from all the dimensions not combined in an index have a Cronbach's Alpha of 0,80 it can be assumed that the measurement is valid.

Affinity for Technology Interaction: ATI got measured with a five-point likert scale. In total it consisted of seven questions. The scale was adopted from "A personal resource for technology interaction: development and validation of the ATI scale" by Franke and colleagues (Franke et al., 2019). For ATI the second item of the scale was dropped to improve the internal consistency. The final ATI scale used in this study consists of six questions. The Cronbach's Alpha for the final ATI scale is 0,90 (M: 3,02 ; SD: 0,20).

Price consciousness: PC got measured with a five-point likert scale. In total it, consisted of four questions. The scale got adopted from "Price perceptions and consumer shopping behaviour: a field study" by Lichtenstein (Lichtenstein et al., 1993). The first item of the scale was dropped to improve the internal consistency. The final Cronbach's Alpha is 0,82 (M: 2,86 ; SD: 0,25)

Financial Risk Perception: FRP was measured with one question: asking about what kind of lottery participants would prefer to take part in. Participants could choose between 6 different lotteries. Every lottery had two possible payoffs which could each occur with 50% of change (p=0,5). The total sum of the payoffs rose steadily, while the distribution of the sum payoffs became more and more uneven distributed. This measurement got adopted from Eckel et al and Charness et al (Charness et al., 2013; Eckel & Grossman, 2008). The first four answer possibilities are defined as risk averse, the fifth represents risk neutrality and the sixth risk loving behaviour. The answers got recoded accordingly. The mean is 1,31 and the SD is 0,67.

Electricity Independence Aspiration: EIA from electricity supplier got adopted from Hackbarth et al paper: "Attitudes, preferences, and intentions of German households concerning participation in peer-to-peer electricity trading" (Hackbarth & Löbbe, 2020). EIA was measured with only one item, asking participants if they would like to be more independent from energy suppliers in general. Participants could answer "yes", "no" and "undecided". 48,5% of the participants stated that they would like to be more independent from their energy supplier, 41% are undecided and 10,4% don't want to be more independent.

Demographics & Socio economics: To gain insights about demographics, participant got asked about the age, gender, if they live in Germany and their education. For the age, participants stated their age in an input box. For the education, participants got asked about their highest general educational qualification. Concerning the socio-economic aspects participants had to state they're net income of all members of their household in 2020. The scale was subdivided in 10.000€ steps. Starting at "0-9.9999 €" and ended with "100.000 € or more ".

Household characteristics: The items investigating household characteristics were comprised of: The number of people living in the household, the total living space of the household, the type of house (apartment house or single-family house) and if participants live in a rented or owned home.

PV ownership: Participants got asked if they own a PV and if they own an electricity storage unit.

Electricity usage: Items connected with electricity usage were: if participants know the amount of the monthly electricity bill (KEB) and the amount of the monthly electricity bill (AEB). Additionally, participants got asked which high consuming electronic devices they use. Namely, refrigerator, freezer, electronic heating, electronic water heater, electric car, air conditioner, washing machine and dishwasher. For the analysis the total sum of all electronic devices' participants use were comprised in an index.

2.3 Data Collection and Analysis

Responses were collected over an online questionnaire, using "Qualtrics". Only responses of German residents were considered. For a greater reach and a faster data collection the platform "survey circle" was used. The questionnaire was online for four weeks.

At the beginning of the questionnaire participants got informed that the participation is voluntary, that the analysis is for the completion of a Master Thesis, and that all information given by the participants will only be analysed anonymously. At the end of the briefing all participants had to accept the conditions or end the survey.

At the end of the questionnaire a detailed debriefing was provided to the participants., giving them insights about the specific goals and procedures of the study.

In total 154 responses were received. From the 154 responses 20 got deleted. These responses got deleted because of too short, or too long response time, and inconsistent answering of the reserve questions. Finally, 134 responses got analysed.

For the data analysis IDM SPSS 26 was used. The indexes and the data treatment got applied as described above. To analyse the mediation the SPSS Plug-in “Process” was used (Hayes, 2018). The mediation analysis followed the approach of Baron et. al. (Baron & Kenny, 1986). For all DVs, as well as the WTP for the respective technologies, first a simple linear regression with all the IV, the explanatory variables and the control variables got conducted to gain an overview of all the relations. Following, the simple linear regressions a stepwise multiple regression for the WTP and the DVs got carried out to get detailed insights of the most important relations and the respective effect sizes. The significant variables of the stepwise multiple regression were then analysed in a enter multiple regression. Finally, the mediation analyses connected with the hypothesis got conducted; using “Process”.

III. Results

This section is divided into five main parts. One main part for each of the respective technology application (P2P, SEMD, P2P & SEMD). Those three main parts are again subdivided in the WTP and the MSP relations. For each WTP analyses there's a simple linear regression and a multiple regression analysis. For the MSP analyses there's a simple linear regression, a multiple regression analysis and finally the mediation analysis to test the hypothesis. After those three main parts two more main parts for the electricity buying and selling price follow. Those two are comprised of a simple linear regression for the respective price, a multiple regression and lastly the sequential mediations as supposed in the hypothesis.

3.1. P2P Electricity Trading

3.1.1.WTP P2P Electricity Trading

3.1.1.1. Simple Linear Regressions WTP P2P. Single direct relations between the IV, the explanatory variables, the control variables, and the WTP in P2P trade are evaluated here. The constructs with a significant relation can be seen in the table below.

Table 1: Simple Linear Regressions WTP P2P

Concepts	R	R²	Adjusted R²	CI (Low/ High)	F value	df1/df2	Unstandardized B
EIA	0,319***	0,102	0,095	0,257 / 0,795	14,946	1 / 132	0,526
PEB	0,367***	0,135	0,128	0,289 / 0,734	20,244	1 / 130	0,5

* p < .05 ** p < .01 *** p < .001

3.1.1.2. Multiple Regression WTP P2P First, a stepwise multiple regression using all significant variables from the single linear regressions was applied to detect significant multiple regression relations. For EIA and PEB significant multiple regression relations were found. Following, a multiple regression using enter method was applied to predict the P2P WTP from: EIA and PEB.

The multiple regression model explains a statistically significant amount of variance in the P2P WTP. F(1/129)=10,136, p= 0,002, the predictor variables explain 19,8% (R^2=0,198, adjusted R^2=0,185) of the P2P WTP variance.

EIA significantly predicts the P2P WTP, β=0,255, t(131)=3,184, p=0,002. For each SD increase in the EIA there is a 0,419 increase in the P2P WTP, B= 0,419, 95% CI [0,159 /

0,680].

PEB also significantly predicts the P2P WTP, β=0,322, t(131)=4,024, p<0,00. For each SD increase of PEB there is a 0,448 increase in the P2P WTP, B=0,448, 95% CI [0,228 / 0,680].

3.1.2. MSP P2P Electricity Trading

3.1.2.1. Simple Linear Regressions MSP P2P. Single direct relations between the IV, the explanatory variables, the control variables, the WTP and the minimum savings participants must achieve to join a P2P electricity trading community are evaluated here. The constructs with a significant relation can be seen in the table below.

Table 2: Simple Linear Regressions MSP P2P

Concepts	R	R^2	Adjusted R^2	CI (Low/High)	F value	df1/df2	Unstandardized B
Education	0,271**	0,074	0,067	-3,933 / -0,926	10,482	1 / 132	-2,379
Household size	0,172*	0,03	0,022	0,009 / 1,355	4,013	1 / 132	0,682
House type	0,266**	0,071	0,064	2,515 / 10,896	10,021	1 / 132	6,706
House ownership	0,229**	0,053	0,045	1,532 / 9,828	7,334	1 / 132	5,679
PEB	0,261**	0,068	0,061	-6,45 / -1,404	9,479	1 / 132	-3,927
TP	0,244**	0,06	0,052	-3,618 / -0678	8,355	1 / 132	-2,148
KEB	0,3***	0,09	0,083	3,251 / 11,105	13,071	1 / 132	7,178
AEB	0,258*	0,067	0,053	0,006 / 0,103	4,992	1 / 70	0,054
N of gadget	0,309***	0,096	0,089	1,496 / 4,859	13,974	1 / 132	3,177
WTP	0,396***	0,157	,151	-6,088 / -2,617	38,892	1 / 132	-5,175

* p < .05 ** p < .01 *** p < .001

3.1.2.2. Multiple Regression MSP P2P. First, a stepwise multiple regression using all significant variables from the single linear regressions was applied to detect significant multiple regression relations. For WTP, the number of gadgets, KEB, and TP significant multiple regression relations were found. Following, a multiple regression using enter method was applied to predict the P2P MSP from: WTP, number of gadgets, KEB, and TP. The multiple regression model explains a statistically significant amount of variance in the P2P MSP. F(1/129)=5,551, p=0,02, the predictor variables explain 41,2% (R^2=0,412, adjusted R^2=0,394) of the P2P MSP variance.

P2P WTP significantly predicts the P2P MSP, β= -0,432, t(129)= -6,238, p<0,001. For each increase of a SD in the P2P WTP there is a -4,687 € decrease in the P2P MSP, B= -4,687, 95% CI [-6,173 / -3,2].

The number of gadgets significantly predicts the P2P MSP, β=0,314, t(129)=4,636, p<0,001. For each gadget more used by the participants there is a 3,226 € increase in the P2P MSP, B=3,226, 95% CI [1,849 / 4,602].

KEB significantly predicts the MSP, β=0,232, t(129)=3,4, p=0,001. For participants who don't know the amount of their electricity bill there is a 5,555 € increase in the P2P MSP, B= 5,555, 95% CI [2,322 / 8,787].

TP also significantly predicts the P2P MSP, β=-0,162, t(129)=2,356, p=0,02. For each increase in SD of TP there is a -1,422 € decrease in the P2P MSP, B= -1,422, 95% CI [-2,616 / -0,228].

3.2.1.3. Mediation Analysis

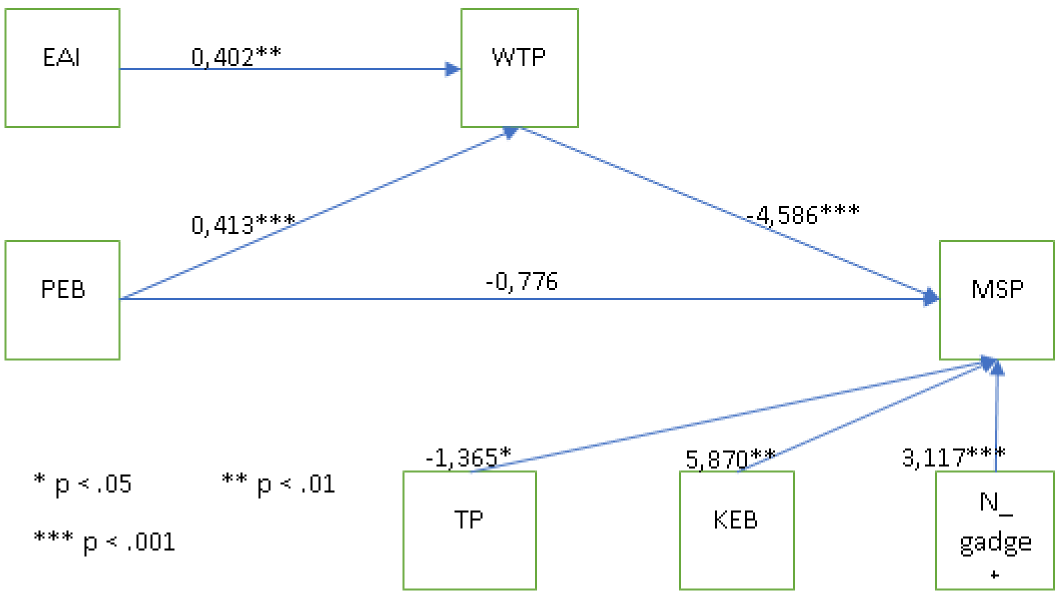

Figure 3 Conceptual Framework P2P MSP

For the conceptual framework, the mediation analysis acts as starting point: to the mediation analysis, covariates were added.

Using "Process" Model 4 (Hayes, 2018), PEB was entered as the independent variable, P2P WTP as the mediator variable and P2P MSP as the dependent variable. As covariates TP, KEB, EAI and the number of gates were added.

The indirect effect was statistically significant. Indirect effect (B) = -1,891 (β= -0,126), BSE =0,638, 95% BCI [-3,244 / -0,752]).

PEB significantly predicted the mediator P2P WPT. B=0,4125, β=0,297, SE = 0,116, t(126) =3,561, p<0,001, 95% CI [0,183 / 0,642].

The P2P WTP significantly predicted the DV P2P MSP. B = -4,586 (β= -0,423), SE = 0,829, t(125) = -5,531, p<0,001, 95% CI [-6,226 / -2,946].

The relationship of the IV PEB and the DV P2P MSP wasn't statistically significant anymore when controlled for the mediator P2P WTP. So, we can conclude that P2P WTP fully mediates the relation between PEB and the P2P MSP. H1 gets accepted.

The mediation model predicts the mediator P2P WTP from PEB and the covariate EIA. The mediation model explains a statistically significant amount of the mediator P2P WTP variance. F(5/126)=6,602, p<0,001, MSE=1,005 the predictor variables explain 20,76% (R^2=0,2076), of the mediator P2P WTP variance.

The covariate EIA significantly predicts the mediator P2P WTP, β=0,297, t(126)=2,995, p=0,003. For each SD increase in the EIA there is a 0,402 increase in the mediator P2P WTP, B=0,402, 95% CI [0,136 / 0,667].

The mediation model predicts the DV P2P MSP from the mediator P2P WTP and the covariates: KEB, TP and the number of gadgets. The mediation model explains a statistically significant amount of the DV P2P MSP variance. F(6/125)=15,147, p<0,001, MSE=86,996 the predictor variables explain 42,1% (R^2=0,421), of the DV P2P MSP variance.

The covariate number of gadgets significantly predicts the DV P2P MSP, β=0,305, t(125)=4,426, p<0,001. For each increase in the number of gadgets there is 3,117 € increase in the DV P2P MSP, B= 3,117, 95% CI [1,723 / 4,511].

The covariate TP significantly predicts the DV P2P MSP, β= -0,156, t(125)= -2,211, p=0,029. For each increase in SD of TP there is -1,365 € decrease in the DV P2P MSP, B= -1,365, 95% CI [-2,587 / -0,143].

The covariate KEB significantly predicts the DV P2P MSP, β= 0,245, t(125)= 3,520, p<0,001. For participants who don't know the amount of their electricity bill there is a 5,870 € increase in the DV MSP, B= 5,870, 95% CI [2,569 / 9,17].

3.2. SEMD

3.2.1. WTP SEMD

3.2.1.1. Simple Linear Regressions WTP SEMD. Single direct relations between the IV, the explanatory variables, the control variables, and the SEMD WTP are evaluated in this section. The constructs with a significant relation can be seen in the table below.

Table 3: Simple Linear Regressions WTP SEMD

Concepts	R	R²	Adjusted R²	CI (Low/High)	F value	df1/df2	Unstandardized B
N of gadget	0,179*	0,032	0,025	2,334 / 3,84	4,352	1/132	0,188
EIA	0,261**	0,068	0,061	0,175 / 0,785	9,683	1/132	0,48
PEB	0,171*	0,029	0,022	0,001 / 0,531	3,915	1/132	0,266
ATI	0,294***	0,086	0,079	0,183 / 0,649	12,46	1/132	0,416

* p < .05 ** p < .01 *** p < .001

3.2.1.2. Multiple Regression WTP SEMD. First, a stepwise multiple regression using all significant variables from the single linear regressions was applied to detect significant multiple regression relations. For ATI, PEB and the number of gadgets significant multiple regression relations were found. Following, a multiple regression using enter method was applied to predict the SEMD WTP from: ATI, PEB and the number of gadgets. The multiple regression model explains a statistically significant amount of variance in the SEMD WTP. F(1/128)=11,058, p<0,001, the predictor variables explain 16,6% (R^2=0,166, adjusted R^2=0,147) of the SEMD WTP variance.

ATI significantly predicts the SEMD WTP, β=0,334, t(128)=4,042, p<0,001. For each increase of a SD in ATI there is a 0,473 increase in then SEMD WTP, B= 0,473, 95% CI [0,241 /0,705].

PEB significantly predicts the SEMD WTP, β=0,235, t(128)=2,847, p=0,005. For each increase of a SD in PEB there is a 0,365 increase in the SEMD WTP, B=0,365, 95% CI [0,111 / 0,619].

The number of gadgets significantly predicts the WTP, β=0,161, t(128)=1,992, p=0,048. For each increase in the number of gadgets there is a 0,17 increase in the WTP, B= 0,17, 95% CI [0,001 /0,339].

3.2.2. MSP SEMD

3.2.2.1. Simple Linear Regressions MSP SEMD. Single direct relations between the IV, the explanatory variables, the control variables, the WTP and the SEMD MSP are evaluated in this subchapter. The constructs with a significant relation can be seen in the table below.

Table 4: Simple Linear Regressions MSP SEMD

Concepts	**R**	**R^2**	**adjusted R^2**	**CI (low/up)**	**F value**	**df1/df2**	**Unstandardized B**
Education	0,256**	0,066	0,059	-4,139 / -0,879	9,269	1/132	-2,509
Household size	0,183*	0,033	0,026	0,06 / 1,561	4,565	1/132	0,81
House type	0,249**	0,062	0,055	2,323 / 11,725	8,736	1/132	7,024
PEB	0,185*	0,034	0,027	-6,006 / -0,245	4,607	1/132	-3,125
FRP	0,202*	0,041	0,034	0,671 / 7,356	5,643	1/132	4,014
N of gadget	0,271**	0,073	0,066	1,204 / 5,005	10,436	1/132	3,104
WTP	0,354***	0,125	0,119	-5,598 / -2,097	18,901	1/132	-3,848

* p < .05 ** p < .01 *** p < .001

ATI only has a significant relation with the SEMD WTP but not with the SEMD MSP. For a valid mediation the IV must predict the mediator and the DV in a simple linear regression. So H3 gets rejected.

3.2.2.2. Multiple Regression MSP SEMD. First, a stepwise multiple regression using all significant variables from the single linear regressions was applied to detect significant multiple regression relations. For WTP, FRP, Education and the number of gadgets significant multiple regression relations were found. Following, a multiple regression using enter method was applied to predict the SEMD MSP from: WTP, FRP, Education and the number of gadgets. The multiple regression model explains a statistically significant amount of variance in the SEMD MSP. $F(1/129)=6{,}06$, $p=0{,}015$, the predictor variables explain 31,3% ($R^2=0{,}313$ adjusted $R^2=0{,}291$) of the SEMD MSP variance.

SEMD WTP significantly predicts the SEMD MSP, $\beta= -0{,}393$, $t(129)= -5{,}218$, $p<0{,}001$. For each increase of a SD in the SEMD WTP there is a -4,268 € decrease in the SEMD MSP, B= -4,268, 95% CI [-5,887 / -2,65].

The number of gadgets significantly predicts the SEMD MSP, $\beta=0{,}312$, $t(129)=4{,}179$, $p<0{,}001$. For each increase in the number of gadgets there is a 3,584 € increase in the SEMD MSP, B= 3,584, 95% CI [1,887 / 5,281].

FRP significantly predicts the SEMD MSP, β=0,208, t(129)=2,844, p=0,005. For each increase of SD in FRP (from risk averse to, risk neutral, risk seeking) there is a 4,132 € increase in the SEMD MSP, B=4,132, 95% CI [1,258 / 7,006].

Education significantly predicts the SEMD MSP, β= -0,183, t(129)= -2,462, p=0,015. For each increase of SD in education there is a -1,792 € decrease in the SEMD MSP, B= -1,792, 95% CI [-3,232 / -0,352].

3.2.2.3. Mediation Analysis

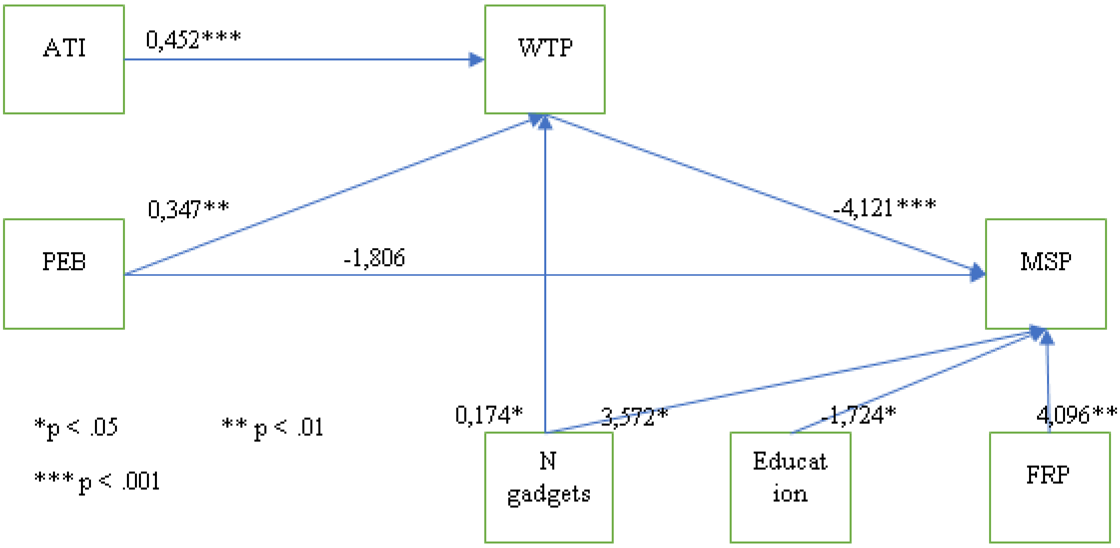

Figure 4 Conceptual Framework SEMD MSP

For the conceptual framework, the mediation analysis acts as starting point. To the mediation analysis covariates were added.

Using "Process" Model 4 (Hayes, 2018), PEB was entered as the independent variable, SEMD WTP as the mediator variable and SEMD MSP as the dependent variable. As covariates ATI, FRP, Education and the number of gadgets were added.

The indirect effect was statistically significant. Indirect effect (B) = -1,430 (β= -0,085), BSE =0,710, 95% BCI [-2,927 / -0,155]).

PEB significantly predicted the mediator SEMD WPT. B=0,347, β=0,223, SE=0,131, t(126)=2,647, p=0,009, 95% CI [0,088 / 0,606].

The mediator SEMD WTP significantly predicted the DV SEMD MSP. B = -4,121 (β=-0,379), SE=0,881, t(125) = -4,681, p<0,001, 95% CI [-6,864 / -2,379].

The relationship of the IV PEB and the DV SEMD MSP wasn't statistically significant anymore when controlled for the mediator SEMD WTP. So, we can conclude that SEMD WTP fully mediates the relation between PEB and the SEMD MSP. H2 gets accepted

The mediation model predicts the mediator SEMD WTP from the IV PEB and the covariates: ATI and the number of gadgets.

The mediation model explains a statistically significant amount of variance in the mediator SEMD WTP. $F(5/126)=5{,}243$, $p<0{,}001$, $MSE=1{,}312$ the predictor variables explain 17,22% ($R^2=0{,}1722$), of the mediator SEMD WTP variance.

The covariate ATI significantly predicts the mediator SEMD WTP, $\beta=0{,}319$, $t(126)=3{,}74$, $p<0{,}001$. For each increase of a SD in ATI there is a 0,452 increase in the mediator SEMD WTP, B=0,452, 95% CI [0,213 / 0,691].

The covariate number of gadgets significantly predicts the mediator SEMD WTP, $\beta=0{,}165$, $t(126)=2{,}02$, $p=0{,}0455$. For each increase in the number of gadgets there is a 0,1743 increase in the mediator SEMD WTP, B= 0,1743, 95% CI [0,004 / 0,366].

The mediation model predicts the DV SEMD MSP from the mediator SEMD WTP and the covariates: FRP, Education and the number of gadgets. The model explains a statistically significant amount of variance in the DV SEMD MSP. $F(6/125)=9{,}893$, $p<0{,}001$, $MSE=128{,}121$ the predictor variables explain 32,3% ($R^2=0{,}323$), of the DV SEMD MSP variance.

The covariate number of gadgets significantly predicts the DV SEMD MSP, $\beta=0{,}3{,}11$, $t(125)=4{,}122$, $p=0{,}001$. For each increase in the number of gadgets there is 3,572 € increase in the DV SEMD MSP, B=3,572, 95% CI [1,857 / 5,287].

The covariate FRP significantly predicts the DV SEMD MSP, $\beta=0{,}207$, $t(125)=2{,}796$, $p=0{,}006$. For each increase of SD in FRP (from risk averse to, risk neutral, risk seeking) there is a 4,096 € increase in the DV SEMD MSP, B= 4,096, 95% CI[1,197 / 6,995].

The covariate education significantly predicts the DV SEMD MSP, $\beta= -0{,}177$, $t(125)= -2{,}298$, $p=0{,}023$. For each increase of SD in education there is -1,734 € decrease in the DV SEMD MSP, B= -1,734, 95% CI [-3,223 / -0,241].

3.3. P2P & SEMD

3.3.1. WTP P2P & SEMD

3.3.1.1. Simple Linear Regressions WTP P2P & SEMD. Single direct relations between the IV, the explanatory variables, the control variables, and the P2P & SEMD WTP are evaluated here. The constructs with a significant relation can be seen in the table below.

Table 5: Simple Linear Regressions WTP P2P & SEMD

Concepts	**R**	**R^2**	**Adjusted R^2**	**CI (Low/High)**	**F value**	**df1/df2**	**Unstandardized B**
Education	0,215*	0,406	0,039	0,039/0,324	6,375	1/132	0,182
EIA	0,215*	0,046	0,039	0,081/0,662	6,392	1/132	0,371
PEB	0,26**	0,068	0,061	0,136/0,626	9,457	1/132	0,381
ATI	0,265**	0,07	0,063	0,132/0,574	9,97	1/132	0,353
KEB	0,184*	0,024	0,027	-0,817/-0,035	4,635	1/132	-0,426

* $p < .05$ ** $p < .01$ *** $p < .001$

3.3.1.2. Multiple Regression WTP P2P & SEMD. First, a stepwise multiple regression using all significant variables from the single linear regressions was applied to detect significant multiple regression relations. For PEB and ATI significant multiple regression relations were found. Following, a multiple regression using enter method was applied to predict the P2P & SEMD WTP from: PEB and ATI. The multiple regression model explains a statistically significant amount of variance in the P2P & SEMD WTP. $F(1/129)=16{,}64$, $p<0{,}001$, the predictor variables explain 18% ($R^2=0{,}18$, adjusted $R^2=0{,}167$) of the P2P & SEMD WTP variance.

PEB significantly predicts the P2P & SEMD WTP, $\beta=0{,}333$, $t(129)=4{,}079$, $p<0{,}001$. For each increase of a SD in PEB there is a 0,487 increase in the P2P & SEMD WTP, B=0,487, 95% CI [0,251 / 0,722].

ATI significantly predicts the P2P & SEMD WTP, $\beta=0{,}343$, $t(129)=4{,}202$, $p<0{,}001$. For each increase of a SD in ATI there is a 0,457 increase in the WTP, B=0,457, 95% CI [0,242 / 0,672].

3.3.2. MSP P2P & SEMD

3.3.2.1. Simple Linear Regressions MSP P2P & SEMD. Single direct relations between the IV, the explanatory variables, the control variables, the WTP and the P2P & SEMD MSP are evaluated here. The constructs with a significant relation can be seen in the table below.

Table 6: Simple Linear Regressions MSP P2P & SEMD

Concepts	R	R²	Adjusted R²	CI (low/up)	F value	df1/df2	Unstandardized B
Age	0,207*	0,043	0,036	0,05/0,482	5,922	1/132	0,266
Education	0,271**	0,074	0,067	-6,032/-1,458	10,493	1/132	-3,745
House type	0,175*	0,031	0,023	0,212/13,679	4,164	1/132	6,946
PEB	0,253**	0,064	0,057	-10,027/-2,037	8,923	1/130	-6.032
WTP	0,428***	0,183	0,177	-9,497/-4,429	29,547	1/132	-6,963

* p < .05 ** p < .01 *** p < .001

3.3.2.2. Multiple Regression MSP P2P & SEMD. First, a stepwise multiple regression using all significant variables from the single linear regressions was applied to detect significant multiple regression relations. For P2P & SEMD WTP and education significant multiple regression relations were found. Following, a multiple regression using enter method was applied to predict the P2P & SEMD MSP from: P2P & SEMD WTP and education. The multiple regression model explains a statistically significant amount of variance in the P2P & SEMD MSP. F(1/131)=18,121, p=0,019, the predictor variables explain 21,7% (R^2=0,217, adjusted R^2=0,205) of the P2P & SEMD MSP variance.

P2P & SEMD WTP significantly predicts the P2P & SEMD MSP, β= -0,387, t(131)= -4,891, p<0,001. For each increase of a SD in the P2P & SEMD WTP there is a -6,305 € decrease in the P2P & SEMD MSP, B=-6,305, 95% CI [-8,855 / -3,755].

Education significantly predicts the P2P & SEMD MSP, β= -0,188, t(131)= -2,378, p=0,019. For each increase of a SD in Education there is a -2,598 € decrease in the P2P & SEMD MSP, B= -2,598, 95% CI [-4,759 / -0,436].

3.3.2.3. Mediation Analysis

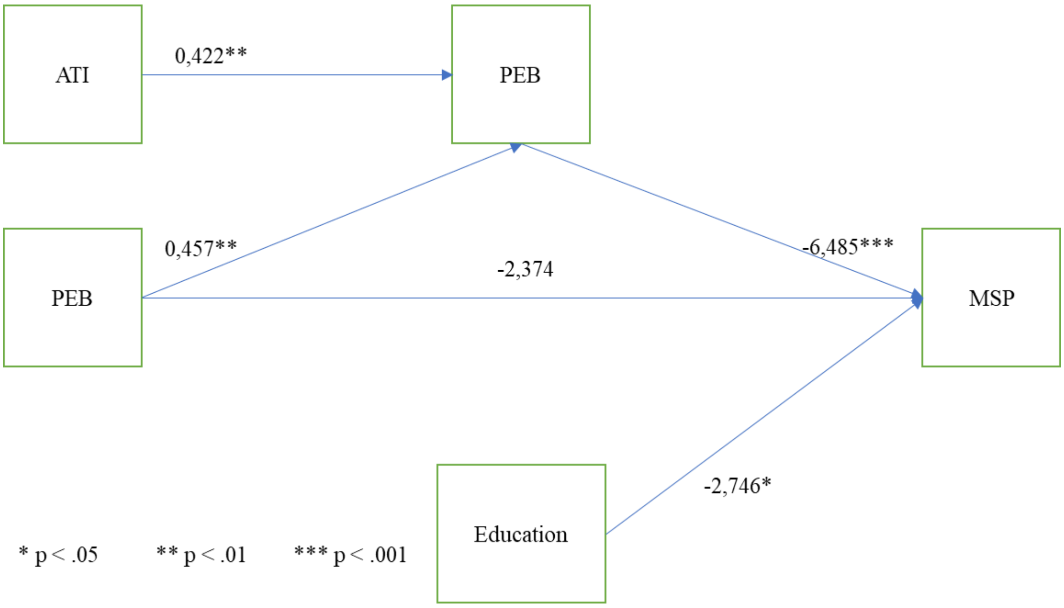

Figure 5 Conceptual Framework MSP P2P&SEMD

For the conceptual framework, the mediation analysis acts as starting point. To the mediation analysis covariates were added.

Using "Process" Model 4 (Hayes, 2018), PEB was entered as the independent variable, P2P & SEMD WTP as the mediator variable and P2P & SEMD MSP as the dependent variable. As covariates ATI and education were added.

The indirect effect was statistically significant. Indirect effect (B) = -2,964 (β= -0,125), BSE=1,082, 95% BCI [-5,234 / -1,063].

PEB significantly predicts the mediator P2P & SEMD WPT: B=0,457 (β=0,313), SE=0,121, t(128)=3,788, p=0,002, 95% CI [0,218 / 0,696].

The mediator P2P & SEMD WTP significantly predicts the DV P2P & SEMD MSP: B= -6,485 (β= -0,398), SE=1,390, t(128)= -4,666, p<0,001, 95% CI [-9,235 / -3,735].

The relationship of the IV PEB and the DV P2P & SEMD MSP wasn't statistically significant anymore when controlled for the mediator P2P & SEMD WTP. So, we can conclude that P2P & SEMD WTP fully mediates the relation between PEB and the P2P & SEMD MSP. The H4 gets accepted.

The mediation model predicts the mediator P2P & SEMD WTP from the IV PEB and the covariate ATI. The model explains a statistically significant amount of variance in the mediator P2P & SEMD WTP. F(3/128)=10,168, p<0,001, MSE=1,117. The predictor variables explain 19,24% (R^2=0,1924), of the mediator P2P & SEMD WTP variance.

The covariate ATI significantly predicts the mediator P2P & SEMD WTP, β=0,317, t(128)=3,796, p=0,002. For each increase of a SD in ATI there is a 0,422 increase in the mediator P2P & SEMD WTP, B=0,422, 95% CI [0,202 / 0,642].

The mediation model predicts the DV P2P & SEMD MSP from P2P & SEMD WTP and the covariate, Education. The model explains a statistically significant amount of variance in the DV P2P & SEMD MSP. F(4/127)=10,713, p<0,001, MSE=276,086 the predictor variables explain 25,23% (R^2=0,2523), of the DV P2P & SEMD MSP variance.

The covariate education significantly predicts the DV P2P & SEMD MSP, β= -0,199, t(127)= -2,484, p=0,014. For each increase of a SD in education there is -2,746 € decrease in the DV P2P & SEMD MSP, B= -2,746, 95% CI [-4,933 / -0,559].

3.4. P2P Electricity Price

3.4.1. Sell Price

3.4.1.1. Simple Linear Regressions Sell Price. Single direct relations between the IV, control variables, explanatory variables, P2P WTP, P2P MSP and the price to sell 1 kWh in a P2P community are evaluated here. The constructs with a significant relation with the selling price can be seen in the table below.

Table 7: Simple Linear Regressions Sell Price

Concepts	R	R^2	Adjusted R^2	CI (Low/High)	F value	df1/df2	Unstandardized B
Gender	0,214*	0,046	0,038	-6,118 / -0,591	5,774	1/121	-3,354
PEB	0,225*	0,05	0,042	-3,915 / -0,458	6,274	1/118	-2,187
ATI	0,191*	0,037	0,028	0,125 / 3,351	4,549	1/121	1,738
P2P MSP	0,228*	0,052	0,044	0,038 / 0,038	6,461	1/118	0,173

* p < .05 ** p < .01 *** p < .001

3.4.1.2. Multiple Regression. First, a stepwise multiple regression using all significant variables from the single linear regressions was applied to detect significant multiple regression relations. For P2P MSP and the gender significant multiple regression relations were found. Following, a multiple regression using enter method was applied to predict the P2P electricity selling price from: P2P MSP and the gender. The multiple regression model explains a statistically significant amount of variance in the P2P electricity selling price. F(2/117)=6,26, p=0,003, the predictor variables explain 9,7% (R^2=0,097, adjusted R^2=0,081) of the P2P electricity selling price variance.

The P2P MSP significantly predicts the P2P electricity selling price, β=0,209 , t(117)=2,369, p=0,019. For each SD of P2P MSP there is a 0,158 cent increase in the P2P electricity selling price, B=-0,158, 95% CI 0,026 / 0,291].

The gender significantly predicts the P2P electricity selling price, β= -0,212, t(117)= -2,408, p=0,018. For female participants there is a -3,312 cent decrease in the P2P electricity selling price when compared to men, B= -3,312, 95% CI [-6,036 / -0,588].

3.4.1.3. Sequential Mediation

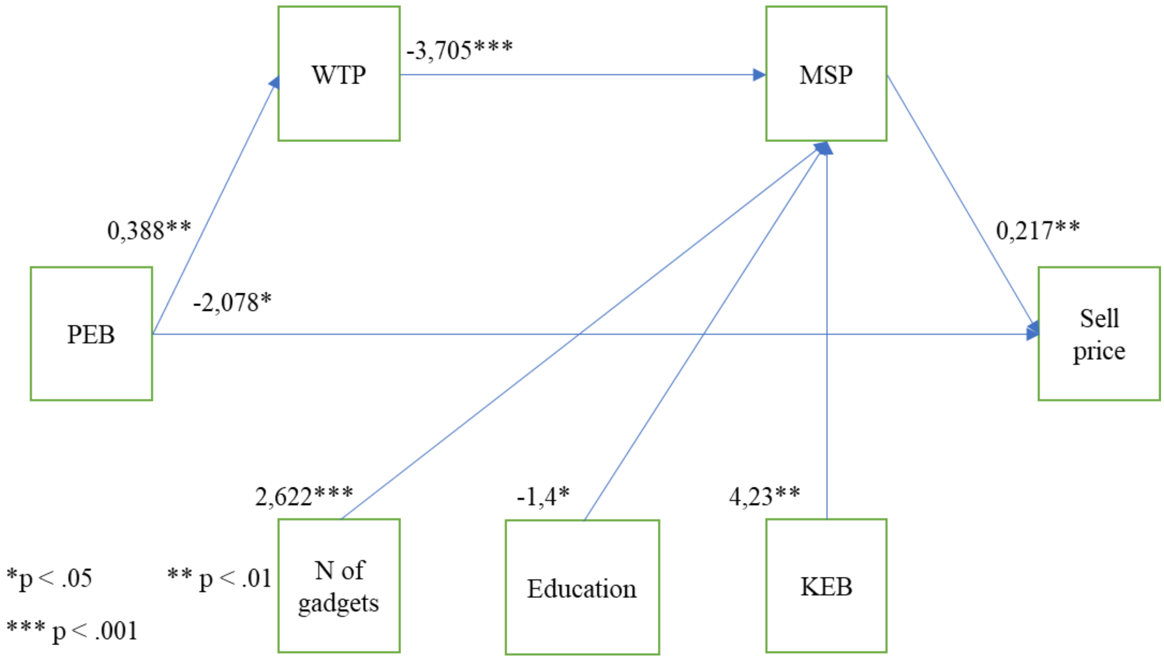

Figure 6 Conceptual Framework Sell Price

For the conceptual framework, the sequential mediation analysis acts as starting point. To the sequential mediation analysis covariates were added.

Using "Process" Model 6 (Hayes, 2018), PEB was entered as the independent variable, P2P WTP as the first mediator variable, P2P MSP as the second moderator variable, and the

P2P electricity selling price as the DV. As covariates KEB and education and number of gadgets were added.

The indirect effect from PEB over P2P WTP and P2P MSP on the P2P electricity selling price was statistically significant. Indirect effect (B) = -0,3126 (β= -0,032), BSE=0,178, 95% BCI [-0,732 / -0,045].

PEB significantly predicted the first mediator P2P WPT: B=0,388 (β=0,311), SE=0,111, t(113)=3,505, p<0,001, 95% CI [0,169 / 0,608].

The P2P WTP significantly predicted the second mediator P2P MSP: B= -3,705 (β= -0,354), SE=0,859, t(112)= -4,315, p<0,001, 95% CI [-5,406 / -2,004].

The P2P MSP significantly predicted the DV P2P electricity selling price: B=0,217 (β=0,294), SE=0,081, t(111)=2,681, p=0,009, 95% CI [0,057 / 0,378].

The indirect effects of PEB on the P2P electricity selling price over P2P WTP was not significant. Neither the indirect effect of PEB on the P2P electricity selling price over P2P MSP.

The effect of the IV PEB on the DV P2P electricity selling price was still statistically significant when controlled for the mediators P2P WTP and P2P MSP.

PEB significantly predicts the DV P2P electricity selling price, B= -2,078 (β= -0,2179, t(111)= -2,286, p=0,024. For increase of a SD in PEB there is -2,098 decrease in the DV P2P electricity selling price, B= -2,098, 95% CI [-3,916 / -0,280].

So, we can conclude that P2P WTP and the P2P MSP partially mediates the relation between PEB and the P2P electricity selling price. H5 gets accepted.

The sequential mediation model predicts the first mediator P2P WTP from the IV PEB. The model explains a statistically significant amount of variance in the first mediator P2P WTP. F(4/113)=4,272, p=0,003, MSE=0,871 the predictor variables explain 13,14% (R^2=0,1314), of the P2P WTP variance.

The sequential mediation model predicts the second mediator P2P MSP from the first mediator P2P WTP and the covariates, number of gadgets, education and KEB. The model explains a statistically significant amount of variance in the second mediator P2P MSP. F(5/112)=11,847, p<0,001, MSE=72,501 the predictor variables explain 34,59% (R^2=0,3459), of the P2P MSP variance.

The covariate number of gadgets significantly predicts the second mediator P2P MSP, β=0,301, t(112)=3,891, p<0,001. For each increase in the number of gadgets there is 2,622 € increase in the P2P MSP, B=2,622, 95% CI [1,287 / 3,958].

The covariate education significantly predicts the second mediator P2P MSP, β= -0,180, t(112)= -2,316, p=0,022. For each increase of a SD in education there is -1,4 € decrease in the P2P MSP, B= -1,4 , 95% CI [-2,598 / -0,202].

The covariate KEB significantly predicts the second mediator MSP, β= -0,204, t(112)= -2,638, p=0,01. For participants that don't know the amount of their electricity bill there is 4,23 € increase in the P2P MSP, B=4,23, 95% CI [1,053 / 7,407].

The sequential mediation model predicts the DV P2P electricity selling price from the second mediator P2P MSP and the IV PEB. The model explains a statistically significant amount of variance in the DV P2P MSP. F(4/127)=2,71, p=0,017, MSE=53,375. The predictor variables explain 12,78% (R^2=0,1278), of the DV P2P electricity selling price variance.

3.4.2. Buy Price

3.4.2.1. Simple Linear Regressions Buy Price

Table 8: Simple Linear Regressions Buy Price

Concepts	**R**	**R^2**	**Adjusted R^2**	**CI (Low/High)**	**F value**	**df1/df2**	**Unstandardized B**
PEB	0,182*	0,033	0,025	-0,392 / -0,26	4,026	1/117	-1,974

* p < .05 ** p < .01 *** p < .001

Only PEB significantly predicts the P2P electricity buying price, β=-0,182 , t(117)=-2,006, p=0,047. For each increase of a SD in PEB there is a -1,974 decrease in the P2P electricity buying price, B= -1,974, 95% CI[-3,922 / -0,026].

3.4.2.2. Sequential Mediation

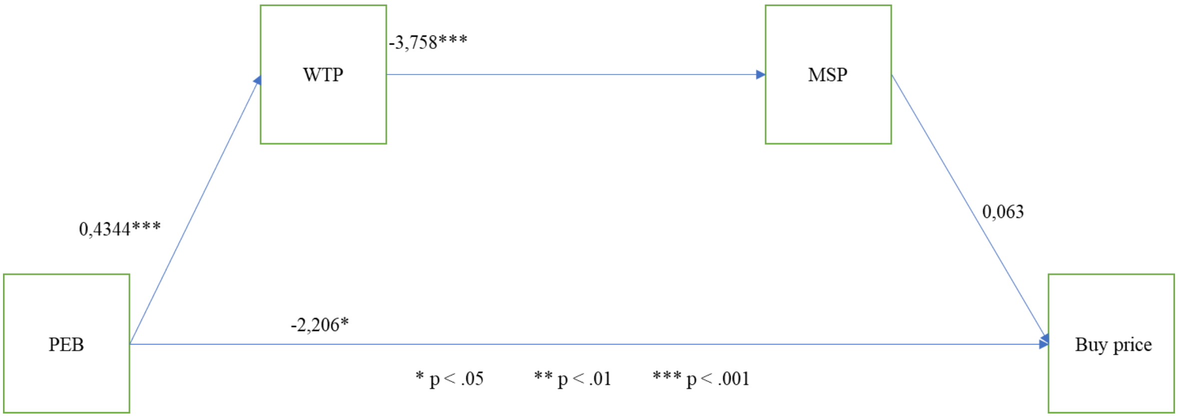

Figure 7 Conceptual Framework Buy Price

As PEB is the only predictor for the electricity buying price, a sequential mediation between PEB and the P2P electricity buying price over P2P WTP and P2P MSP isn't significant. H6 gets dropped

Nevertheless a sequential mediation was tested using "Process" Model 6 (Hayes, 2018), PEB was entered as the independent variable, P2P WTP as the first mediator variable, P2P MSP as the second mediator variable, and the P2P electricity buying price as the DV.

The indirect effect from PEB over P2P WTP and P2P MSP wasn't statistically significant.

The indirect effect from PEB over P2P WTP and P2P MSP on the P2P electricity buying price wasn't statistically significant. Indirect effect (B) = 0,664 (β= 0,059), BSE=0,442 , 95% BCI [-0,138 / 1,605].

PEB significantly predicted the P2P WPT: B=0,434 (β=0,3487), SE= 0,109, t(114) =3,973, p<0,001, 95% CI [0,218 / 0,651].

P2P WTP significantly predicted the P2P MSP: B= -3,758 (β= -3,359), SE=0,963, t(113)= -3,902, p<0,001, 95% CI [-5,666 / -1,850].

P2P MSP wasn't significantly predicting the DV P2P electricity buying price: B=0,964 (β= 0,075), SE=0,085, t(113)=0,576, p=0,451, 95% CI [–0,104 / ß,2321].

Only PEB significantly predicted the DV P2P electricity buying price. B= -2,206 (β= -0,206), SE=1,059, t(112) =-2,083, p=0,04, 95% CI [-4,305 / -0,108].

IV. Discussion

4.1 P2P

For the P2P electricity market only two variables predict the P2P WTP, the PEB and EIA. Both have a positive relation with the P2P WTP. So, participants with a high PEB or higher electricity independence aspirations have a higher WTP. In the multiple regression both items stayed significant and predict a combined variance of 19.8% (R=0,198) in the P2P WTP.

The P2P MSP has numerus single direct relation predictors. The P2P MSP has positive relations with; Household size, house type, house ownership, KEB, AEB and the number of gadgets. Meaning that for participants with bigger houses or a higher monthly electricity bill the expected P2P MSP are higher. Further for participants that live in a single-family home, own their home, or don't know the amount of the monthly electricity bill, the P2P MSP are higher too. Negative single relations were found for: education, PEB, TP and the P2P WTP. So, if participants have a higher education, PEB or P2P WTP the P2P MSP are lower. Also, for participants that value future consumption higher (TP) the expected P2P MSP are lower.

In the multiple regression for the P2P MSP, the P2P WTP, the number of gadgets, KEB, and TP predict 41,2% (R^2=0,412) of the P2P MSP variance significantly. Interesting is that ATI has no significant relation with the P2P WTP nor the P2P MSP. Also, CI has no significant relation with P2P WTP or MSP. Even though both were being described as some of the main explanatory variables by the literature.

H1 got accepted, so the relation of PEB and the P2P MSP is fully mediated by the P2P WTP. The effect size of the indirect effect is -1,891. Thus, PEB is the main explanatory variables when determining the P2P MSP.

For the conceptual framework, EIA predicts the mediator (P2P WTP) as covariant and all the significant relations from the multiple regression (number of gadgets, KEB, and TP) predict the DV P2P MSP. The model explains 42,1% (R^2=0,421) of variance. Thus, the conceptual framework adds explanatory power when compared to the multiple regression (41,2%).

The indicated average MSP are 10,62€ per month. This represents 15,42% decrease of the average amount of the monthly electricity bill (68,85€) stated by the participants. This strongly differs from the 19€ monthly decrease indicated by Mengelkamp et. al. (E. Mengelkamp et al., 2019).

4.2 SEMD

It was found that the number of gadgets, EIA, PEB, as well as ATI all have positive simple linear relations with the SEMD WTP. The higher the agents are in PEB or their ATI is, the higher the respective WTP is. For participants who want to be more independent from their electricity supplier the WTP is increasing. ATI is by far the strongest predictor for the SEMD WTP. In the multiple regression to predict the SEMD WTP, ATI, PEB and the number of gadgets are significant. They predict a combined variance of 16,6% in the SEMD WTP.

Regarding the SEMD MSP, there are more significant predictors. Positive single linear relations were found for: the number of gadgets, household size, house type and FRP. An increasing number of gadgets, or an increasing household size leads to bigger MSP. For house type participants that live in a single-family home the MSP must be higher. Concerning FRP, risk averse participants have to lowest MSP and the MSP is constantly increasing for risk neutral and again for risk seeking agents. Negative relations with SEMD MSP were found for; Education, PEB and SEMD WTP. Meaning that an increase in Education, PEB or SEMD WTP decreases the MSP.

The SEMD WTP had with a R^2 of 0,125 the strongest relation with the MSP. It should be highlighted that there was no relation detected for ATI with SEMD MSP. This indicates that ATI only is an important predictor in the SEMD WTP, but with no impact on the monetary aspects connected to SEMD use. Despite the literature indicated, that ATI is one of the main predictors for the SEMD MSP. H3 got dropped for this reason.

In the multiple regression to predict the SEMD MSP, SEMD WTP, FRP, education and the number of gadgets are significant predictors. They explain a combined variance of 31,3% (R^2=0,313).

H2 got accepted, so SEMD WTP is fully mediating the relation of PEB and the SEMD MSP. The effect size of the indirect effect is -1,430. Thus, PEB is main explanatory variables when determining the SEMD MSP.

As ATI has such a strong relation with the SEMD WTP it’s an important predictor in the conceptual framework.

The mediation model predicts 32,3% (R^2=0,323) of the SEMD MSP variance. This slightly improves the multiple regression model which covers 31,3% (R^2=0,313) of the SEMD MSP variance. ATI and the number of gadgets are predicting the SEMD WTP as a covariates. The covariates predicting the SEMD MSP are: the number of gadgets, education and FRP. The conceptual framework provides insights about the dynamics in the determination of the SEMD MSP by consumers. Overall, the SEMD predictors for the WTP and the MSP are connected to most of the areas proposed by the literature, covering, ATI, financial aspects, electricity consumption and demographic factors.

The indicated average MSP 11,83€ represents a 17,18% decrease of the average amount of the monthly electricity bill (68,85€) stated by the participants.

4.3 P2P & SEMD

The P2P & SEMD WTP has positive single relations with; EIA, education, ATI, and PEB. Meaning that participants with a higher education, ATI or PEB have a higher P2P & SEMD WTP. Also, if participants have electricity independence aspirations the P2P & SEMD WTP is higher. A negative single relation was found for KEB. So, participants that don't know the amount of the monthly electricity bill have a lower P2P & SEMD WTP.

PEB and ATI have the highest R^2. Those are also the only two variables that significantly predict P2P WTP in a multiple regression. With 18% (R^2=0,18) of explained variance in the P2P & SEMD WTP.

The P2P & SEMD MSP has a positive single linear relation with age and house type. The P2P & SEMD MSP are increasing with age and are higher for participants that live in a single-family home. Negative single linear relations with the P2P & SEMD MSP were found for: Education, PEB and the P2P & SEMD WTP. Meaning that participants with a higher education, PEB or P2P & SEMD WTP have lower P2P & SEMD MSP. In the multiple regression only P2P & SEMD WTP and education predicted P2P & SEMD MSP significantly. The multiple regression predicts 21,7% (R^2=0,217) of the P2P & SEMD MSP.

ATI only predicts the P2P & SEMD WTP. Thus, it is contradicting the previous finding that state ATI as one of the most important concepts when determining P2P MSP or the SEMD MSP.

H4 got accepted. P2P & SEMD WTP fully mediates the relation between PEB and the P2P & SEMD MSP. The effect size of the indirect effect is -2,964. Thus, PEB is the main explanatory variables when determining the P2P & SEMD MSP. In the conceptual framework the ATI predicts the moderator P2P & SEMD WTP and the education predict the P2P & SEMD MSP as a covariate. The mediation model with the covariates explains 25,23%

(R^2=0,2523) of the P2P & SEMD MSP variance. This is an improvement to the multiple regression. So, the conceptual framework adds explanatory power in understanding the dynamics that determine the P2P & SEMD MSP.

The stated average MSP are 14,37€ per month what represents a 20,87% decrease in the average monthly electricity costs stated by the participants. This is higher than the single average SEMD MSP and the P2P MSP. Nevertheless, the P2P & SEMD MSP are significantly lower than the single combined MSP's of P2P (10,62€) and respectively SEMD (11,83€). This indicated that a combination of both release synergies that make the combination more valuable to participants than just one of the technologies.

4.4 P2P Electricity Selling Price

The P2P electricity selling price had positive simple linear relations with ATI and P2P MSP. Participants high in ATI would charge higher prices for their self-generated electricity. Also, participants that expect higher monthly savings from a P2P electricity market are expected to charge higher prices. Negative single linear relations were found for; Gender and PEB. If participants are high in PEB they are expected to charge lower prices. In terms of gender, female participants are expected to demand lower prices when compared to male participants.

In a multiple regression P2P MSP and the gender predict the price significantly. The Multiple regression accounts for 9,7% (R^2=0,097) of the variance.

For the sequential mediation, P2P WTP and P2P MSP were found to partially mediate the relation between PEB and the P2P selling price. H5 got accepted.

The indirect effect of PEB over P2P WTP and P2P MSP to the P2P selling price is -0,313. But PEB still has a direct effect on the P2P electricity selling price of -2,078. This makes PEB the main explanatory variable.

The sequential moderation accounts for 12,78% (R^2=0,1278) of the P2P selling price variance. This improves the explained variance of the multiple regression and therefore adds explanatory power.

In the conceptual framework, besides the IV PEB and the mediator P2P WTP, the number of gadgets, education and KEB predict the second mediator P2P MSP.

The average selling price for self-generated electricity was indicted with 0,16 € per kWh. This is above the feed in tariffs paid in Germany and below the average electricity price. This indicates that a P2P electricity selling could work.

4.5 P2P Electricity Buying Price

The P2P electricity buying price only had negative simple linear relations with PEB. The effect size is -2,206. If participants are high in PEB, the electricity buying price decreases. This is an unexpected relation as it was assumed that PEB has a positive relation with the buying price. This relation must be investigated further to proof or disproof it.

The H6 got dropped, as there's no significant sequential moderation.

The indicated buying price was 0,19€ per kWh. This is lower than the price for green electricity in Germany. Nevertheless, the price is higher than the indicated P2P electricity selling price. This indicates that a healthy market could be established, as competitive selling prices which are lower than the buying prices are most important for a market to function efficiently. This contradicts the findings of Ecker et. al., where the selling price was higher than the buying price in two out of three conditions (Ecker et al., 2018).

4.6. Explanatory Variables

The importance of ATI is lower than expected as there was no relation with ATI and any MSP. ATI has no impact on the MSP in association with the respective technology use. Only a positive relation with the electricity selling price was detected. This relation is of some importance, as ATI has a positive relation with all the WTPs. WTP itself predicts a lower electricity selling price over the MSP, but ATI predicts a higher electricity selling price. ATI, its particularly important for the SEMD and the P2P & SEMD WTP, as ATI has a significant relation in the simple linear and the multiple regression with the SEMD WTP and the P2P & SEMD WTP. Thus, ATI is an explaining covariate in the respective conceptual frameworks.

Electricity usage variables also provide some explanatory power. The knowledge about the electricity bill (KEB) and the amount of the electricity bill have simple linear relations with the P2P MSP. KEB is even significant in the multiple regression and the final conceptual framework, explaining the P2P MSP. Also, KEB is a significant covariant for the MSP in the P2P electricity selling price conceptual framework.

Electricity independence aspirations (EIA) shows a relation in the single and multiple regression with the P2P WTP. EIA is an explanatory variable in the P2P MSP conceptual framework and predicts the mediator WTP as a covariate. Also, a single linear relation of EIA with the WTP in SEMD use got detected.

The impact of financial aspects was smaller as in the literature. PC had no significant relation with any of the tested WTPs, MSPs or final prices. TP were significant in the P2P MSP, in the simple linear and the multiple regression. In the conceptual framework the TP explains some of the P2P MSP variance as a covariate. FRP on the other hand shows a significant relation with the SEMD MSP in the simple linear and the multiple regression. FRP explains some of the SEMD MSP variance as a covariate in the SEMD conceptual framework.

Community identity had no significant relation with any tested variables.

Summarising, EIA, TP, ATI, KEB and FRP had a significant relation with one or several of the tested mediation analyses. Thus, H7 can be partially accepted. This indicates that the explanatory variables add important explanatory power to the investigated mediation analyses.

4.7. Control Variables

The importance of household characteristics should not be underestimated. Three of the four tested household characteristics variables (household size, house type and house ownership) have single linear relations with the P2P MSP. Household size and house type have single linear relations with the SEMD MSP. Further, house type has a single linear relation with the P2P & SEMD MSP. Even though household characteristics didn't enter the conceptual framework they might have an important influence in determining the MSP in all the three-technology application.

The number of high electricity consuming gadgets predicts the P2P MSP and the SEMD MSP in the simple linear and multiple regression analysis. For SMED the number of gadgets also predicts the WTP. The number of gadgets is an explanatory variable in the P2P MSP and the SEMD MSP conceptual frameworks. Also, in the P2P electricity selling price conceptual framework, the number of gadgets explain some of the MSP variance as a covariate.

From the demographics control variables, education seems to be an important predictor. Education explains some of the variance of the MSP in SEMD and the P2P & SEMD conceptual frameworks. Moreover, education also predicts some of the variance of the MSP in the P2P selling price conceptual framework. Thus, agents with a high education would be very valuable for a P2P electricity market, as they would expect lower MSP. Also, female participants are expected to charge a lower price for selling electricity. The group difference is significant in the linear regression and in multiple regression with the final electricity selling price. Age also has a positive significant single linear relation with the P2P & SEMD MSP. Thus, expected MSP are increasing with the Age.

No relations were found for PV ownership or the income.

Some relations for the control variables with the WTP and the MSP could be detected. Only the number of gadgets and the education entered some final conceptual frameworks as control variables. Both seem to have an important explanatory role, as they have significant relations with many of the investigated concepts.

4.8. Final Framework

The final conceptual framework is a combination of all the previous presented conceptual frameworks, with all the significant relations of the mediation analysis.

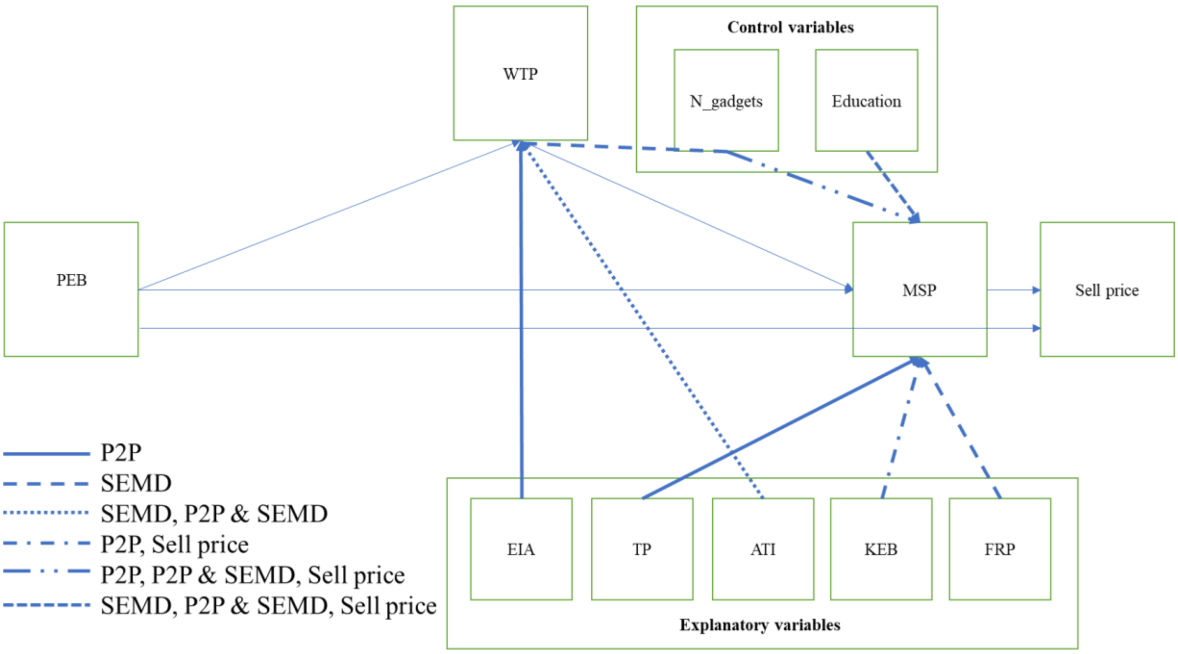

Figure 8 Final Conceptual Framework

5. Conclusion

The indicated selling and buying prices would make a functioning P2P electricity market possible. PEB is the single most important external variable for predicting the WTP and the MSP. Therefore, a P2P electricity market should firstly focus on making participants high in PEB to join the P2P electricity trading community, as PEB predicts a higher WTP, lower MSP as well as a lower selling price for electricity. All three aspects are crucial for a well-functioning P2P electricity market. For a fully automated P2P electricity market with the integration of SEMD it would be wise to also pay attention to participants with a high ATI as they are predicted to have a higher WTP. Nevertheless, due to the positive relation of ATI with the electricity selling price, too many agents with a high ATI could decrease a P2P electricity markets efficiency.

A P2P market setup should also consider the importance of educated participants, as they expect lower the MSP. Also, electricity literacy should be considered, as participants that know about their electricity bill are also expected to have lower MSP. Household characteristics had significant relations, they might be explained by the bigger electricity consumption when living in or owing a single-family home, as single-family homes tend to be bigger than apartments. The same counts for the number of gadgets, as the more electricity is consumed, the bigger is the monthly bill and thus the MSP might increase in the same ratio. Nevertheless, those control variables have relations with all the tested technology applications, and thus should be considered when setting up a P2P market.

When setting up a P2P electricity market, market designers should especially pay attention to the PEB. The explanatory and control variables, that were found to have significant relation in the mediation analyses are of importance too, as the mediation analyses have all higher R^2 then the multiple regressions. Also, variables that have positive effect on the WTP and negative on the MSP are of interests, because those effects predict that participants are willing to trade electricity and don’t expect too high savings in return. Also, those participants are expected to charge lower prices for their electricity.

The findings about the WTP, the MSP and the electricity prices provide new insights that first, a P2P electricity market could function efficiently. Second, about what groups and concepts should be considered when creating such a market.

This study provided a in depth analysis of the relations that shape the WTP and MSP for P2P, SEMD and P2P & SEMD use. Further, the relations with the electricity prices got pointed out. Most important a mediation of WTP between PEB and the MSP got proven. Also, the sequential mediation for the electricity selling price from PEB over WTP and MSP to the setting price got proven. This underlines the importance of PEB as most important predictor and provides important insights for future research.

Finally, if a P2P market is setup regarding the above-mentioned aspects, it would increase the efficiency, what results in more electricity trade, balances the electricity grid, saves electricity and CO2 emissions, and lastly even creates revenue for all the market participants. Making P2P electricity trade in combination with SEMD an appropriate tool to counteract the uncertainties and fluctuations that come along with renewable electricity sources.

6. Limitations

The concepts of SEMD use and especially the P2P electricity trade aren't easy to understand. Participants might have had difficulties to fully comprehend the mechanisms, impacts and benefits connected with the use of these technologies. Thus, the accurate answering of the corresponding questions could have been impacted.

There was no random selection of participants, moreover the participants aren't representative of the German population. The average age of the study participants is lower than the German average. Also, the average income of the study participants is lower than the German average. This could have distorted the results. There are also slightly more female participants than male, but the difference is not huge, so an interference is not very probably.

Stepwise multiple regressions are criticized in recent literature. The stepwise analysis chooses items based on the significance level. This approach leads to a low p value but might neglect variables with a high explanatory power, but a slightly lower p value. Thus, with a rising number of explanatory variables, the possibility that stepwise multiple regressions are neglecting important variables is increasing. As this study used numerus explanatory variables, as well as control variables, the stepwise multiple regression had to check for several variables. Nevertheless, the number of variables entered in the stepwise multiple regressions was maximum 10. What still is a reasonable amount to check with a stepwise multiple regression. (Smith, 2018)

Also, the setup of the FRP measurement wasn't ideal, as it is firstly measuring risk aversion (with four items) and secondary risk neutrality and risk seeking (respectively one item). Nevertheless, the measurements and the corresponding theoretical framework is valid and thus the measurement is valid. However, the difference in the number of items could have led to some distortion of the outcome.

With an average answering time of 21,5 minutes, the questionnaire took long to answer. This could have affected the concentration and thus the answer accuracy of the participants. Also, three related technology use got investigated. This might have led to bias, as previous answers of participants could have affected following answers.

The number of participants that own a PV or a storage unit was very small. This might explain why no relations for PV or storage ownership could be detected.

The respective question for the buying price was asked in a way that didn't ask for the maximum price participants would still be willing to pay for one kWh. Just the price they'll be willing to pay was asked for. This might have misled some participants and therefore impacted the result.

The exclusion of participants that stated not to sell or buy any electricity on P2P electricity market might have impacted the final prices results, as the 16 excluded participants were part of the WTP and the MSP analysis but were excluded for the final prices analysis.

7. Future Research

Future research should further investigate the final electricity buying and selling prices on a P2P market, as this research only explains 12,78% of the selling price variance and no explaining model could be found for the buying price. Gathering more information about the concepts and dynamics that shape the final prices would be valuable to understand the price determination in a P2P electricity market.

Also, an experimental study of group differences between participants with a PV, a PV + storage unit and no PV or storage unit regarding WTP, MSP and the electricity prices would provide interesting insights. To investigate, if and how the ownership status influences the WTP, MSP and the electricity prices. This would help to determine the importance of the respective groups in a P2P market. Optimally this would be carried out with participants that belong to the above-mentioned groups. However, a study with a manipulation trough framing those groups might already provide some insights.

An experimental study investigating group differences between P2P electricity trading vs. P2P & SEMD electricity trading participants with respect to the final prices for electricity, would further provide insights about the importance and adoption of SEMD in a P2P trading market.

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Appendix

P2P electricity trading questionnaire text:

"*A peer-to-peer electricity trade allows you to join with other households in your neighbourhood to form what is called an electricity trading community. In order to trade and share privately generated electricity with one another without a intermediary (energy company).*

If you for instance own a power generation facility, such as solar PV panels, a P2P electricity trading community enables you to sell all the energy you generate that you do not store in a battery or consume directly to other community members through the power grid.

So, if other participants don't generate any or enough solar, wind or biogas power, they can buy excess power from other power trading community members.

Participants that do not have their own power generation facility can also become part of the electricity trading community. These participants can purchase electricity from local renewable energy sources from other members that have an excess.

All individuals in a geographically defined area, such as a town, county, federal state, or state can join the electricity trading community.

The trade is handled via an online market platform. On this market platform, buyers and sellers can each set a purchase price and a selling price for energy. If the purchase price is equal to or higher than the selling price, the trade is carried out at the selling price set by the seller and the electricity is fed into the grid.

So, all exchanges of energy are voluntary and at a price that both the buyer and seller find beneficial. Prices in this market are expected to fluctuate depending first on the capacity of energy supply (for example high capacity during sunny hours because of PV energy production) and second on the demand.

P2P electricity markets are then a system to allow neighbours to share energy they don't need and encourage local, renewable, sources of energy production while generating extra income or energy savings for participating households. "

P2P electricity price information:

"Household customers in Germany paid an average of 31.71 ct per kWh in 2020, for electricity from all existing energy sources (renewable and non-renewable energy sources).

Household customers in Germany paid an average of 32.71 ct per kWh in 2020 for electricity from exclusively renewable energy sources.

Selling price for solar electricity:
Producers who commissioned their photovoltaic system in 2016 currently receive 12.31 ct per kWh as a feed-in tariff for the sale of their solar power. "

SEMD questionnaire text:
"Smart Energy Management Devices allow you to view your current and past electricity consumption and compare it with other participants.
Furthermore, they allow you to automatically control and manage your electricity consumption. Appliances such as heating, lighting, washing machines, dishwashers, air conditioners, etc. can be set/controlled using an app and thus can be turned on, off, higher, or lower as needed.
Smart Electricity Management Devices can then be used to both provide more information on which devices are using the most energy in your household, as well as shift the times at which these devices run to save on electricity bills.
For example, a Smart Electricity Management enabled washing machine can decide to run when prices are lower or when a solar panel has excess energy (during the day) to minimise the users electricity bill."

P2P & SEMD questionnaire text:
"Smart Electricity Management Devices combined with a P2P energy market allows you to control electronic devices so that they automatically switch on/off or set to a higher or lower level at a set electricity price on the P2P market, or at a set production capacity.
As an electricity consumer, you can set a price. When this price is reached on the P2P Market, the electricity consumption of the corresponding devices is automatically controlled according to the conditions you set.
In other words, the electronic devices are switched on/off or set to a higher or lower level. Alternatively, you can simply specify when you need the device to run, for example the dishwasher should run before you return home from work, and the Smart Electricity

Management Device will choose the time to run to minimise your costs by using excess renewable energy produced by your neighbours.
This allows you to automate your electricity consumption so that, for example, at times when you or other market participants produce a lot of green electricity, your electronic devices automatically switch on to consume or store this electricity directly, reducing the cost of energy and better utilising local sustainable energy sources."

Questionnaire:

Questionnaire to assess the potential of P2P energy trading communities in connection with Smart Electricity Management Devices. This survey is part of the development of a Master's Thesis in Psychology in Business and Economics at the Universidade Católica Portuguesa. The survey is being conducted by Till Tinsahli, under the supervision of Dr. Ian Scott. Your participation is completely voluntary and you can withdraw at any time. The survey is short (about 20 minutes) and you will find detailed instructions on how to complete it. The data collected will be used for research purposes only and no information will be used in the analyses and/or results that could potentially identify a participant. If at any time you have questions about the study or the procedures, please contact: Till.tinsahli@gmx.de There will be questions regarding preferred payouts in the course of the questionnaire. These are purely hypothetical questions for study purposes. Therefore, actual payouts will not be made. I consent to participate in this study and authorise the use of the data I voluntarily provide in the confidence that it will be used in the context of the aims of this study and the guarantee of confidentiality and anonymity provided by the researcher. I am aware that I can send an email to have the data deleted at any timeThank you very much!

○ *I agree*

Gener

- ○ *Male*
- ○ *Female*
- ○ *Non-binary*
- ○ *I prefer not to say*

Age:

____

Do you live in Germany?

- ○ *Yes*
- ○ *no*

Please enter your zip code

____

What is your highest general qualification?

- ○ *Left school without a diploma*
- ○ *Hauptschul oder Realschulabschluss*
- ○ *High school diploma or equivalent*
- ○ *University studies without a degree*
- ○ *Bachelor's degree*
- ○ *Master's degree*
- ○ *PhD degree*

Which of the following categories best describes your employment status?

- ○ *Student*
- ○ *Employed, part-time*
- ○ *Employed, full-time*
- ○ *Without employment*
- ○ *Retired*
- ○ *Handicapped, unable to work*
- ○ *Self-employed*

What was your net income in 2020?

- ◯ *0 – 9.999€*
- ◯ *10.000 – 19.999€*
- ◯ *20.000 – 29.999€*
- ◯ *30.000 – 39.999€*
- ◯ *40.000 – 49.999€*
- ◯ *50.000 – 59.999€*
- ◯ *60.000 – 69.999€*
- ◯ *70.000 – 79.999€*
- ◯ *80.000 – 89.999€*
- ◯ *90.000 – 99.999€*
- ◯ *100.000€ or more*
- ◯ *I prefer not to say*

How many people in total live in your household (including you)?

- ○ *1*
- ○ *2*
- ○ *3*
- ○ *4*
- ○ *5*
- ○ *6*
- ○ *7 or more*

What is the total living space of your household in m²?

- ○ *10-20 m²*
- ○ *20-30 m²*
- ○ *30 - 40 m²*
- ○ *40 - 50 m²*
- ○ *50 - 60 m²*
- ○ *60 - 70 m²*
- ○ *70 - 80 m²*
- ○ *80 - 90 m²*
- ○ *90-100 m²*
- ○ *100 m² or more*

What kind of house do you live in?

- ◯ *Apartment building*
- ◯ *Single-family house*
- ◯ *Other:* ____

Do you currently live in rented accommodation or your self-owned home?

- ◯ *Rent*
- ◯ *Self-owned home*

Do you own a photovoltaic facility?

- ◯ *Yes*
- ◯ *No*
- ◯ *Another renewable electricity generation plant (e.g. wind turbine) (Please specify what kind of plant it is)* ____

Do you have a power storage / battery?

- ◯ *Yes*
- ◯ *No*

I would like to be more independent from my energy supplier.

- ◯ *Yes*
- ◯ *Undecided*
- ◯ *No*

How regularly do you carry out the following activities (from never to always)?

	Never	*Rarely*	*Sometimes*	*Usually*	*Always*	*No indication*
How often do you switch off the light when you leave a room?	○	○	○	○	○	○
How often do you turn off the standby mode of electronic devices?	○	○	○	○	○	○
How often do you turn down the heating or air conditioning to reduce energy consumption?	○	○	○	○	○	○
How often do you turn off the TV when you leave a room?	○	○	○	○	○	○
How often do you limit time in the shower to save water?	○	○	○	○	○	○
How often do you wait to use the washing machine or dishwasher until you have a full load?	○	○	○	○	○	○

At what temperature do you usually wash most of your clothes?

	Hot	*Warm*	*Cold*
At what temperature do you usually wash most of your clothes?	○	○	○

Do these statements apply to you?

	Yes	*No*	*Not specified*
Are you currently a member of an environmental, nature or animal protection group?	○	○	○
Did you donate money to an environmental, nature conservation or wildlife protection group in the past year?	○	○	○
Have you increased the amount of organically grown fruit and vegetables you consume in the last year?	○	○	○

How often have you carried out the following activities in the past year (from never to very often)?

	Never	*Rarely*	*Sometimes*	*Often*	*Very often*	*Not specified*
How often do you watch TV programmes, films or internet videos on environmental issues?	○	○	○	○	○	○
How often do you talk to others about your environmental behaviour?	○	○	○	○	○	○

Have you reduced your meat consumption in the past year?

	Yes	*No*	*I do not eat the type of meat asked for*
Have you reduced the amount of beef you consume in the past year?	○	○	○
Have you reduced the amount of pork you consume in the past year?	○	○	○
Have you reduced the amount of poultry you consume in the past year?	○	○	○

How often have you done the following activities in the last year (from never to very often)?

	Never	*Rarely*	*Sometimes*	*Often*	*Very often*	*Not specified*
How often have you participated in a carpool last year?	○	○	○	○	○	○
How often have you used public transport in the last year?	○	○	○	○	○	○
How often have you walked or cycled instead of driving in the last year?	○	○	○	○	○	○

To what extent do the following statements apply or not to you?

	Applies completely	*Applies somewhat*	*Neither nor*	*Tends not to apply*	*Does not apply*
I like to take a detailed look at technical systems/devices.	○	○	○	○	○
I deal mostly with technical systems/devices because I have to.	○	○	○	○	○
I like to spend time familiarising myself with a new technical system/device.	○	○	○	○	○
When I have a new technical system/device in front of me, I try it out intensively.	○	○	○	○	○
I try to understand exactly how a technical system/device works.	○	○	○	○	○
It is enough for me to know the basic functions of a technical system/device.	○	○	○	○	○
I try to make full use of the possibilities of a technical system/device.	○	○	○	○	○

To what extent do you agree or disagree with the following statements?

	Fully agree	*Rather agree*	*Neither nor*	*Tend not to agree*	*Do not agree*
I am not willing to make extra efforts to find lower prices.	○	○	○	○	○
I shop at more than one shop to benefit from low prices.	○	○	○	○	○
The money saved by looking for low prices is usually not worth the time and effort.	○	○	○	○	○
I would never shop in more than one shop to find low prices.	○	○	○	○	○

To what extent do you agree or disagree with the following statements?

	Fully agree	*Rather agree*	*Neither nor*	*Rather disagree*	*I dont agree*
I get what I need in the local community.	○	○	○	○	○
My local community helps me meet my needs.	○	○	○	○	○

To what extent do you agree or disagree with the following statement?

	Fully agree	*Rather agree*	*Neither nor*	*Rather disagree*	*Disagree*
I feel like a member of this local community.	○	○	○	○	○
I belong to this local community.	○	○	○	○	○

To what extent do you agree or disagree with the following statements?

	Fully agree	*Rather agree*	*Neither nor*	*Rather disagree*	*Disagree*
I have a say about what goes on in my local community.	○	○	○	○	○
People in this local community are good at influencing each other.	○	○	○	○	○

To what extent do you agree or disagree with the following statement?

	Fully agree	*Rather agree*	*Neither nor*	*Rather disagree*	*Disagree*
I feel connected to this local community.	○	○	○	○	○
I have a good relationship with other people in this local community.	○	○	○	○	○

Page Break

Look at the table below with the different lotteries 1,2,3,4,5,and 6 and decide which lottery you would like to play. The probabilities for the payout possibilities A and B are 50% for each (p = 0.5). Thus, in each lottery (1,2,3...) the payoff A or B occurs with 50% probability respectively.

	Auszahlung A	Auszahlung B
Lotterie 1	20€	20€
Lotterie 2	16€	28€
Lotterie 3	12€	36€
Lotterie 4	8€	44€
Lotterie 5	4€	52€
Lotterie 6	0	56€

Now please indicate which lottery you have chosen.

- ◯ *Lottery 1*
- ◯ *Lottery 2*
- ◯ *Lottery 3*
- ◯ *Lottery 4*
- ◯ *Lottery 5*
- ◯ *Lottery 6*

Page Break

In the following, a total of six tables with payouts are presented to you. The payouts vary only slightly from each other.

See the table below with different options for payouts (A,B,C...). Of each payout option (A,B,C...) you will receive a part of the payout "today" and another part "in 5 weeks". Choose one of the payouts (A, B, C, ...) whose combined value you would like to receive today and in five weeks.

Auszahlung	A	B	C	D	E	F
Heute	19€	15,20€	11,40€	7,60€	3,80€	0
und in 5 Wochen	0	4€	8€	12€	16€	20€

Please indicate your preferred payout.

- ○ *A*
- ○ *B*
- ○ *C*
- ○ *D*
- ○ *E*
- ○ *F*

See the table below with different options for payouts (A,B,C...). Of each payout option (A,B,C...) you will receive a part of the payout "today" and another part "in 5 weeks". Choose one of the payouts (A, B, C, ...) whose combined value you would like to receive today and in five weeks.

Auszahlung	A	B	C	D	E	F
Heute	18€	14,40€	10,80€	7,20€	3,60€	0
und in 5 Wochen	0	4€	8€	12€	16€	20€

Please indicate your preferred payout.

- ○ *A*
- ○ *B*
- ○ *C*
- ○ *D*
- ○ *E*
- ○ *F*

See the table below with different options for payouts (A,B,C...). Of each payout option (A,B,C...) you will receive a part of the payout "today" and another part "in 5 weeks". Choose one of the payouts (A, B, C, ...) whose combined value you would like to receive today and in five weeks.

Auszahlung	A	B	C	D	E	F
Heute	17€	13,60€	10,20€	6,80€	3,40€	0
und in 5 Wochen	0	4€	8€	12€	16€	20€

Please indicate your preferred payout.

- ○ *A*
- ○ *B*
- ○ *C*
- ○ *D*
- ○ *E*
- ○ *F*

See the table below with different options for payouts (A,B,C...). Of each payout option (A,B,C...) you will receive a part of the payout "today" and another part "in 5 weeks". Choose one of the payouts (A, B, C, ...) whose combined value you would like to receive today and in five weeks.

Auszahlung	A	B	C	D	E	F
Heute	16€	12,80€	9,60€	6,40€	3,20€	0
und in 5 Wochen	0	4€	8€	12€	16€	20€

Please indicate your preferred payout.

- ○ *A*
- ○ *B*
- ○ *C*
- ○ *D*
- ○ *E*
- ○ *F*

See the table below with different options for payouts (A,B,C...). Of each payout option (A,B,C...) you will receive a part of the payout "today" and another part "in 5 weeks". Choose one of the payouts (A, B, C, ...) whose combined value you would like to receive today and in five weeks.

Auszahlung	A	B	C	D	E	F
Heute	14€	11,20€	8,40€	6,50€	2,80€	0
und in 5 Wochen	0	4€	8€	12€	16€	20€

Please indicate your preferred payout.

- ◯ *A*
- ◯ *B*
- ◯ *C*
- ◯ *D*
- ◯ *E*
- ◯ *F*

See the table below with different options for payouts (A,B,C...). Of each payout option (A,B,C...) you will receive a part of the payout "today" and another part "in 5 weeks". Choose one of the payouts (A, B, C, ...) whose combined value you would like to receive today and in five weeks.

Auszahlung	A	B	C	D	E	F
Heute	11€	8,80€	6,60€	4,40€	2,20€	0
und in 5 Wochen	0	4€	8€	12€	16€	20€

Please indicate your preferred payout.

- ◯ *A*
- ◯ *B*
- ◯ *C*
- ◯ *D*
- ◯ *E*
- ◯ *F*

Page Break

*What is your favorite color?
Regardless of your favorite color, please write "white" in the text box under "Other".*

- ○ *Blue*
- ○ *Green*
- ○ *White*
- ○ *Yellow*
- ○ *Red*
- ○ *Other:* ____

Page Break

What are your monthly electricity costs?

- ○ *Amount in € (please specify)* ____
- ○ *I do not know my monthly electricity costs*

Page Break

Following you will be asked some questions about a peer-to-peer electricity trading community.

A peer-to-peer electricity trade allows you to join with other households in your neighborhood to form what is called an electricity trading community. In order to trade and share privately generated electricity with one another without an intermediary (energy company. If you for instance own a power generation facility, such as solar PV panels, a P2P electricity trading community enables you to sell all the energy you generate that you do not store in a battery or consume directly to other community members through the power grid. So, if other participants don't generate any or enough solar, wind or biogas power, they can buy excess power from other power trading community members. Participants that do not have their own power generation facility can also become part of the electricity trading community. These participants can purchase electricity from local renewable energy sources from other members that have an excess. All individuals in a geographically defined area, such as a town, county, federal state, or state can join the electricity trading community. The trade is handled via an online market platform. On this market platform, buyers and sellers can each set a purchase price and a selling price for energy. If the purchase price is equal to or higher than the selling price, the trade is carried out at the selling price set by the seller and the electricity is fed into the grid. So, all exchanges of energy are voluntary and at a price that both the buyer and seller find beneficial. Prices in this market are expected to fluctuate depending first on the capacity of energy supply (for example high capacity during sunny hours because of PV energy production) and second on the demand. P2P electricity markets are then a system to allow neighbors to share energy they don't need and encourage local, renewable, sources of energy production while generating extra income or energy savings for participating households

If you had the opportunity, how likely would you be to participate in such an electricity trading community?

- ○ *Very likely*
- ○ *Likely*
- ○ *Undecided*
- ○ *Unlikely*
- ○ *Very unlikely*

Information: Household customers in Germany paid an average of 31.71 ct per kWh in 2020, for electricity from all existing energy sources (renewable and non-renewable energy sources).

Household customers in Germany paid an average of 32.71 ct per kWh in 2020 for electricity from exclusively renewable energy sources.

Selling price for solar electricity: Producers who commissioned their photovoltaic system in 2016 currently receive 12.31 ct per kWh as a feed-in tariff for the sale of their solar power.

Imagine you are the owner of a photovoltaic system and part of an electricity trading community in which you buy and sell electricity. For how much money would you sell one *kWh of the electricity generated by your photovoltaic system to your neighbors in an electricity trading community? (Please select)*

- ○ *I wouldn't sell electricity*
- ○ *0 cent per kWh*
- ○ *1 cent per kWh*
- ○ *2 cents per kWh*
- ○ *3 cents per kWh*
- ○ *4 cents per kWh*
- ○ *5 cents per kWh*
- ○ *6 cents per kWh*
- ○ *7 cents per kWh*
- ○ *8 cents per kWh*
- ○ *9 cents per kWh*
- ○ *10 cents per kWh*
- ○ *11 cents per kWh*
- ○ *12 cents per kWh*
- ○ *13 cents per kWh*
- ○ *14 cents per kWh*
- ○ *15 cents per kWh*
- ○ *16 cents per kWh*
- ○ *17 cents per kWh*
- ○ *18 cents per kWh*

- *19 cents per kWh*
- *20 cents per kWh*
- *21 cents per kWh*
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- *23 cents per kWh*
- *24 cents per kWh*
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- *34 cents per kWh*
- *35 cents per kWh*
- *36 cents per kWh*
- *37 cents per kWh*
- *38 cents per kWh*
- *39 cents per kWh*

- ○ *40 cents per kWh*
- ○ *41 cents per kWh*
- ○ *42 cents per kWh*
- ○ *43 cents per kWh*
- ○ *44 cents per kWh*
- ○ *45 cents per kWh*
- ○ *46 cents per kWh*
- ○ *47 cents per kWh*
- ○ *48 cents per kWh*
- ○ *49 cents per kWh*
- ○ *50 cents per kWh*
- ○ *More than 50 cents per kWh*

Imagine you are part of an electricity trading community in which you can buy and sell electricity. How much money would you pay to buy one kWh of renewable electricity from members of the electricity trading community? (Please select)

- ◯ *I wouldn't buy electricity*
- ◯ *0 cent per kWh*
- ◯ *1 cent per kWh*
- ◯ *2 cents per kWh*
- ◯ *3 cents per kWh*
- ◯ *4 cents per kWh*
- ◯ *5 cents per kWh*
- ◯ *6 cents per kWh*
- ◯ *7 cents per kWh*
- ◯ *8 cents per kWh*
- ◯ *9 cents per kWh*
- ◯ *10 cents per kWh*
- ◯ *11 cents per kWh*
- ◯ *12 cents per kWh*
- ◯ *13 cents per kWh*
- ◯ *14 cents per kWh*
- ◯ *15 cents per kWh*
- ◯ *16 cents per kWh*
- ◯ *17 cents per kWh*
- ◯ *18 cents per kWh*

- ○ *19 cents per kWh*
- ○ *20 cents per kWh*
- ○ *21 cents per kWh*
- ○ *22 cents per kWh*
- ○ *23 cents per kWh*
- ○ *24 cents per kWh*
- ○ *25 cents per kWh*
- ○ *26 cents per kWh*
- ○ *27 cents per kWh*
- ○ *28 cents per kWh*
- ○ *29 cents per kWh*
- ○ *30 cents per kWh*
- ○ *31 cents per kWh*
- ○ *32 cents per kWh*
- ○ *33 cents per kWh*
- ○ *34 cents per kWh*
- ○ *35 cents per kWh*
- ○ *36 cents per kWh*
- ○ *37 cents per kWh*
- ○ *38 cents per kWh*
- ○ *39 cents per kWh*

○ *40 cents per kWh*

○ *41 cents per kWh*

○ *42 cents per kWh*

○ *43 cents per kWh*

○ *44 cents per kWh*

○ *45 cents per kWh*

○ *46 cents per kWh*

○ *47 cents per kWh*

○ *48 cents per kWh*

○ *49 cents per kWh*

○ *50 cents per kWh*

○ *More than 50 cents per kWh*

How much must be the minimum monthly savings in € for you to join an electricity trading community? (Please select)

- ◯ *0€*
- ◯ *min 1€*
- ◯ *min 2 €*
- ◯ *min 3 €*
- ◯ *min 4 €*
- ◯ *min 5 €*
- ◯ *min 6 €*
- ◯ *min 7 €*
- ◯ *min 8 €*
- ◯ *min 9 €*
- ◯ *min 10 €*
- ◯ *min 11 €*
- ◯ *min 12 €*
- ◯ *min 13 €*
- ◯ *min 14 €*
- ◯ *min 15 €*
- ◯ *min 16 €*
- ◯ *min 17 €*
- ◯ *min 18 €*
- ◯ *min 19 €*

- *min 20 €*
- *min 21 €*
- *min 22 €*
- *min 23 €*
- *min 24 €*
- *min 25 €*
- *min 26 €*
- *min 27 €*
- *min 28 €*
- *min 29 €*
- *min 30 €*
- *min 31 €*
- *min 32 €*
- *min 33 €*
- *min 34 €*
- *min 35 €*
- *More than 35 €*

Page Break

In the following, you will be asked some questions about Smart Electricity Management Devices.

Smart Energy Management Devices allow you to view your current and past electricity consumption and compare it with other participants. Furthermore, they allow you to automatically control and manage your electricity consumption. Appliances such as heating, lighting, washing machines, dishwashers, air conditioners, etc. can be set/controlled using an app and thus can be turned on, off, higher, or lower as needed. Smart Electricity Management Devices can then be used to both provide more information on which devices are using the most energy in your household, as well as shift the times at which these devices run to save on electricity bills. For example, a Smart Electricity Management enabled washing machine can decide to run when prices are lower or when a solar panel has excess energy (during the day) to minimise the users electricity bill.

If you had the option, how likely would you be to use Smart Electricity Management Device?

- ○ *Very likely*
- ○ *Likely*
- ○ *Undecided*
- ○ *Unlikely*
- ○ *Very unlikely*

<div>Imagine you have electric heating in your home. What must be the minimum monthly savings for you to use a Smart Electricity Management Device to control your heating? This

would, for example, turn down the heating in times of high energy demand, or turn it up if a lot of solar power is being produced currently. (Please select)

- ◯ *0€*
- ◯ *1 €*
- ◯ *2 €*
- ◯ *3 €*
- ◯ *4 €*
- ◯ *5 €*
- ◯ *6 €*
- ◯ *7 €*
- ◯ *8 €*
- ◯ *9 €*
- ◯ *10 €*
- ◯ *11 €*
- ◯ *12 €*
- ◯ *13 €*
- ◯ *14 €*
- ◯ *15 €*
- ◯ *More than 15 €*

Imagine you have a washing machine. What must be the minimum monthly savings for you to use a Smart Electricity Management Device to control your washing machine? So that *the washing machine runs automatically when there is a surplus of electricity. For example, when there is a lot of solar power produced during the day (Please select)*

- ◯ *0€*
- ◯ *1 €*
- ◯ *2 €*
- ◯ *3 €*
- ◯ *4 €*
- ◯ *5 €*
- ◯ *6 €*
- ◯ *7 €*
- ◯ *8 €*
- ◯ *9 €*
- ◯ *10 €*
- ◯ *11 €*
- ◯ *12 €*
- ◯ *13 €*
- ◯ *14 €*
- ◯ *15 €*
- ◯ *More than 15 €*

Which of these electrical devices do you have in your household?

- ☐ *Refrigerator*
- ☐ *Freezer*
- ☐ *Electronic heating*
- ☐ *Electronic hot water boiler*
- ☐ *Electric car*
- ☐ *Air conditioner*
- ☐ *Washing machine*
- ☐ *Dishwasher*

How much must the minimum monthly savings of all your electrical appliances together (heating, lighting, washing machines, dishwashers, air conditioners, electric car, etc.) be in

€? So that you would use Smart Electricity Management Devices to control your electrical appliances. (Please select)

- ○ *0€*
- ○ *1 €*
- ○ *2 €*
- ○ *3 €*
- ○ *4 €*
- ○ *5 €*
- ○ *6 €*
- ○ *7 €*
- ○ *8 €*
- ○ *9 €*
- ○ *10 €*
- ○ *11 €*
- ○ *12 €*
- ○ *13 €*
- ○ *14 €*
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- ◯ *28 €*
- ◯ *29 €*
- ◯ *30 €*
- ◯ *31 €*
- ◯ *32 €*
- ◯ *33 €*
- ◯ *34 €*
- ◯ *35 €*
- ◯ *More than 35 €*

Page Break

In the following, you will be asked some questions about Smart Electricity Management Devices in combination with a Peer-to-Peer power trading community.

Smart Electricity Management Devices combined with a P2P energy market allows you to control electronic devices so that they automatically switch on/off or set to a higher or lower level at a set electricity price on the P2P market, or at a set production capacity. As an electricity consumer, you can set a price. When this price is reached on the P2P Market, the electricity consumption of the corresponding devices is automatically controlled according to the conditions you set. In other words, the electronic devices are switched on/off or set to a higher or lower level. Alternatively, you can simply specify when you need the device to run, for example the dishwasher should run before you return home from work, and the Smart Electricity Management Device will choose the time to run to minimise your costs by using excess renewable energy produced by your neighbours. This allows you to automate your electricity consumption so that, for example, at times when you or other market participants produce a lot of green electricity, your electronic devices automatically switch on to consume or store this electricity directly, reducing the cost of energy and better utilising local sustainable energy sources.

If you had the opportunity, how likely would you be to use Smart Electricity Management Devices in combination with a peer-to-peer power trading community?

- ○ *Very likely*
- ○ *Likely*
- ○ *Undecided*
- ○ *Unlikely*
- ○ *Very unlikely*

Imagine you have electric heating in your home. What must be the minimum monthly savings for you, to use a Smart Electricity Management Device in combination with a Peer-to-Peer electricity trading community to control your heating? To use surplus renewable energy *generated by your neighbors. Or to profit from fluctuating prices on peer-to-peer electricity market. (Please select)*

- ◯ *0€*
- ◯ *1 €*
- ◯ *2 €*
- ◯ *3 €*
- ◯ *4 €*
- ◯ *5 €*
- ◯ *6 €*
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- ◯ *19 €*

○ *20 €*

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○ *23 €*

○ *24 €*

○ *25 €*

○ *More than 25 €*

Imagine you have an electric washing machine in your home. What must be the minimum monthly savings for you to use a Smart Electricity Management Device in combination with a Peer-to-Peer electricity trading community to control your washing machine? So that the washing machine runs automatically when surplus renewable energy is generated by your *neighbors. Or so that you benefit from fluctuating prices on the peer-to-peer electricity market. (Please select)*

- ○ *0€*
- ○ *1 €*
- ○ *€ 2*
- ○ *3 €*
- ○ *4 €*
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- ○ *19 €*

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- *21€*
- *22 €*
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- *24 €*
- *25 €*
- *More than 25 €*

How much must the minimum monthly savings of all your electrical appliances together (heating, lighting, washing machines, dishwashers, air conditioners, electric car, etc.) be in

€ ? So that you would use Smart Energy Management Devices in combination with peer-to-peer electricity trading. (Please select)

- ◯ *0€*
- ◯ *1 €*
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- ◯ *48 €*
- ◯ *49 €*
- ◯ *50 €*
- ◯ *More than 50 €*