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ORIGINAL ARTICLE

Not all homeowners are alike: a segmentation model based on a quantitative analysis of Dutch adopters of residential photovoltaics

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Abstract The implementation of residential photovoltaics must increase more rapidly to combat climate change and its impacts. This challenge is addressed in this study by introducing a segmentation model in order to develop a theoretical and empirical foundation for understanding the heterogeneity of potential adopters. Data were collected by means of a survey among Dutch adopters (n = 1395) and the data is analysed with statistical descriptive analyses and nonparametric tests. The five segmentation groups are divided by the homeowners' educational background or profession (technical, financial-economic or other) and level of environmental concern. The results demonstrate that the groups are substantial in size and that there are significant differences between these groups on personal characteristics such as homeowners' level of environmental concern and the level of influence of their social network on their decision to adopt. In addition, significant differences are found between the groups on the perceived characteristics of the residential photovoltaics such as perceived complexity and aesthetics, and the amount of previous practice with other energy measures in their home. Accordingly, these insights can be used by policymakers and the public and private sectors to promote residential photovoltaics more effectively by targeting the segmentation groups more adequately. The different groups will be drawn to different aspects and therefore, a broader pallet of benefits must be presented; a mix of different communication channels must be used; objective and non-technical assistance in the decision-making must be offered; and different kind of products must be provided.

Keywords Residential photovoltaics · Private homeowners · Adopters renewable energy · Educational background and profession · Environmental concern · Diffusion of innovations theory

Introduction

To combat climate change, the built environment must reduce its CO_2 emissions by 50% by 2030 (UNEP 2018). The use of residential photovoltaics (RPV) can make a significant contribution in this regard. In addition to enhancing energy security and energy affordability (Bondio et al. 2018; Balta-Ozkan et al. 2015), RPV

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also have economic and employment benefits (SolarPower Europe 2018). However, RPV are far from reaching their full potential. In 2018, photovoltaics[1] accounted for only a small share of 4.5% of the total net electricity generation in the European Union (EU, Jäger-Waldau 2018), whereas rooftop photovoltaics alone have the potential to grow to a quarter of total electricity demand (Bódis et al. 2019). To facilitate this uptake, previous studies have demonstrated that tailoring messages to targeted homeowners is more effective than a 'one-size-fits-all' approach (Wolske et al. 2018; Vasseur and Kemp 2015b; Sachs et al. 2019). However, more insight into potential RPV adopters is needed to make policy actions, communication and marketing campaigns more effective by targeting specific groups (Petrovich et al. 2019).

The diffusion of innovations (DOI) theory (Rogers 2003) has been tested and proved useful for RPV adoption in several studies in the past (e.g. Busic-Sontic and Fuerst 2018; Wolske et al. 2017; A. Palm 2017; Faiers and Neame 2006; Bondio et al. 2018; Vasseur and Kemp 2015a). According to this theory, the personal characteristics of the potential adopter play an important role in the adoption process next to the perceived characteristics of the RPV by the potential adopter. This means that people will evaluate the advantages and disadvantages of RPV in relation to their personal situation (Rogers 2003).

In the past, DOI theory has been used to develop segmentation models in order to gain a better understanding of potential RPV adopters. For instance, Faiers and Neame (2006, (n = 1000)) studied the differences between innovators, early adopters, early majority, late majority and laggards in RPV adoption in Central England. This study demonstrates differences in the perceived RPV characteristics but these findings are not representative anymore as the RPV market has evolved rapidly since then. Vasseur and Kemp (2015b, (n = 817)) investigated the differences between Dutch voluntary and involuntary adopters (when people buy a house with RPV), and potential RPV adopters and rejecters. They found differences in socio-demographic factors (age, level of education, income), level of influence by their social network and level of environmental concern. However, this study does not give a further segmentation of the voluntary adopters. In addition, a study of Sigrin et al. (2015, (n = 1234)) discusses the differences in personal characteristics and perceived RPV characteristics between adopters and non-adopters, early and more recent adopters, and buyers and leasers in the USA. This study reveals differences between the groups on socio-demographic factors (income, level of education, house size); other expectations about expected energy prices in the future; perception of house value after RPV adoption; and differences on how they received their information about RPV. Furthermore, a Swiss study of potential RPV adopters defines a premium segment, who care more about the aesthetic features of RPV (such as coloured or building integrated photovoltaics) and have a higher environmental concern, and a value segment who is more price-sensitive (Petrovich et al. 2019, (n = 408)). Lastly, J. Palm and Eriksson (2018, (n = 58)) investigated the personal characteristics of Swedish (potential) RPV adopters in more depth, and studied the differences between non-adopters, environmentally engaged adopters, a professionally skilled group and accidental adopters and found differences on how these groups found their information about RPV and their level of environmental concern.

Despite these previously developed segmentation models, there are also understudied aspects and aspects with inconclusive results. First, previous studies demonstrate inconclusive results regarding the level of environmental concern and RPV adoption. Some studies demonstrate that a high level of environmental concern will enhance RPV adoption (J. Palm and Eriksson 2018; Petrovich et al. 2019; Vasseur and Kemp 2015b), whereas a quantitative study by Wolske et al. (2017, n = 904), among potential adopters in the USA, demonstrates that pro-environmental norms only indirectly increase the interest in RPV through perceived personal benefits. Moreover, a study by Schelly (2014, n = 48), based on qualitative interviews with RPV adopters in Wisconsin (USA), points out that environmental values alone are not sufficient and/or not always needed for RPV adoption. In view of these inconclusive previous results, more data on this topic are collected in this study by using the homeowners' level of environmental concern as one of the segmentation criteria.

Second, there are only limited studies on the influence of the type of educational background or profession in relation to RPV adoption. There are studies which have studied the level of education in relation to RPV adoption: some studies suggest that people with a higher level of education are more willing to adopt (Schelly 2014; Vasseur and Kemp 2015b; Sigrin et al.

[1] Total of ground-mounted and rooftop photovoltaics.

2015) but other studies do not identify this correlation (Wolske et al. 2017; White 2019) which makes them inconclusive. In addition, these studies did not investigate the nature of the educational or professional background whereas other studies suggest that an interest in technology (Schelly 2014), affinity with energy (Leenheer et al. 2011), a technical background (Broers et al. 2019) or an energy-related profession (J. Palm and Eriksson 2018) can enhance the willingness to adopt RPV. However, these studies are limited in number and the majority of them are qualitative studies with a limited number of respondents. In order to contribute to this literature, we will use the homeowners' educational background and profession (technical[2] and/or financial-economic[3] or other) as one of the segmentation criteria to study the differences between the personal characteristics and perceived RPV characteristics between the groups.

Therefore, this paper aims at developing a segmentation model in order to gain a theoretical and empirical foundation for understanding the heterogeneity of potential RPV adopters. The five segmentation groups are divided by the homeowners' educational background or profession (technical, financial-economic or other) and their level of environmental concern. Data were collected by means of a statistical analysis of an online survey among participants in a Dutch regional RPV project in the city region of Parkstad Limburg in the Netherlands (n = 1395) and the data is analysed with statistical descriptive analyses and nonparametric tests. In our study, we examined the (significant) differences between the segmentation groups in relation to the homeowners' personal characteristics and their perceived RPV characteristics, based on DOI theory (Rogers 2003). The results demonstrate significant differences between the groups and these insights can be used by policymakers and the public and private sectors to promote RPV more effectively by targeting them more adequately.

The paper is structured as follows. The 'The residential photovoltaics market' section presents an overview of the development of the photovoltaics market in Europe and the Netherlands. The 'Diversity of (potential) adopters of residential photovoltaics' section presents a discussion of previous research, while the 'Research method' section presents the research methodology and conceptual framework used in this empirical investigation. The empirical results and analysis are presented in the 'Results' section, while the final section examines these results and makes recommendations.

The residential photovoltaics market

Europe and the Netherlands

In 2018, 19% of the EU's cumulative photovoltaics system capacity was installed on residential rooftops (SolarPower Europe 2018). However, market conditions for RPV differ substantially in the various countries, due to different energy policies, regulations and public support programmes (Jäger-Waldau 2018). The first wave of RPV diffusion was driven primarily by policy incentives[4] (Curtius et al. 2018); nevertheless, such incentives are being increasingly phased out in the light of retail grid parity[5] having been reached in most countries in Western Europe (Petrovich et al. 2019; Karneyeva and Wüstenhagen 2017; Jäger-Waldau 2019; Weiss 2013). In the Netherlands, the dominating energy sources in the central electricity system are natural fossil gas (50.4%) and coal (24.0%, CBS 2020). At the end of 2018, the share of renewables was just 7.4% (CBS 2019a) and photovoltaics account for a relatively small share of 1.9% in the Dutch net electricity generation (Jäger-Waldau 2018), with 57.8% of these photovoltaics being installed on residential rooftops (CBS 2019e). Since 2011, the main incentive for RPV in the Netherlands has been a net-metering scheme[6] (Jäger-Waldau 2019), which will be phased out between 2023 and 2030 (Rijksoverheid 2019b).

[2] Technical education: e.g. technology, industry, engineering, ICT, mathematics, natural sciences. Technical professions: e.g. engineers and technical researchers, specialists in nature and technology, construction workers, metal workers, machine technicians, electricians and electronics technicians, production machine operators, construction and industry auxiliaries, ICT specialists (CBS 2019d).

[3] Financial-economic education: e.g. business administration, trade, financial and business services. Financial-economic professions: e.g. salespeople, purchasers, sellers, business management, commissioners, accountants, financial specialists, accountants, economists, business administration, business services (CBS 2019d).

[4] Examples of these support initiatives are subsidies, tax-benefits and feed-in tariffs (FiT).

[5] Grid parity: achieving a stage of development of PV technology at which it is competitive with conventional electricity sources (Weiss 2013).

[6] Net metering allows consumers who generate some or all of their own electricity to use that electricity at any time, instead of when it is generated.

City region of Parkstad Limburg

In addition to national incentives for RPV, there are also regional and municipal policies aimed at enhancing the adoption of RPV, such as the Solar Panel Project Parkstad (SPPP). This project is used as a case study in this research. At the end of 2016, the city region of Parkstad Limburg in the Netherlands (244,447 inhabitants CBS 2018) launched the SPPP to increase the adoption of RPV among its residents. The SPPP provides an 'all-in-one' offer, including an audit to check individual circumstances and needs[7], purchasing the RPV panels, installing them and offering 15 years of guarantee and service. In addition, participants can make use of a low-interest loan (15 years, 1.5%) offered by the municipalities. Everyone can join the project (enhancing inclusivity) because there is no credit check. Participants who make use of the loan enjoy an immediate financial benefit, because the monthly costs of repaying the loan are lower than the energy savings. The service provider (Volta Limburg) was selected after a tender procedure, and is carrying out the SPPP on behalf of the municipalities. The service provider coordinates the RPV installers and is the first point of contact for all participants. However, the participants sign a contract with the municipality and not with the service provider, which gives the participant more security in the case of a service provider going bankrupt. To reduce the burden on participants, applications for VAT refunds are also organised within the project (Parkstad Limburg 2019).

In 2017, approximately 82.1% of all photovoltaics in the region of Parkstad Limburg were RPV (CBS 2019e). The remainder was placed on other buildings (such as public and commercial buildings) as there is no large ground-mounted photovoltaics park in the region. Figure 1 presents the installed capacity of RPV in 2018 in Parkstad (212.4 W/capita) compared to the average in the Netherlands (134.3 W/capita, CBS 2019c, 2019e). By comparison, the largest RPV capacity per capita in Europe is in Belgium, with 150 W/capita in 2016 (Wilkinson 2018). Notwithstanding the above, the Dutch potential for RPV is much higher, namely 2,386 W/capita (PBL 2014).

Looking at the impact of the SPPP, Fig. 1 indicates that the amount of RPV per capita in Parkstad increased more than at the national level in 2015. This can be explained by the fact that a pilot solar project was launched in one of the municipalities of the city region (Landgraaf) in that year. A strong increase is also visible in 2017, the year in which the SPPP was launched. Figure 2 demonstrates that in 2017 the average national increase was +24.2 W/capita, and in the city region +65.5 W/capita (CBS 2019e, 2019c). The difference can only be partly be justified by the installed capacity in the SPPP in 2017 (namely +24.9 W/capita, Volta Solar 2019; CBS 2019c). The remaining 16.4 W/capita can be explained by the assumption that the project caused a 'spin-off' resulting from the increased media attention, a possible increase in the level of discussion in social networks and the increased visibility of solar panels in the streets. Due to this spin-off effect, the impact of the project is much larger than the project itself. This project demonstrates that an all-in-one offer contributes to a more rapid increase in the adoption of RPV. Due to this success, the project has been copied by various other Dutch municipalities—for example, in Eijsden-Margraten, Schinnen, Stein, Beek, Heumen, Maasgouw, Oss, Roermond and eight municipalities in the southeast Brabant region[8] .

Diversity of (potential) adopters of residential photovoltaics

Personal characteristics

As discussed in the introduction, the homeowners' personal characteristics level of environmental concern and educational background or profession (technical, financial-economic or other) will be used in this study as segmentation criteria to study the differences between the homeowners' personal and perceived RPV characteristics. Previous research has demonstrated that there are several personal characteristics which can influence the RPV adoption. First, numerous studies have been undertaken to study the possible relation between sociodemographic factors and RPV adoption, such as age (Islam 2014; Briguglio and Formosa 2017; Balcombe et al. 2013), household composition (Sigrin et al. 2015; Balcombe et al. 2013) and gender (Leenheer et al. 2011; Tjørring 2016). However, due to substantial

[7] Such as roof size, orientation, technical condition of roof and fuse box, current electricity use, shading of trees or neighbouring objects.

[8] From personal communication with Pim Derwort from the city region of Parkstad Limburg (Jan 2020).

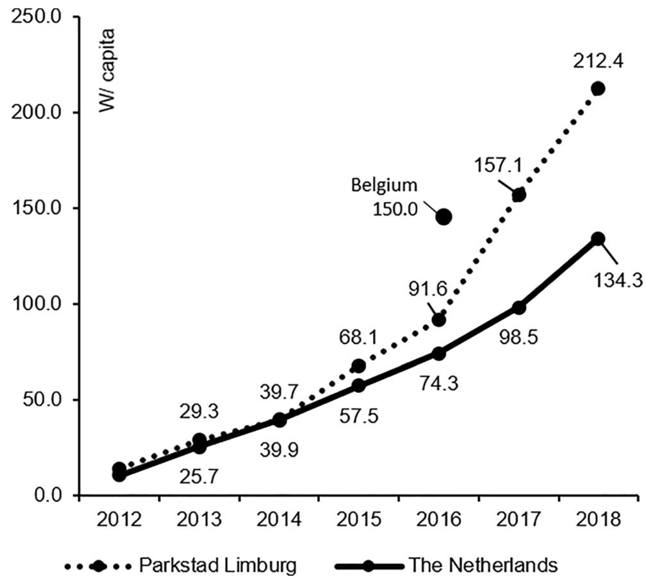

Fig. 1 Yearly average installed capacity RPV per capita in the city region of Parkstad Limburg in comparison with the Netherlands (CBS 2019c, 2019e)

contradictions among the results of these studies, further investigations into these socio-demographic characteristics will be investigated in this study. In addition, the communication behaviour of the homeowner can also be an important factor as previous studies point out (Rogers 2003). First, there is the way in which homeowners receive information about an innovation such as RPV. Previous studies have demonstrated that communication with peers who have already adopted RPV is an important communication channel in the decision to adopt RPV (Baranzini et al. 2017; Fornara et al. 2016; Petrovich et al. 2019; Rai and Robinson 2013; Scarpa and Willis 2010; Sigrin et al. 2015; A. Palm 2017; Bondio et al. 2018; Abreu et al. 2019; Yamamoto 2015; Rai et al. 2016; Wolske et al. 2017; Schelly 2014; Busic-Sontic and Fuerst 2018). Second, after adopting RPV, the adopters can also influence others in their social network by sharing their experiences and acting as an ambassador for RPV (Broers et al. 2019). Therefore, communication behaviour will be studied in more depth in this paper as this is an important influencing factor in the adoption process.

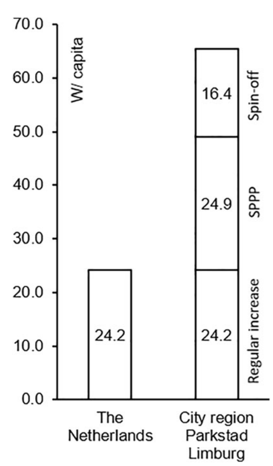

Fig. 2 Increase in RPV in 2017 in the city region of Parkstad Limburg in comparison with the Netherlands (CBS 2019c, 2019e; Volta Solar 2019)

Perceived characteristics

In addition to personal characteristics, the adoption of RPV is also influenced by the way the RPV characteristics are perceived by the potential adopters. This means that the homeowner develops a general perception of the RPV system which will determine the decision to adopt or to reject. Rogers (2003) describes five attributes which can lead to a more favourable perception: (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability and (5) observability (Rogers 2003), but also stresses that other attributes can also be important in different contexts or technologies.

First, RPV must be perceived to have a *relative advantage* over the status quo (Wolske et al. 2017). This can be a financial advantage, which has been studied in numerous previous studies—for example, energy cost-savings (Sigrin et al. 2015; Wolske et al. 2018; Islam 2014; Hille et al. 2018; Bondio et al. 2018; Balcombe et al. 2013; Korcaj et al. 2015); protection against rising electricity prices (Balcombe et al. 2014; Islam 2014; J. Palm and Tengvard 2011; Wittenberg and Matthies 2016; Sigrin et al. 2015; Bondio et al. 2018; Balcombe et al. 2013); or financial incentives (Karneyeva and Wüstenhagen 2017; Simpson and Clifton 2017; J. Palm 2018; Sarzynski et al. 2012; Bondio et al. 2018; De Groote et al. 2016; Sun et al. 2018; Dharshing 2017; Vasseur and Kemp 2011; Balcombe et al. 2013; Schaffer and Brun 2015; Timilsina et al. 2012; Karjalainen and Ahvenniemi 2019). Moreover, the way homeowners perceive these financial-economic factors is important, and therefore, some studies suggest there should be more focus on perceived affordability than on costs alone (Vasseur and Kemp 2015a; Rai and Beck 2015).

In addition, another perceived relative advantage can be gaining identity expression (referred to as 'social status' by Rogers (2003)). Adopters want to express their 'green status' which is especially the case for highly visible innovations such as RPV (Korcaj et al. 2015). Associated with this is the perception of the aesthetic features of RPV, which can also be an important attribute of the RPV system in view of the high visibility aspect. Accordingly, several studies argue that improving the aesthetic features of solar panels is key to expanding the diffusion of RPV (Petrovich et al. 2019; Faiers and Neame 2006; Bao et al. 2017; Hille et al. 2018; Hampton and Eckermann 2013; Balcombe et al. 2013; J. Palm and Tengvard 2011; Vasseur and Kemp 2015b).

Second, RPV are more likely to be adopted if they are perceived to be *compatible* with the homeowners' personal situation, which will make RPV more familiar (Rogers 2003). Previous practice with other energy renovation measures (ERM) can contribute to this (Rogers 2003; Wolske et al. 2017). Nevertheless, technical issues that are encountered when installing RPV can hinder the adoption—for example, not having enough suitable roof-space, or shading from trees and neighbouring buildings.

The third perceived RPV characteristic is the perception of the *complexity* of the RPV technology (Rogers 2003; J. Palm 2018; Karakaya and Sriwannawit 2015)—for example, concerns about the quality of the RPV system or a lack of understanding of the technicalities of the RPV system (Karakaya and Sriwannawit 2015). If the RPV system is perceived as too complex to handle or to implement, it is likely that the homeowner will reject the technology.

Trialabilty is the fourth RPV characteristic. With some innovations it is possible to try out the technology before adopting it (such as a cellphone) but this is not really possible with RPV, except for certain plug-and-play systems. As a result, homeowners will want to reduce their uncertainty relating to making a decision on RPV by seeking social reinforcement and asking peers about their experiences. This can have a positive influence on the decision to adopt RPV, as numerous studies have demonstrated (Baranzini et al. 2017; Fornara et al. 2016; Petrovich et al. 2019; Rai and Robinson 2013; Scarpa and Willis 2010; Sigrin et al. 2015; A. Palm 2017; Bondio et al. 2018; Abreu et al. 2019; Yamamoto 2015; Rai et al. 2016).

Finally, *observability* can also enhance the adoption rate, which means that the technology is visible to other members of the social system—for example, the fact that RPV is visible by people in their social network and in their neighbourhood. This effect will emphasise their 'conferral of status' on potential RPV adopters (Rogers 2003), and therefore, this characteristic is related to identity expression, as discussed earlier, but places more emphasis on 'being part of the group' than on expressing their green status. Observability can increase the probability of further RPV adoptions through interpersonal communication, raised awareness and feelings of perceived social pressure (Busic-Sontic and Fuerst 2018). Wolske et al. (2017) state that seeing others with RPV systems indirectly influences interest by increasing the perceived relative advantage of RPV and reducing the perceived risks. This is also demonstrated in several studies focused on geographical peer effects (Curtius et al. 2018; Bollinger and Gillingham 2012; Graziano and Gillingham 2014; Linder 2013; Rai and Robinson 2013; Richter 2013; Dharshing 2017; Balta-Ozkan et al. 2015; Schaffer and Brun 2015; Müller and Rode 2013; Davidson et al. 2014; Kwan 2012; Busic-Sontic and Fuerst 2018).

Concluding, this study undertakes an in-depth examination of the RPV characteristics perceived by the homeowner in relation to the different segmentation groups based on educational background or profession and level of environmental concern.

Research method

Conceptual framework

The literature review demonstrates that the personal characteristics of potential RPV adopters and the perceived characteristics of the RPV system can influence the homeowners' decision-making process when considering whether to opt for RPV. To our knowledge, no segmentation models for the adoption of RPV have been developed based on educational background or profession and level of environmental concern. We therefore contribute to closing this research gap by introducing a novel segmentation model based on these segmentation criteria. Figure 3 presents the conceptual framework which is based on the previously discussed literature and used to collect and analyse the data. The segmentation model will provide a deeper understanding about the diversity of the personal characteristics of potential RPV adopters and their perceived RPV characteristics.

Data collection and analysis

To gather data, an online survey (setup in Qualtrics) was sent by email to 2787 participants of the SPPP[9] in May 2019, and reminders were sent 1 and 2 weeks later. The survey was first pre-tested on ten RPV owners. This outreach resulted in 1395 fully completed surveys. Due to the fact that only homeowners who responded to the survey were studied, there is a possible selection bias, as this group may not represent the entire sample. The data from the online survey was analysed in IBM SPSS 25 and the significant differences between the segmentation groups were tested with descriptive analyses and nonparametric tests. Kruskal-Wallis tests were used to determine whether there were significant differences ($p < .05$) between the different segmentation groups on the independent ordinal (5-point Likert scale) and scale variables (Kruskal and Wallis 1952). The Kruskal-Wallis test orders the scores from low to high and gives them a ranking number. The ranks were added together within a group, after which the test statistics were calculated. In this case, a high mean score means 'less' and a low score 'more', in terms of the setup of the 5-point Likert scale, where 1 = very much, 2 = quite a lot, 3 = average, 4 = a little and 5 = not at all. Subsequently, Mann-Whitney *U* test pairwise multiple comparisons were carried out as a post hoc procedure to determine between which groups the significant differences occur (Mann and Whitney 1947). In addition, significance values were adjusted by the Bonferroni correction[10] for multiple tests (Bonferroni 1936). To analyse the nominal variables, chi-square tests were performed to determine the significant differences between the segmentation groups, and as a post hoc procedure Pearson's chi-square pairwise tests were conducted, also using the Bonferroni correction for multiple tests.

Results

Sample profile

Table 1 presents the socio-demographic details of the study sample in comparison to the Dutch average. There are significant differences from the Dutch average ($p < .001$) on the socio-demographic aspects of gender, age-groups (25–64 years), household composition and housing type. First, the sample consists of a majority of men (79.6%). A possible explanation could be that men are more interested in RPV and other energy renovation measures as demonstrated in previous studies (Leenheer et al. 2011; Tjørring 2016), but there are also studies that do not report this difference (Wolske et al. 2017). Moreover, our sample also reveals a majority of households of couples (85.9%), and this could therefore also mean that the men were more willing to fill in the survey.

Second, the average age of the respondents was 55 years (min. 24, max. 87), which confirms previous research: Wolske et al. (2017) found a mean age of 56, Balcombe et al. (2013) reported that the group between the ages of 45 and 64 was more aware and had a more positive attitude towards installing RPV, while Vasseur and Kemp (2015b) found that voluntary adopters were located in the age category of 50–59 years. Third, the sample has fewer households with children (41.1%) than the Dutch average (44.3%), which contrasts with earlier research on RPV adoption which reports that households with children are more likely to adopt RPV (Sigrin et al. 2015; Balcombe et al. 2013). Fourth, regarding educational background and profession, the sample reveals significantly more persons with a technical education (39.3%) or profession (29.7%) than the Dutch average (respectively 16.7%, 17.4%, Min. EZK 2019). In addition, the sample demonstrates that 22.4% of the respondents have a financial-economic education and 15.8% have a financial-economic profession. By contrast, 18.5% of Dutch working people had a financial-economic profession in 2018, which is

[9] These are participants who had their RPV system installed in 2017 or 2018.

[10] When conducting multiple analyses on the same dependent variable, the chance of committing a type I error increases, thus increasing the likelihood of arriving at a significant result by pure chance. The significance level for the *p* value is therefore altered by dividing it by the number of tests (10 in this case, $p < .005$).

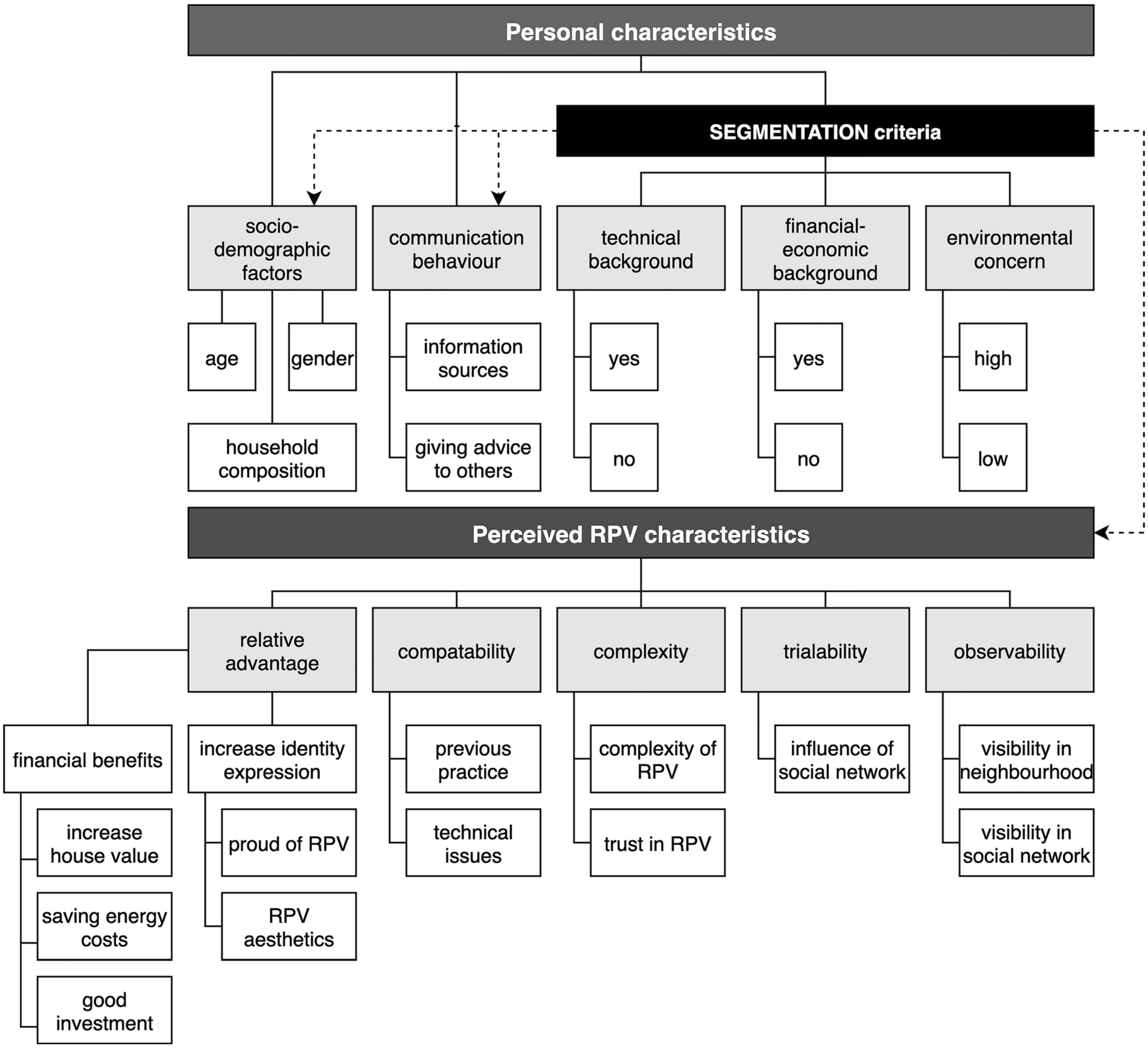

Fig. 3 Conceptual framework for this study, based on the literature review

significantly higher ($p < .01$, CBS 2019d, numbers for education are lacking).

Another consideration to take into account is that the respondents did not necessarily make the decision to adopt RPV on their own. It is very likely that this is a joint decision, made together with their partner and/or family. Whenever that is the case, the profile of the joint decision-maker is also relevant, but these data were not collected in this study. The differences can be explained by the fact that the sample does not represent an average sample of Dutch homeowners of single-family, owner-occupied homes but is made up only of RPV adopters in a certain region. However, the insights into the characteristics of these RPV adopters and their perception of the RPV characteristics can also be relevant for other homeowners whose situation is different (Galvin and Sunikka-Blank 2014; Fawcett and Killip 2014; Berry et al. 2014).

Segmentation groups

The total sample of respondents was divided into five mutually exclusive segmentation groups, based on the segmentation criteria of the conceptual framework (Fig.

Table 1 Socio-demographic characteristics of the study sample compared to the Dutch average (Rijksoverheid 2019a; CBS 2018; Detiger and Oostrom 2019; CBS 2019b; Min. EZK 2019)

	Study-sample (%)	Dutch average (%)	Chi-Square
Gender			501.2***
Female	20.4	50.4	
Male	79.6	49.6	
Age (years) [1]			
< 25	0.1	0.4	3.8
25 - 44	20.5	27.2	31.6***
45 - 64	52.9	46.6	22.3***
≥ 65	26.5	25.8	0.4
Household composition [1]			
Single person household	9.9	17.5	55.9***
Couple without child(ren)	49.0	38.2	69.3***
Household with child(ren)	41.1	44.3	37.0***
Technical background			
Education	39.3	16.7	490.9 ***
Profession	29.7	17.4	146.3 ***
Financial-economic background			
Education	22.4	-	
Profession	15.8	18.5	6.9 **

** $p < .01$, *** $p < .001$

[1] *Dutch average in the group single-family, owner-occupied homes (Min. BiZ, 2019)*

3). Table 2 presents the questions concerning these segmentation criteria: first, the questions about having a technical or financial-economic education or profession; and second, two questions about the respondents' general environmental concern. The last two are measured on a 5-point Likert scale and respondents were considered to have a high environmental concern when they answered 'very much' or 'quite a lot' to one of these two questions. Subsequently, Table 3 presents the five segmentation groups used to analyse the data and explore the possible differences between the groups.

Level of environmental concern and homeowners' background

Figure 4 presents the level of environmental concern in relation to educational background and profession (see Tables 5 and 6 in the Appendix). The statistical analysis demonstrates statistically significant differences between some groups. Group E-T+F reported that it was significantly less environmentally conscious than groups E-T-F and E+T+F ($p < .05$). In addition, group E+T+F found it significantly less important to make a positive contribution to the environment than groups E-T+F and E-T-F ($p < .05$; see Tables 5 and 6 in the Appendix).

In addition, the respondents were asked whether environmental concern was one of their reasons for adopting RPV. An overwhelming number of respondents (63.5%; see Fig. 5b) mentioned environmental concern as one of the reasons for adopting RPV. Concerning differences, the non-environmentalists mentioned environmental concern as a reason for adopting RPV significantly less frequently ($p < .001$; see Fig. 5b) than the other groups. There were no significant differences between the other groups on this aspect, which can be explained by the fact that these groups all had a higher environmental concern than the non-environmentalists.

Personal characteristics of the segmentation groups

First, regarding the socio-demographic differences between the groups, the results of the statistical tests reveal no statistical significant differences in age and household composition (see Table 7 in the Appendix). However, there are significant differences regarding gender. In group E-T-F, there are significantly fewer men (61.1%) than in all the other groups ($p < .001$), and there are significantly fewer men in group E-T+F (77.2%) than in groups E+T-F (98.2%) and E+T+F (96.6%, $p < .001$). Moreover, in group N-E, there are significantly fewer men than in group E+T-F (87.9%; $p < .001$; see

Table 2 Survey questions used as segmentation criteria

Questions	Scale
Do you have a technical education?	Yes/no
Do you have a technical profession?	Yes/no
Do you have a financial or economic education?	Yes/no
Do you have a financial or economic profession?	Yes/no
How environmentally conscious do you find yourself in comparison to others?	Very much*/quite a lot*/average/a little/not at all
How important is it to you to make a positive contribution to the environment?	Very much*/quite a lot*/average/a little/not at all

*High environmental concern

Tables 7 and 8 in the Appendix). This can be explained by the fact that more men opt for a technical education or technical jobs in the Netherlands (Min. EZK 2019).

Second, regarding communication behaviour, the respondents reported that they were initially informed about the SPPP in different ways. Most mentioned people in their social network (37.5%), followed by the project information evening (27.5%), social media or internet (15.6%), the local newspaper (14.8%), while 4.6% mentioned other sources (see Fig. 5a). There are no statistically significant differences between the groups regarding information sources (see Table 7 in the Appendix). Furthermore, after adopting their RPV system, the homeowners can also influence others in their social network by sharing their experiences. Regarding the SPPP, the results reveal that an overwhelming majority of respondents (93.8%) recommended the project to others in their social network (with no significant differences between the groups; see Table 7 in the Appendix). Furthermore, groups E+T-F and E+

Table 3 Segmentation of study sample into five mutually exclusive segmentation groups

		Segmentation groups	High environmental concern	Technical background	Financial-economic background	Number in sample	Share in sample %
	E-T-F	Environmentally motivated people with no technical or financial-economic background	1	0	0	540	38.7
	E+T-F	Environmentally motivated people with a technical background and no financial-economic background	1	1	0	439	31.5
	E-T+F	Environmentally motivated people with a financial-economic background and no technical background	1	0	1	228	16.3
	E+T+F	Environmentally motivated people with a technical and financial-economic background	1	1	1	89	6.4
	N-E	People with a low environmental concern	0	0/1	0/1	99	7.1
		TOTAL				**1395**	**100.0**

1= yes; 0 = no

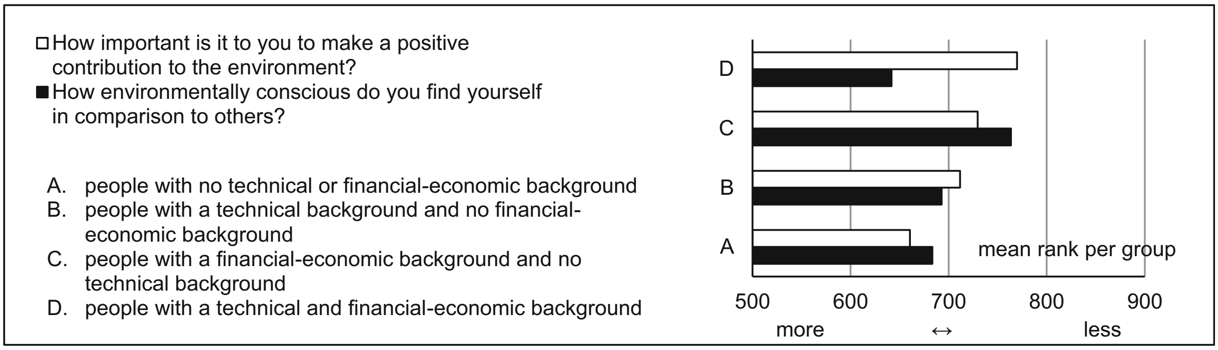

Fig. 4 Level of environmental concern in relation to educational background and profession (mean rank per group)

T+F advised others in their social network about energy renovation measures significantly more than the other groups ($p < .001$), which is probably related to their technical background and expertise.

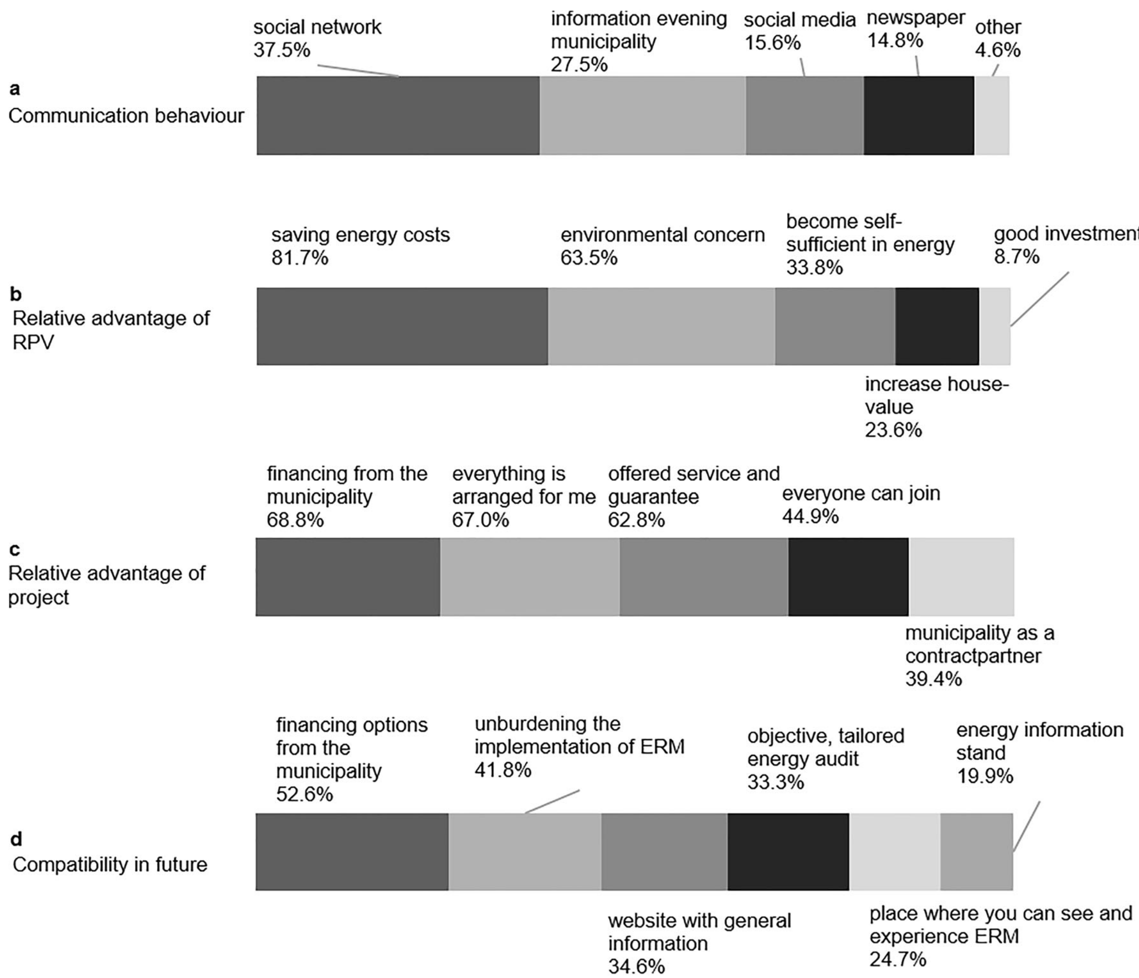

Fig. 5 *Descriptive study results of the nominal variables.* ***a*** *Communication behaviour: respondents' initial information sources about the project.* ***b*** *Relative advantage of RPV: reasons for adopting residential photovoltaics (multiple options possible).* ***c*** *Relative advantage of project: appreciated aspects in the project (multiple options possible).* **d** Compatibility in future: future help wanted from the municipality (multiple options possible)

Perceived characteristics

Relative advantage of the project The SPPP was appreciated highly by the respondents; they graded the project with an average of 8.3/10, with no significant differences between the segmentation groups. There were also no significant differences between the groups on whether the project met their wishes and expectations (see Table 9 in the Appendix). Figure 5c demonstrates that various different aspects were appreciated in relation to the SPPP (multiple options possible): financing from municipality (68.8%), everything is arranged (67.0%), offered service and guarantee (62.8%), everyone can join (44.9%), and municipality as contract partner (39.4%). There was only one significant difference: group E-T+F found the aspect that everyone can join significantly less important than group E-T-F ($p < .001$; see Fig. 6a and Tables 7 and 8 in the Appendix).

Relative advantage of residential photovoltaics Figure 5b reveals that, in addition to environmental concern (mentioned by 63.5%), financial motives for adopting RPV were mentioned frequently by the respondents: saving energy costs (81.7%), increasing house value (23.6%) and seeing it as a good investment (8.7%). There were no statistically significant differences between the groups on these aspects (see Table 7 in the Appendix). In addition, there were no significant differences on perceived advantage of the RPV system and perceived increased house value after implementing RPV (see Table 9 in the Appendix). In addition, the results demonstrate that the non-environmentalists were significantly ($p < .001$) less proud of their RPV system than the other groups (see Tables 9 and 10 in the Appendix). This could be explained by the fact that this group displayed less environmental concern and therefore found a 'green image' less important. In addition, group E-T+F liked the aesthetics of their RPV significantly less ($p < .001$) than group E+T-F (see Fig. 6c and Tables 9 and 10 in Appendix).

Compatibility To investigate the compatibility of RPV with other energy measures, respondents were asked whether they had implemented other energy renovation measures. More than half (52.9%) of the respondents had done so in the past 5 years. From this group, 53.0% had installed insulation, 43.8% high-efficiency glazing, 48.8% a high-efficiency gas-boiler, 2.7% a heat-pump and 1.9% a thermal solar collector. This demonstrates that the level of adoption of more innovative technologies was much lower for this group (except for RPV). Group E-T-F had installed significantly less ERM than groups E+T-F and E+T+F, and group E+T+F had installed more ERM than groups E-T+F and N-E ($p < .001$; see Fig. 6b and Tables 9 and 10 in the Appendix). This demonstrates that individuals with a technical background had more previous experience with installing comparable measures. In addition, the majority (84.3%) experienced no technical problems when installing their RPV system, with no significant differences between the groups (see Table 7 in the Appendix).

To investigate how the perceived compatibility for implementing other energy measures in the future could be enhanced, the participants were asked how the municipality could help them in thefuture. Figure 5d presents the following aspects: financing options (52.6%), unburdening the implementation of ERM (41.8%), website with general information (34.6%), objective, tailored energy audit (33.3%), place where you can see and experience ERM (24.7%) and an energy information stand (19.9%). However, there were no significant differences between the segmentation groups on these aspects (see Table 7 in the Appendix).

Complexity Figure 6d indicates that group E-T-F found their RPV system significantly more complicated than the other groups ($p < .001$), except for group E-T+F. In addition, group E-T+F found their RPV system more complex than groups E+T-F and E+T+F ($p < .001$). Furthermore, the non-environmentalists trusted their RPV system significantly less than group E+T-F ($p < .001$; see Tables 9 and 10 in the Appendix). This demonstrates that people with a technical background or profession find their RPV system less complicated, which could be an important influencing factor to enhance adoption (Rogers 2003).

Trialability and observability As stated before, 37% of the respondents stated that they were informed about the SPPP by people in their social network (no significant differences between groups). This is in line with multiple other studies that communication with peers who have already adopted RPV can influence the decision to adopt RPV positively (Baranzini et al. 2017; Fornara et al. 2016; Petrovich et al. 2019; Rai and Robinson 2013; Scarpa and Willis 2010; Sigrin et al. 2015; A. Palm 2017; Bondio et al. 2018; Abreu et al. 2019; Yamamoto 2015; Rai et al. 2016; Wolske et al. 2017;

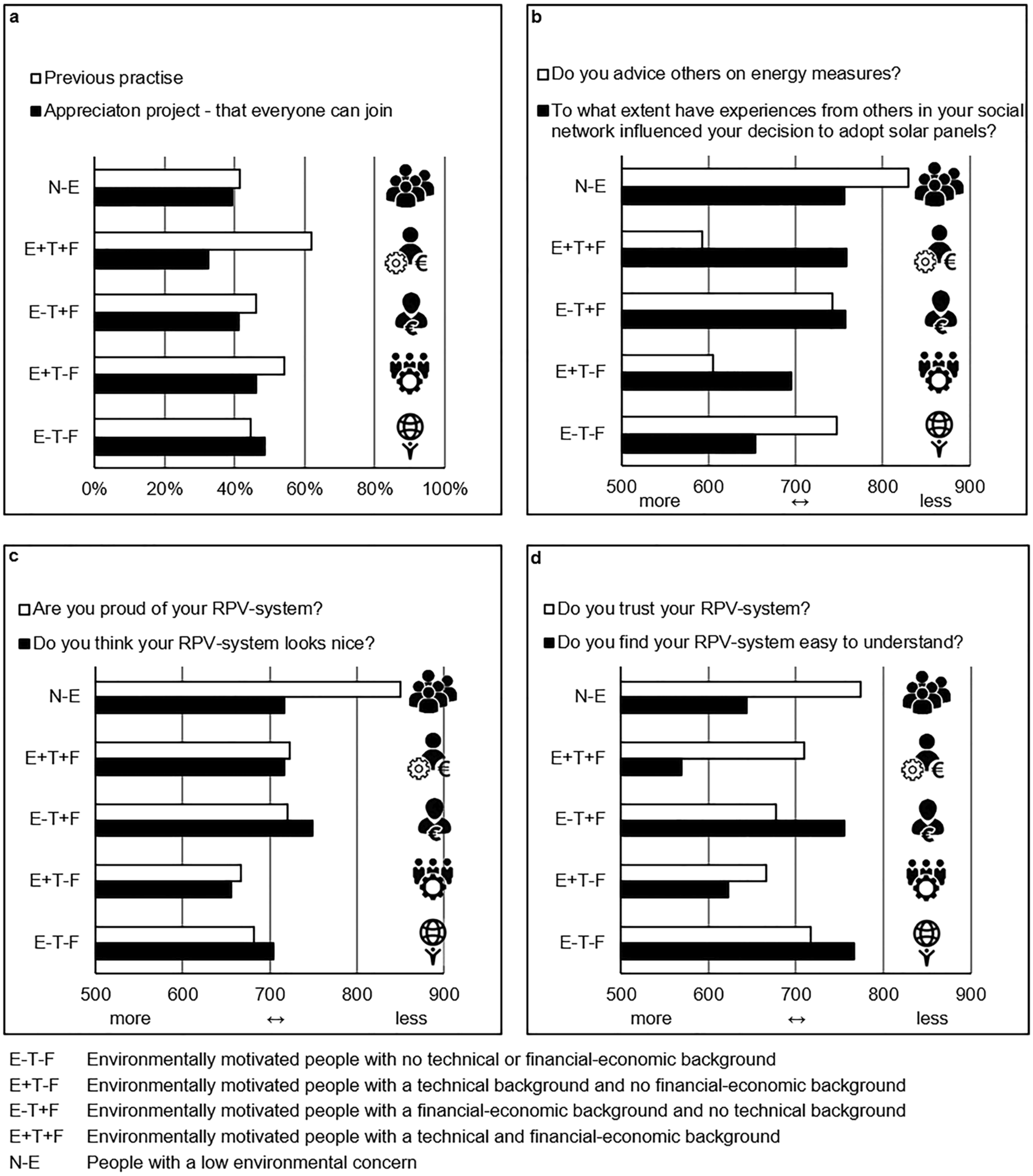

Fig. 6 *Statistical study results of nominal and ordinal variables with significant differences between the segmentation groups ($p < .05$). **a** Compatibility and relative advantage of project: percentage per segmentation group for appreciation project and previous practice. **b** Communication behaviour and trialability: mean rank per segmentation group for communication behaviour. **c** Relative advantage of RPV: mean rank per group per segmentation group for perceived aesthetics and proudness. **d*** Complexity: mean rank per segmentation group for perceived complexity and trust

Schelly 2014; Busic-Sontic and Fuerst 2018). The results demonstrate that group E-T-F had been significantly more influenced by others in their social network than group E-T+F ($p < .001$; see Fig. 6b). In addition, there were no statistically significant differences between the segmentation groups for the visibility of RPV in their social network and neighbourhood (see Tables 9 and 10 in the Appendix).

Discussion and conclusions

The uptake of residential photovoltaics must increase more rapidly to combat climate change and its impacts. In order to address this issue, this study aimed to gain a better understanding of the heterogeneity of potential RPV adopters in order to make policy actions, communication and marketing campaigns more effective by targeting specific groups. We developed a segmentation model based on data from a survey of RPV adopters in the city region of Parkstad Limburg in the Netherlands, and identified five substantial segmentation groups based on people's type of educational background or profession (technical, financial-economic or other) and level of environmental concern. First, environmentally motivated people with no technical or financial-economic background (38.7%); second, environmentally motivated people with a technical background, but no financial-economic background (31.5%); third, environmentally motivated people with both a technical and a financial-economic background (16.3%); fourth, environmentally motivated people with a financial-economic background, but no technical background (6.4%) and fifth, people who are less environmentally motivated (7.1%). The results demonstrate that there are significant differences between these groups relating to personal characteristics and their perception of the RPV characteristics (see Table 4). This segmentation model makes a contribution to the literature which adds insights to the research on RPV adoption by households. Recommendations are made per segmentation group in the sections below, based on these results. This is so that they can be targeted more effectively by policies and the private sector in order to increase the uptake of RPV.

Relative advantage of the project

One mechanism by which local governments can increase RPV adoption is by removing relevant barriers for homeowners (White 2019). The regional SPPP demonstrates that this kind of project (the all-in-one offer) can have a significant impact on the diffusion of RPV: the project caused a significant increase in RPV adoption in the region compared to the national increase. There was also the 'spin-off' effect, which is presumably caused by increased media attention, peer effects and increased visibility in the region. Moreover, the project was highly appreciated by the participants, especially the all-in-one offer of the municipalities, which is something that has been suggested previously for the wider scope of energy renovation measures (Mahapatra et al. 2019). In addition, other benefits of the project are reduced carbon emissions, increased energy security, decreased energy bills, local economic activity and job opportunities. Due to this success, the project has been copied by several other municipalities in the Netherlands.

The all-in-one offer in the SPPP was highly appreciated by the participants. First, the financing (low-interest loan) offered by the municipality. This loan addresses the perceived high upfront costs that are often mentioned in other research as an important barrier (Wolske et al. 2018; Hille et al. 2018; Scarpa and Willis 2010; Islam 2014; J. Palm 2018; Karakaya and Sriwannawit 2015; Balcombe et al. 2013, 2014), and confirms other studies which suggest that leasing systems can help to grow the RPV market (Sigrin et al. 2015; Rai and Sigrin 2013; Liu et al. 2014). Moreover, this loan—without the credibility check—makes RPV also available for people with a lower income and will therefore contribute to the inclusivity of RPV. Second, the majority of the respondents appreciate that everything is arranged for them in the project, from start to finish. Other studies have argued that the complexity of administrative procedures and comparing quotes from different companies can be a barrier for the uptake of RPV (J. Palm 2018; Karteris and Papadopoulos 2012; A. Palm 2017; J. Palm and Eriksson 2018). All these aspects are organised for the participants in this project. Third, the offered guarantee and service within the SPPP addresses concerns about increasing maintenance costs, which is mentioned in other research as an important barrier (Claudy et al. 2013; Rai et al. 2016; Balcombe et al. 2013). Fourth, the respondents mention that the fact the municipality is the contract partner and not the company as an advantage. Contractors are often seen as unreliable and non-transparent by homeowners, which can hinder the uptake of RPV (Abreu et al. 2019; Knudsen 2002; Margolis and Zuboy 2006; J. Palm and Eriksson 2018). Difficulties in finding trustworthy, transparent and impartial information are mentioned as a significant barrier complicating the adoption of RPV (Balcombe et al. 2014). Having the municipality as a contract partner in the SPPP reduces these perceived risks for homeowners, as the former is regarded as a neutral party which provides objective and transparent information (Wolske et al. 2017).

Table 4 Overview of statistical study results. Statistically significant differences between segmentation groups are marked with an 'x' ($p <$ .05, after Bonferroni correction)

	Characteristic	Question		E+T	E-T+F	E+T+F	N-E
Personal characteristics	Socio-demographic characteristics	What is your gender?	E-T-F	X	X	X	X
			E+T-F		X		X
			E-T+F			X	
			E+T+F				
	Communication behaviour	Do you advise others on energy measures?	E-T-F	X		X	
			E+T-F		X		X
			E-T+F			X	
			E+T+F				X
Perceived RPV-characteristics	Relative advantage – project	Reason for participation in project - environmental concern	E-T-F				X
			E+T-F				X
			E-T+F				X
			E+T+F				X
		Appreciation project - that everyone can join	E-T-F			X	
			E+T-F				
			E-T+F				
			E+T+F				
	Relative advantage – RPV	Do you think your RPV system looks nice?	E-T-F				
			E+T-F		X		
			E-T+F				
			E+T+F				
		Are you proud of your RPV system?	E-T-F				X
			E+T-F				X
			E-T+F				X
			E+T+F				
	Complexity	Do you find your RPV system complicated?	E-T-F	X		X	X
			E+T-F		X		
			E-T+F			X	
			E+T+F				
		Do you trust your RPV system?	E-T-F				
			E+T-F				X
			E-T+F				
			E+T+F				
	Compatibility	How many other ERM did you install the past five years?	E-T-F	X		X	
			E+T-F				
			E-T+F			X	
			E+T+F				X
	Trialability	To what extent have experiences of others in your social network influenced your decision to adopt solar panels?	E-T-F		X		
			E+T-F				
			E-T+F				
			E+T+F				

Segmentation model

Compared to other developed segmentation models for RPV adoption, this model provides a segmentation of RPV adopters based on educational background or profession and level of environmental concern. The study findings reveal significant differences between the segmentation groups concerning personal characteristics and RPV characteristics perceived by the homeowners.

First, the group of *environmentaly motivated people with no technical or financial-economic background (E-T-F)* displays similarities with the 'environmentally engaged adopters' group discussed in the segmentation study of J. Palm and Eriksson (2018) because both groups often find information about RPV too technical and complicated. To counter this, a clear explanation about the operation of the RPV system must be given, in a less technical way, to reduce the level of complexity of the system that they perceive. In addition, this group is more influenced in their decision-making process by the experiences of RPV adopters in their social network. Therefore, this group can be targeted more effectively by making use of existing social networks to promote RPV. This supports previous literature which reports that potential adopters look for assurance from trusted sources such as neighbours, family and friends (Baranzini et al. 2017; Fornara et al. 2016; Petrovich et al. 2019; Rai and Robinson 2013; Scarpa and Willis 2010; Sigrin et al. 2015; A. Palm 2017; Bondio et al. 2018; Abreu et al. 2019; Yamamoto 2015; Rai et al. 2016; Wolske et al. 2017; Schelly 2014; Busic-Sontic and Fuerst 2018).

Another significant feature of this group is that they mention environmental concern for RPV adoption more often than those with a low environmental concern. Therefore, it can be effective to emphasise the environmental benefits in communication and marketing campaigns for this group. This is also suggested in other research, but for a broader group (Bondio et al. 2018; Wolske et al. 2018; Vasseur and Kemp 2015b; Wolske et al. 2017; Leenheer et al. 2011; Tjørring 2016; Schelly 2014; J. Palm 2018; Wittenberg and Matthies 2016; Sun et al. 2018). However, framing RPV only as an environmental decision may limit the adoption by less environmentally minded people (Schelly 2014), and communicating a broader pallet of RPV benefits is recommended to overcome this. Lastly, as this group finds it more important that everyone can join, inclusivity can be organised and highlighted clearly in communication and marketing campaigns.

Second, the group of *environmentally motivated people with a technical background and no financial-economic background (E+T-F)* bears a resemblance to the 'professionally skilled' group in the segmentation study by J. Palm and Eriksson (2018), because both groups demonstrate more knowledge about RPV and find their RPV system less complex than the other groups. This group can be targeted more effectively by emphasising the technical specifications of the RPV system. The study results also demonstrate that this group has more previous practice with other energy measures, and also has more experience in advising people in their social network. Based on the above, this group can be used and facilitated by policymakers and companies as an ambassador for energy renovation measures such as RPV. For the third group, the—*environmentally motivated people with a technical and financial-economic background (E+T+F)*, the same recommendations can be made as for the prior group.

Fourth, the group of *environmentally motivated people with a financial-economic background and no technical background (E-T+F)*. The results demonstrate that these people have a lower environmental concern than others. This (cautiously) confirms studies from other fields which demonstrate that students majoring in financial-economic disciplines display lower environmental scores than students with other university majors (Hodgkinson and Innes 2001; Smith 1995; Tikka et al. 2000; Lang 2011; Sherburn and Devlin 2004; Thapa 2001). In addition, this group finds inclusivity (everyone can join) in a project less important. Consequently, these two aspects can be highlighted less in communication and marketing to target this group more effectively.

In addition, this group reveals that they like the aesthetics of their RPV system less, which corresponds with the 'early majority' group identified by Faiers and Neame (2006), as they also find their RPV system visually less attractive. In addition, this group demonstrates similarities with the 'premium segment' identified by Petrovich et al. (2019), because the latter is more interested in colour or building integrated photovoltaics and is willing to pay more for these. Therefore, offering aesthetically more attractive photovoltaics could enhance the RPV uptake by this group. Lastly, this group finds their RPV system more complex, and therefore, a clear, less technical explanation about the operation of the RPV system must be given to increase their comprehensibility of the system, as for the other groups with no technical background.

Lastly, *the group of less environmentally motivated people (N-E)*. They can be targeted more effectively by placing less emphasis on the environmental benefits in communication and marketing campaigns and more on a broader pallet of RPV benefits. The results also demonstrate that this group is less proud about their RPV system, which suggests that they are less interested in increasing their 'identity expression' when installing RPV (expressing 'green status'). In addition, they trust their system less, which can be countered by a clear explanation of both the RPV system and the conditions of joining the project. Finally, the results demonstrate that this group has less experience in installing other measures in their home.

Communication strategies

The results demonstrate that the five segmentation groups have to be targeted in different ways to make policies, communication and marketing campaigns more effective. The different groups will be drawn to different aspects in a campaign and therefore, a broader pallet of RPV benefits must be presented (e.g. environmental and financial benefits). The specific aspects that trigger certain people are not mutually exclusive, and attention must therefore be devoted to all those aspects so that people can select for themselves which criteria are relevant for them. The potential RPV adopters with a technical background can be specifically targeted by sharing technical information and reviews in technical magazines and by means of information stands at local hardware stores. Existing social networks can be used to promote RPV—for example, neighbourhood and music associations and sport and recreation clubs. The findings reveal that this is especially effective for people with no technical or financial-economic background, as they put more trust in their peers when making a decision. For instance, local governments could make it possible for people with a technical background to advise others on RPV in their social networks. In addition, people without a technical background could be unburdened by offering them objective assistance in the decision-making process—in particular with the comparison of offers and by giving a clear, less technical explanation about the operation of the RPV system. A local government or non-profit organisation could offer such a service. Furthermore, communication campaigns could reach out to potential adopters who already have adopted other energy measures in their home. Lastly, the uptake by people with a financial-economic background could be enhanced by offering aesthetically more attractive photovoltaics.

Limitations and implications for further research

Even though the presented segmentation model was developed from empirical evidence relating only to RPV adopters in a certain region and in a specific municipal project, the insights into the characteristics of these RPV adopters and their perception of the RPV characteristics could also be relevant for other homeowners whose situation is different or for other energy-saving household technologies such as energy renovation measures or the use of electric cars. Nevertheless, follow-up studies could include non-adopters, other regions, other contexts and an investigation of other educational backgrounds and professions. Extending the scope of data collection could generate further elaboration of this model and could include other energy-saving household technologies. In addition, the sample consists of a large number of respondents with a high environmental concern, which would be different when non-adopters are included. The group of non-environmentalists and the group with another background than technical or financial-economic could also be divided into subgroups in follow-up studies.

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Declarations

Conflict of interest The authors declare no competing interests.

Appendix. Statistical results

Table 5 Statistical tests among groups based on educational background and profession

Question	Ordinal scale	Kruskal-Wallis *U*	Mean rank per group A	B	C	D
How environmentally conscious do you find yourself in comparison to others?	Very much*/quit a lot*/average/a little/not at all	10.54*	683.30	692.87	763.45	641.79
How important is it to you to make a positive contribution to the environment?	Very much*/quit a lot*/average/a little/not at all	12.53**	660.58	711.63	729.61	769.70

A = persons with no technical or financial-economic background

B = persons with a technical background and no financial-economic background

C = persons with a financial-economic background and no technical background

D = persons with a technical-economic background

*$p < .05$

**$p < .01$

***$p < .001$

B: significant ($p < .05$) before Bonferroni correction

Table 6 Pairwise follow-up tests (Mann-Whitney *U*)

		B	C	D
Environmental consciousness in comparison to others	A	135,171.50	62,577.50*	25,738.00
	B		53,586.50 B	21,385.50
	C			9,832.50*
Importance making a positive contribution to the environment	A	127,182.00B	63,535.50 B	22,986.00*
	B		58,270.00	21,258.00
	C			11,225.00*

Table 7 Statistical test results nominal variables

Question	Nominal scale	Pearson chi-square
Personal characteristics		
What is your household composition?	Single person/single with child(ren)/with partner/with partner and child(ren)	16.72
What is your gender?	Man/woman	227.62***
Did you recommend the project to others?	Yes/no	2.94
Compatibility		
Did you experience technical difficulties when installing RPV?	Yes/no	6.72
Communication behaviour		
How were you initially informed about the project?	Information evening municipality/social network/newspaper/radio/-tv/social media/other	22.74
Relative advantage		
What was your reason for participating in the project? (multiple options possible)		
Making a positive contribution to the environment	Yes/no	61.29***
Saving energy costs	Yes/no	10.55*
Good investment	Yes/no	2.00
Increase house value	Yes/no	7.80
Become self-sufficient in energy	Yes/no	0.77
What do you appreciate most in the project? (multiple options possible)		
Financing from the municipality	Yes/no	9.40
Municipality as a contract partner	Yes/no	5.87
Everything is arranged for me	Yes/no	7.48
Everyone can join	Yes/no	11.29*
Offered service and guarantee	Yes/no	8.19
How can the municipality help you to make your home even more energy-efficient in future?		
Financing options from the municipality	Yes/no	5.18
Unburdening the implementation of ERM	Yes/no	10.10*
Website with general information	Yes/no	5.64
Objective, tailored energy audit	Yes/no	3.87
Place where you can see and experience the ERM	Yes/no	5.20
Energy information stand	Yes/no	8.35

Table 8 Pairwise follow-up tests nominal variables (Pearson chi-square)

		E+T-F	E-T+F	E+T+F	N-E
Gender	E-T-F	192.21***	18.45***	43.04***	26.44***
	E+T-F		80.77***	0.87	23.94***
	E-T+F			16.86***	5.01
	E+T+F				4.89
Reason participation in project - environmental concern	E-T-F	0.98	0.08	4.04 B	56.42***
	E+T-F		0.26	1.97	45.18***
	E-T+F			2.68	42.10***
	E+T+F				16.20***
Reason participation in project - saving energy costs	E-T-F	4.89	0.86	2.19	2.35
	E+T-F		0.71	0.03	6.85 B
	E-T+F			0.53	3.90 B
	E+T+F				5.35 B
Appreciation project - that everyone can join	E-T-F	0.70	3.60	7.98***	2.91
	E+T-F		1.39	5.42 B	1.43
	E-T+F			2.01	0.10
	E+T+F				0.94
Future help from municipality - unburdening the implementation of ERM	E-T-F	0.10	5.75 B	0.31	2.37
	E+T-F		6.61 B	0.14	2.90
	E-T+F			4.02 B	0.03
	E+T+F				2.49

Table 9 Statistical test results ordinal variables

Question	Ordinal scale	Kruskal-Wallis *H*	Mean rank per group				
			E+T-F	E-T+F	E+T+F	N-E	N-E
Relative advantage							
Did the project meet your wishes and expectations?	Very much/quite a lot/average/a little/not at all	4.44	683.80	693.71	723.44	676.15	755.54
If you could give the project a rating, what would it be?	Scale (1–10)	8.11	723.15	700.61	672.09	682.94	615.44
Do you think your house value has changed after installing your RPV system?	Increased a lot/increased slightly/no change/decreased slightly/-decreased a lot	2.46	696.05	700.78	679.25	695.35	741.86
Do you think your RPV system gives you an advantage?	A lot of advantage/quite an advantage/fairly an advantage/somewhat of an advantage/no advantage	5.44	676.15	705.87	707.30	701.43	757.75
Do you think your RPV system looks nice?	Very nice/nice/fairly nice/somewhat nice/not nice at all	10.78*	704.48	655.40	749.11	716.39	717.32
Are you proud of your RPV system?	Very proud/proud/fairly proud/somewhat proud/not proud at all	19.86**	681.71	667.13	720.23	722.76	850.26
Observability							
Were there many solar panels visible in your neighbourhood before you had yours installed?	Very much/quite a lot/average/a few/none	8.66	663.60	717.51	711.28	704.44	762.77
Trialability							
To what extent have the experiences of others in your social network influenced your decision to opt for solar panels?	Very much/quite a lot/average/a little/not at all	16.78**	654.26	695.28	757.52	759.13	756.64
Were there people in your social network who already had solar panels before you decided to have them installed?	Very much/quite a lot/average/a few/none	11.33*	663.14	701.66	719.90	783.24	744.87
Complexity							
Do you find your RPV system complicated?	Not/only a little/fairly/complicated/very complicated	58.31***	766.61	621.92	755.95	568.63	643.98
Do you trust your RPV system?	Very much/quite a lot/average/a little/not at all	11.41*	716.55	666.55	677.22	708.89	774.37
Compatibility							
How many other ERM did you install the past five years?	Scale	21.19***	663.70	737.71	673.59	819.42	656.06
Personal characteristics							
What is your age?	Scale (0–100)	5.41	698.75	717.68	680.66	725.31	622.02
How much knowledge do you have about ERM?	Very much/quite a lot/average/a little/not at all	104.16***	785.33	582.65	778.36	529.92	699.20
Do you have to deal with sustainability when performing your work?	Very often/quite often/average/-sometimes/never	130.19***	639.42	408.59	554.58	390.55	510.43
Do you advise others on energy measures?	Very often/quite often/average/-sometimes/never	58.83***	747.54	605.86	742.08	592.97	829.26

Table 10 Pairwise follow-up tests nominal variables (Mann-Whitney *U*)

		E+T-F	E-T+F	E+T+F	N-E
Relative advantage					
Do you think your RPV system looks nice?	E-T-F	110,257.50 B	57,665.50	23,643.00	26,237.00
	E+T-F		43,312.50***	17,765.00	19,897.00
	E-T+F			9632.50	10,775.00
	E+T+F				4398.50
Are you proud of your RPV system?	E-T-F	115,991.00	58,126.50	22,624.50	20,235.50***
	E+T-F		46,206.50	17,993.00	16,099.00***
	E-T+F			10,101.00	9127.00***
	E+T+F				3616.50 B
Trialabilty					
To what extent have the experiences of others in your social network influenced your decision to opt for solar panels?	E-T-F	111,494.00	52,407.50***	20,496.50 B	22,830.00 B
	E+T-F		45,546.00 B	17,736.00	19,798.50
	E-T+F			10,072.50	11,278.50
	E+T+F				4371.00
Were there people in your social network who already had solar panels before you decided to have them installed?	E-T-F	111,939.50	56,564.00	19,882.00 B	23,640.50
	E+T-F		48,727.50	17,216.00	20,383.50
	E-T+F			9242.00	10,868.00
	E+T+F				4191.00
Complexity					
Do you find your RPV system complicated?	E-T-F	94,121.00***	60,429.00	17,205.50***	22,045.50***
	E+T-F		40,315.00***	18,099.00	21,035.00
	E-T+F			7364.00***	9456.00 B
	E+T+F				3934.50
Do you trust your RPV system?	E-T-F	110,037.00 B	58,079.50	23,775.5	24,516.50
	E+T-F		49,265.50	18,362.00	18,370.50***
	E-T+F			9688.50	9706.00 B
	E+T+F				3998.50
Compatibility					
How many other ERM did you install the past five years?	E-T-F	105,870.50 ***	60,680.50	18,694.50 ***	26,377.00
	E+T-F		45,412.50 B	17,171.50	19,228.00
	E-T+F			8031.00***	10,981.50
	E+T+F				3413.50***
Personal characteristics					
How much knowledge do you have about ERM?	E-T-F	83,645.00***	60,951.00	15,414.00***	23,683.00 B
	E+T-F		35,811.00***	17,711.00	18,387.50 B
	E-T+F			6616.00***	10,120.00
	E+T+F				3417.00***
Do you advise others on energy measures?	E-T-F	94,412.00***	61,051.00	18,704.00***	23,528.50 B
	E+T-F		40,219.50***	19,163.00	14,854.00***
	E-T+F			7967.50***	9839.50 B
	E+T+F				2935.00***

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