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What is the Profile of the Investor in Household Solar Photovoltaic Energy Systems?

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Abstract: The implementation of energy-efficient systems in homes is of interest to many people, especially regarding the use of solar photovoltaic (PV) energy systems. Solar PV generation is essential worldwide because it is a significant source of renewable energy, wherein electricity can be stored for future use, and a cost-effective path for residential consumers. In contrast, considering the number of people who invest in PV systems versus those who do not, adherence is significantly unequal throughout society. Accordingly, predominant factors exist that increase the likelihood of residential PV solar power generation system adoption, which are seen as opportunities to increase energy efficiency. Furthermore, the literature is still insufficient regarding the exploration of variables that determine decisions around the purchase of green power generation systems. From this perspective, the current research aims to identify the socio-psychological profile of photovoltaic energy investors by applying four questionnaires, namely, psychological values, the human–nature relationship, motivation analyses, and household characteristics. The research results define the profile and motivations of green energy investors. The attitudes of potential investors are also predicted, and this research contributes to the development of the photovoltaic energy industry production chain by providing relevant information for better photovoltaic policy design and more targeted marketing strategies for companies.

Keywords: solar energy; small-scale generation; investors; socio-psychological; human–nature

1. Introduction

Electricity is essential to sustain all economic activities. However, if current trends continue, global energy demand is expected to double by 2050 [1]. With this significant increase, non-renewable environmental resources are likely to become increasingly scarce [2,3]. This scenario favors the development of renewable generation technologies with low environmental impacts, such as solar photovoltaic (PV) energy [4]. Therefore, solar energy is one of the leading energy sources in the transition from the use of fossil fuels to renewable sources in order to reduce the environmental impacts associated with climate change and the dependence on fossil fuels [5–8]. In this context, small-scale electricity generation systems using photovoltaic solar sources represent an option in the transition to household energy, thereby helping the diversification of the global energy matrix [9]. However, the power sector is changing so fast that policymakers are finding it hard to keep up.

The transition to household energy depends on changes in people's behavior, thoughts, and norms. Therefore, although there are several government incentives, the success of these green technologies depends on individuals' decisions to adopt them [10,11]. This decision is linked to behavioral traits [12], thus showing the importance of understanding investor behaviors [13–15]. Socially responsible consumption refers to the behavior and purchasing decisions of the investor that reduce environmental or social problems [16]. Academic researchers are focusing on green investor studies that address the power of cultural values to investors [17]. Although sustainable development has been widely studied throughout recent decades, information regarding consumer preferences for new environmentally and socially friendly technologies remains relatively untapped [12,18]. Most research is inconclusive when it comes to understanding investor behavior [19]. Alrawl's study [20] stated that there was a pressing need to better understand consumption patterns and find possible solutions for more efficient use. Through behavioral analysis, determinants can be identified that influence green consumption [21].

Previous studies primarily investigated the investor's willingness to pay for renewable electricity, with little research focusing on the motivations behind these investments [13,22]. Reference [19] examined the experiences of residential investors from southeast Queensland in Australia in the acquisition and use of photovoltaic solar energy. Reference [23] defined the factors that affected motivations to install photovoltaic systems in Dutch homes. The only study that sought a more in-depth understanding of investor behavior was carried out by Braito et al. [24], who aimed to identify the socio-psychological profiles of individual and collective investors in the Bolzano/South Tyrol province (Italy) and in the Styria province (Austria). However, no methodology was identified to examine the correlations between psychological and human–nature relationship profiles and motivational factors that influence household investment in renewable energy generation. Research involving the motivational factors and profiles of these investors has not yet been applied to regions of the American continent.

Thus, the research question of this article is: What is the profile of the investor in household solar photovoltaic energy systems? It is assumed there is a socio-psychological profile associated with these investors, and that this profile is related to motivation. These motivations may include an economic advantage, environmental appeal, and social acceptance (status), among others. Furthermore, profile differences in relation to household characteristics of investors may also become apparent.

This paper contributes to the broader literature on investor profiles by highlighting the situation in Brazil. The main contributions are: (1) The result of this research is relevant to companies in the photovoltaic electricity generation chain, which have found a lack of knowledge of the buyer's profile to be one of the most significant barriers to sales, according to [25]; (2) considering that there no research has examined the profile of investors in relation to household photovoltaic energy, this study offers a significant contribution to the better understanding of the profile of these investors; and (3) more detailed knowledge regarding the preferences that motivate acquisition can also contribute to better policy design toward photovoltaic energy and marketing strategies in this sector.

This paper is organized in four sections. The second section presents the method of the study, with a description of the study variables and the questionnaires applied. The third section contains results and discussions, where we present the scenario of the study and the results of the applied questionnaires. Finally, in Section 4 presents the conclusions of this study.

2. Method for Studying Investors Profile

The first step in our methodology was to choose to focus on behavior. Studies regarding the profile of investors and identification of their common behaviors were read until we were able to select the materials to design our methodology. The mixed-method of this research involved four main perspectives: (1) Social and personal behavior, measured by the validated Portrait Value Questionnaire (PVQ); (2) environmental behavior, measured by the questionnaire Human–Nature Relationship (HNR); (3) the personal motivation to complete the household energy transition using solar photovoltaic systems; and (4) the investigation into leading household characteristics. The second step was to select investors of household photovoltaic systems and to apply the four questionnaires. The third step was to calculate the Cronbach's alpha to evaluate the reliability of the responses, and then to statistically analyze the results. Finally, the results were discussed through the analyses obtained from the four applied questionnaires. It was possible to provide the profile of the investors in solar household photovoltaic energy using this methodology.

The following sections present a description of the study variables and questionnaires used to discover the profile of photovoltaic investors.

2.1. Description of Study Variables

To answer the research question of this study, the necessary variables were identified, as listed in Table 1. The data collection of these variables was performed using four questionnaires, with the aim of obtaining a more connected explanation between the transition of the power generation model and the individual determinants of people's behaviors and thoughts. However, this was not easy, as human behavior is complex. The use of the four questionnaires enriched the discussion of the results and allowed for a more coherent analysis regarding investor decision-making. This was done from four perspectives, namely, portrait value, the human–nature relationship, motivations of the investor, and household characteristics. The Portrait Value Questionnaire and the Human–Nature Relationship questionnaire are explained in the next two sections. The questionnaire that sought to understand the motivations regarding installation was developed by [24]. The questionnaire that covered the household characteristics was developed in this study. As behavioral factors are considered to be future drivers of a society that are closely linked to environmental behaviors, knowing the profile of a society has the potential to define the future of electricity and needs to be taken into account.

Table 1. Specifications of variables.

Questionnaires	Variable Name	Measurement	Questions
Portrait Value	Personal focus	5-point Likert scale	Twenty-one sentences developed by Reference [26], Appendix A.
	Social focus		
Human–Nature Relationship	Anthropocentric		Twenty-six sentences developed by Reference [27], Appendix B.
	Ecocentric		
Motivation	Investment opportunity		Five sentences developed by Reference [24], Appendix C.
	Low effort		
	Neighborhood effect		
	Environment protection		
	Decentralized electricity generation		
Household characteristics	City	Discrete	What is the city of your installation?
	Age	Continuous	How old are you?
	Gender	Discrete	What is your gender?
	Level of education	Discrete	What is your level of education?
	Purchasing power	Discrete	What is the monthly family income?
	Number of people in the house	Discrete	What is the number of people in the house?
	System coverage on demand	Discrete	What is the approximate percentage that the installed system covers from your power bill?
	Family origin	Discrete	What is the cultural background of your family?

2.2. Portrait Value Questionnaire

The Schwartz Theory was developed in 1992 in order to identify a set of basic values recognized by society. Schwartz defined these values and organized them into a system to help explain the decision-making, attitudes, and behaviors of individuals [28]. The theory identified ten basic personal values that were recognized between cultures and explained the origin of these values [29]. Table 2 presents these values, which were grouped according to personal focus or social focus.

Table 2. The ten basic personal values.

PVQ Type		PVQ Description
Personal focus	Power	Social status and prestige, control, or dominance over people and resources
	Achievement	Personal success through demonstrating competence according to social standards
	Hedonism	Pleasure and sense of gratification for oneself
	Stimulation	Excitement, novelty, and challenge in life
	Self-direction	Independent thought and action—choosing, creating, exploring
Social focus	Universalism	Understanding, appreciation, tolerance, and protection for the welfare of all people and nature
	Benevolence	Preservation and enhancement of the welfare of people with whom one is in frequent and personal contact
	Tradition	Respect, commitment, and acceptance of the customs and ideas that traditional culture or religion provide
	Conformity	Restraints of actions, inclinations, and impulses likely to upset or harm others and violate social expectations or norms
	Security	Safety, harmony, and stability of society, of relationships, and of self

Source: [26].

There are two ways to measure basic values: the Schwartz Value Survey or the Portrait Values Questionnaire (PVQ). The present study used the PVQ. The PVQ includes short verbal portraits of 20 questions where each passage describes the goals, aspirations, or desires of a person that implicitly point to the importance of a value [29,30]. For each portrait, respondents answer the question: "How much like you is this person?" Responses range from "very much like me" to "not like me at all".

To analyze these values, Schwartz created a circular structure based on the possibility of two values being compatible or incompatible. Values with correlating motivational goals were close and values that had contrasting motivational goals were opposite [31]. Based on this, the ten basic values were grouped into four motivational values, i.e., the opposition between self-transcendence (universalism and benevolence) and self-enhancement (power and achievement), and the opposition between openness to change (hedonism, stimulation, and self-direction) and conservation (tradition, conformity, and security) [28,29,31]. Schwartz's model was confirmed by over 200 samples from 60 countries spanning every continent [30]. Samples from different geographic regions, languages, religions, ages, sexes, and occupations were (already) used for validation (or confirmation) of the model [31].

2.3. The Human–Nature Relationship Questionnaire

The Human–Nature Relationship (HNR) is a general construction of abstract worldviews, values, beliefs, attitudes, and norms of how humans should interact and behave with nature [27]. Flint et al. [32] studied the different typologies of the HNR and Braito et al. [27] developed what is here presented as Table 3, which describes portraits that characterize the seven different profiles of the HNR.

Table 3. Narratives portraying each Human–Nature Relationship (HNR) type's characteristics.

HNR Type		HNR Description
Anthropocentric	Apathy	In their daily life, nature does not play a role. They think they are not dependent on nature to survive. In their opinion, their behavior does not have an impact on nature. They think that engagement for the benefit of nature should not be given too much weight.
	Master	They think they have the right to alter nature. Technological progress enables them to control and improve upon nature. They believe they have the right and obligation to protect themselves from natural threats.
	User	They perceive nature to be a provider of products and services. In their opinion, natural processes enhance economic welfare. They think they have the right to use nature and to enhance natural service provision with technology. They feel responsible to protect nature for today's and future generations' welfare.
Ecocentric	Steward or Guardian	They think their actions may have an impact on nature. They feel responsible to protect nature. They think that mankind can be a threat to nature. They would like technological interventions to be regulated in order to minimize negative effects on nature.
	Partner	Nature is important and enjoyable for them. They try to understand natural processes in order to reflect on their influence on nature According to them, technological interventions are allowed only in cases where both humans and nature benefit. Humans and nature are of equal value.
	Participant	They feel like part of nature. The physical and emotional bond between self and nature is important for them. They think that too few humans recognize the power, value, and beauty of nature. According to them, they do not have the right to use technology to alter nature.
	Nature Distant Guardian	Pets, houseplants, or urban gardening may substitute for their direct experience in nature. Exclusive engagement in nature protection through media is enough for them to connect with nature. An environmentally-oriented lifestyle may help them to become part of nature without having to leave the city.

Source: [27].

The portraits of Table 3 were constructed using the questions asked in the questionnaire, a total of 26 questions. It is important to note that through the study of [27], it was understood to be possible to correlate the PVQ and the HNR, due to the research question "What correlations exist between individuals' understanding of their relationship with nature and their environmental behavior?" In this paper, this correlation is analyzed in Section 3.6.

3. Results and Discussion

This section has six parts: The study scenario, a descriptive analysis of household characteristics, the results of the motivation questionnaire, the results of the Portrait Value Questionnaire, the results of the Human–Nature Relationship, and the statistical analysis of the resulting correlations.

3.1. Scenario of the Study

Electricity generation from solar sources has great potential in Brazil [6]. The geographical location of the country is suitable for the capture of solar energy because almost all of its territory is located between the Tropics of Cancer and Capricorn, where the degree incidence of solar rays is almost perpendicular, thereby favoring high levels of solar irradiation [33,34]. The average annual irradiation in Brazil varies between 1200 and 2400 kWh/m^2/year, which is above the European average [35,36]. Yet, the country's installed capacity for photovoltaic energy generation is lower than other countries [37,38].

In 2012, the National Electric Energy Agency (ANEEL) regulated small-scale power generation with distributed generation using the Net Metering System. These installations were of a distributed type, since they were connected to the distribution network. According to ANEEL, there was a total of 86,622 of these generation systems in June 2019, corresponding to 918,121 kW of power [39]. From 2017 to 2018, distributed small-scale energy generation grew by 151% [39]; therefore, it can be concluded that photovoltaic energy generation is rapidly growing. Using the ANEEL database [39], where all home-generation units using technical data of the operating system are noted, it was possible to identify possible interviewees for this study. In addition, it is noteworthy that the database does not indicate any socio-economic characteristics of investors, therefore the interviewees were selected according to the installed power limit, up to 5 kWp. In total, this survey included 114 respondents. These respondents may represent the entire Brazilian territory and other countries with similar economies, such as the MERCOSUR countries (Argentina, Brazil, Paraguay, Uruguay and Venezuela).

3.2. Descriptive Analysis of Household Characteristics

The results showed that 85% of respondents were men, which could be explained by the fact that families that invest in photovoltaic systems generally belong to a patriarchal family model. As the application of the research was in Brazil, this result is justified, since we still live in a society that follows this model [40,41]. While research around eco-consumerism has suggested that women are generally more aware or concerned about environmental issues, when it comes to new technologies, these results tend to be different [42]. According to studies carried out regarding the gender difference in risky investments, men and women behave differently in their decision-making, with men more likely to invest in riskier businesses [43,44]. According to Reference [45], photovoltaic installation is characterized as a risky investment, thereby justifying the higher percentage of male respondents in the (proposed) questionnaire.

Moreover, Reference [44] cited that people who were part of larger families were also more willing to take on riskier investments. Reference [46] reported that the adoption of photovoltaic systems was more common in larger houses. Our study results confirm this, as 48% of respondents had at least four people residing in the photovoltaic installation home. This result may have been due to several factors, including available space, increased energy use, or a larger household income [47]. Households with more residents tend to use more energy, which may increase the importance of one's own electricity generation in the home. These factors contribute to a greater motivation to install microgeneration systems. Our study showed that people with a high level of education had greater adherence to this technology, as 58% of respondents had completed higher education. This result was in agreement with the fact that people with higher education levels demonstrated less resistance toward risky investments [44]. The index factor of education was also intrinsically coupled to the income of investors, because higher education levels tended to accompany investors with higher incomes, thereby facilitating investment in these systems.

The adoption of new technology tended to be used less by older people, as they were often more reluctant to change and adopt new technologies than younger people [48]. They used an electrical system that worked for many years, so why they should change? These individuals were generally not willing to risk their security for something different [47]. Furthermore, they also did not expect to recover their investment during occupation of their home [49]. However, among the study interviewees, 43% were between 36 and 45 years old, which could considered to be the life stage in which people have financial stability, with fixed jobs and structured families. These characteristics also allowed a greater possibility for these people to obtain bank financing for system installation.

Regarding the relationship between consumer income and the use of photovoltaic energy, 60% of respondent families had an income above nine minimum wages, considering that this wage range corresponds to classes A and B in Brazil [50]. That is, around 40% of families that opted to make the investment did not have a high purchasing power; this may have been due to the financial incentives available for the development of photovoltaic energy in the country, where families have the option to pay the financing with their energy bill savings. These investors are likely to behave rationally in a traditional economic way and expect a high and secure return on their investment [51].

Our results showed that 50% of the investors observed decreases in their electricity bills from 80% up to 100%, that is, half of the people interviewed opted for a system with the capacity to generate enough electricity to supply the total consumption of their residence. This was justified by a financial factor, whereby, due to constant increases in the energy tariff price, the investor sought to generate all or most of the electricity that they consumed [47].

The family culture question was a factor that presented expressive values, where approximately 94% of the respondents had a European culture, of which 47% had a German culture and 36% had an Italian culture. These families followed these cultures because their ancestors were often of European origin. These numbers were quite curious, since Germany and Italy have 40.988 MWp and 19.251 MWp in installed capacity, respectively, whereas, in Brazil, where the solar resource is more favorable, the solar energy capacity is only approximately 23 MWp [38]. Germany is among the world leaders regarding the development and integration of renewable energies, in particular in the area of photovoltaic (PV) systems. More than half of the expansion until 2015 took place in this country's low-voltage grids, amounting to a total of 22 GW [52]. For the most part, the expansion of photovoltaics at the low-voltage level was in relation to small-scale systems, which was a unique characteristic of the German energy transition. Studies that were interested in understanding the profile of German residences that invested in small-scale systems stated that a majority of investors used simple decision rules, such as calculating payback time or relying on their gut feelings, when making investments [53]. Given the Brazilian regulations for small-scale systems, cultural issues may be associated with the two characteristics determined in the German study [53], i.e., "local patriots" regarding the analysis of the sustainable social profile and "yield investors" regarding the analysis of the financial return of a house PV system.

A more similar approach to that of Brazil was taken regarding the analysis of Italian-descent investors, considering the behavior of small-scale systems in Italy. The penetration of photovoltaic (PV) generation in the Italian distribution and transmission grid significantly increased until 2015 [54]. However, a PV market decrease in Italy was observed in the last year due to the closure of the feed-in-tariff contribution from the Italian government. Reference [55] evaluates how solar irradiation affected both the profitability and overall cost of the subsidy of PV projects for Italian consumers, mainly driven by a significant feed-in-tariff scheme that was adopted previously. Like Brazilian regulations, Italians were motivated to invest in PV systems by subsidies on electricity tariffs.

For these reasons, the relationship between the profile of Brazilian investors of German and Italian descent is discussed.

3.3. Motivation Questionnaire Results

There are several motivations associated with the adoption of photovoltaic systems mentioned in the literature. According to the results obtained, some are more prominent than other, as shown in Figure 1, where the y-axis represents the arithmetic mean of the responses and standard deviation, and the bars are the five investigated investment motivations.

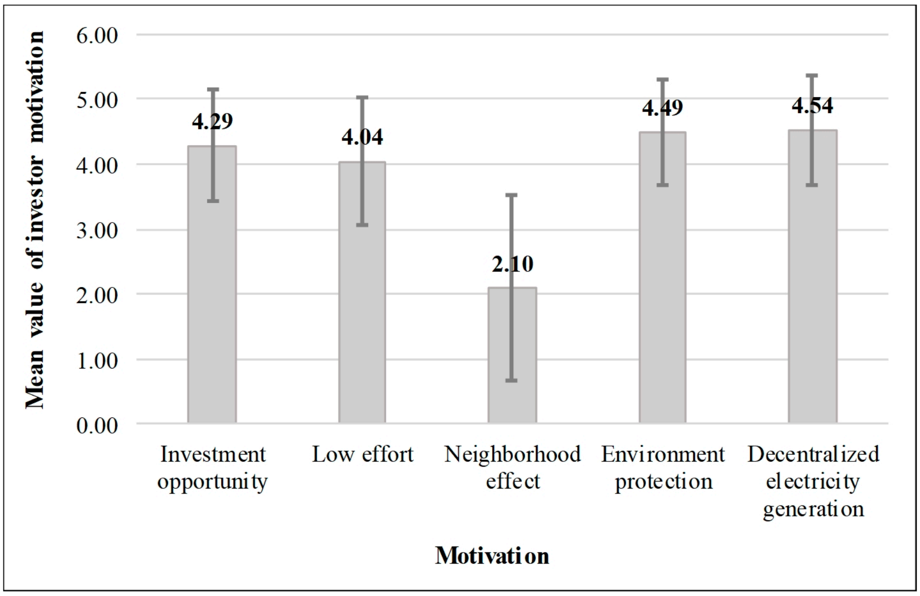

Figure 1. Motivation profile.

Therefore, the decision to install a photovoltaic system on the roof of a house was found to be motivated by several factors [47,56]. The concept of the installation being seen as an investment opportunity also proved to be a relevant factor in investors' decisions, where the individual sought to save money by buying less electricity from the grid [46]. This was seen as a way to both reduce costs from electric energy bills and to protect against future high energy costs [57]. With the cost reductions in equipment associated with the maturation of the photovoltaic energy market, investment in this technology became more attractive. The financial aspect was a relevant factor, but was not the only one that mattered when making this decision [23,56]. The simplicity of the system's installation process required little effort and was considered agile; the fast results of this technology was considered to be a motivating factor for investment. Short installation time was reported as an important factor in the decision to adopt a photovoltaic system [56]. The neighborhood effect factor led to an increase in photovoltaic installations in a given location, due to visibility of the installation, word-of-mouth from neighbors, family, and friends, and social pressure. Due to installation by neighbors, installations within the same neighborhood radius increased because individuals were able to see the benefits of the systems first-hand and want the benefits for themselves [58]. Another motivation was environmental protection, i.e., the investor's desire to be ecologically correct. Because small-scale generation was seen as environmentally friendly, probably due to it being an energy source without carbon dioxide emissions [47], people with a greater environmental conscience had a greater intention to install photovoltaic systems [59]. Among the motivations identified, one could highlight the search for independence regarding energy generation; investors are motivated to protect themselves against increases in electricity bills. With their own generation system, individuals aim to be less susceptible to future increases in energy prices [47].

3.4. Portrait Value Questionnaire Results

The answers obtained via the Portrait Value Questionnaire allowed us to understand which socio-psychological standards played a significant role in photovoltaic system investment decisions. Figure 2 shows the radar chart of the arithmetic mean of the responses, where the gray lines represent the mean values added and subtracted from the standard deviation (σ). From the analysis of the values, it was observed that the average focus of the respondents was social, since values such as universalism, benevolence, and security were selected as "like me" by the vast majority of respondents. In opposition to the social focus, personal focus was not frequent among the respondents, and values such as power and stimulation, most participants responded that they were "a little like this".

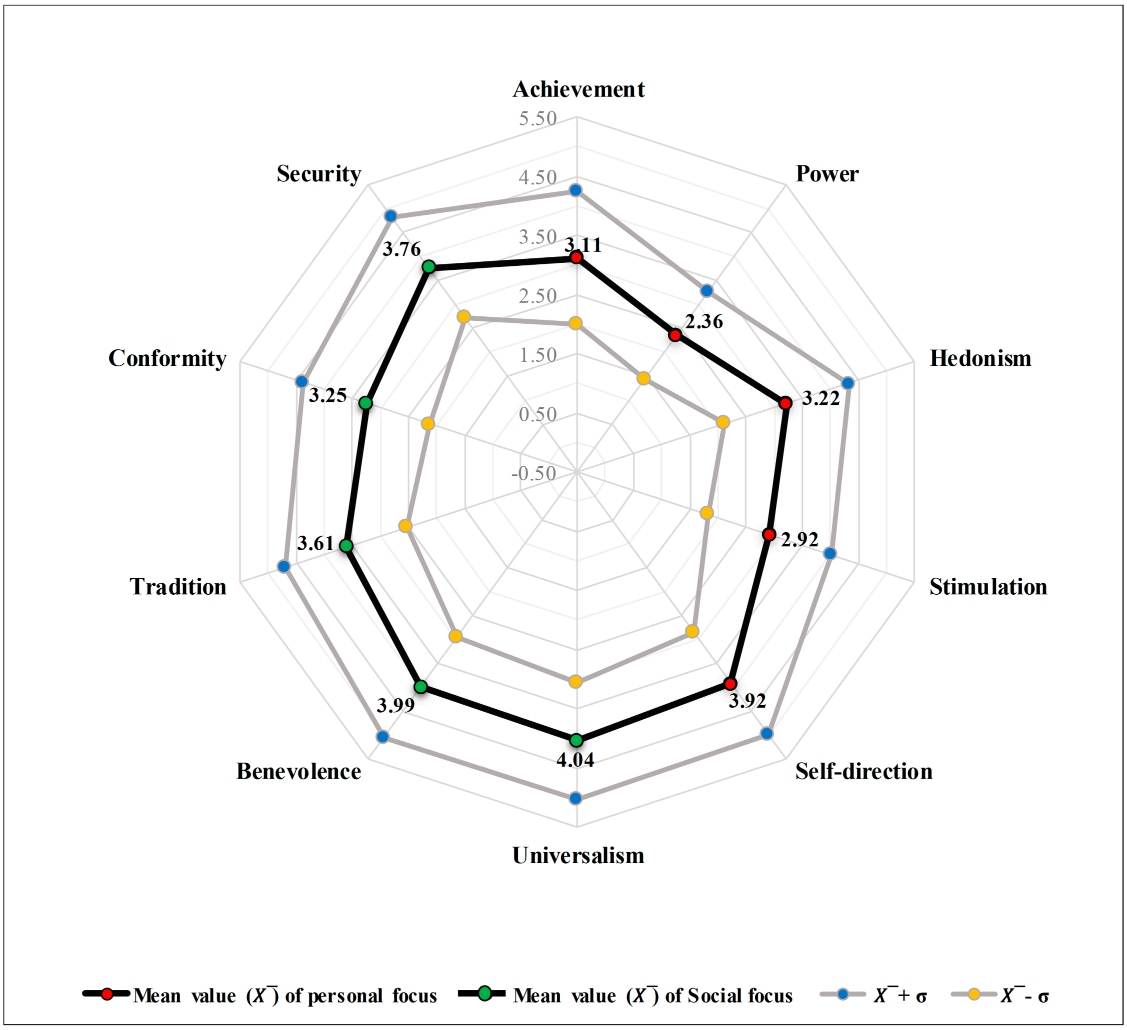

Figure 2. Value profile of respondents.

The results showed that investors were characterized as independent individuals by enhancing the value of self-direction, meaning that they were people who made their own decisions. That is, they did not make decisions motivated by quick or affective reactions or due to the influence of others [60]. Investing in this technology was still a decision-making process, because people who decided to invest in household PV systems expressed the self-determination personality characteristic, that is, the ability to regulate and adapt their own behavior to the demands of a situation to achieve goals and maintain personal values.

The participants analyzed in the present study reported universalism as being a relatively important value. This value is related to a concern for all well-being, people, and nature. Universalism is linked to the survival needs of humans and to the importance of appreciation of the natural environment to sustain life [28]. These people generally perceive that a failure to protect the environment will lead to the destruction of resources on which life depends. Another very respected value was benevolence, which resembles the universalism, as it also values the welfare of others.

According to the circular structure proposed by Schwartz, the values of universalism and benevolence make up the self-transcendence factor, which expresses interests and social characteristics. Within this focus, people who express self-transcendence values are more likely to show altruistic, cooperative, or environmentally-conscious behaviors than people who express self-enhancement values [61]; individualism and materialism are very present characteristics in today's society [62].

Schwartz et. al [61] mentioned that people with self-transcendence characteristics, that is, values such as universalism and benevolence, were more likely to exhibit cooperative or environmentally-conscious behaviors than self-enhancement-focused people, who tend to value power, achievement, and hedonism. Our results confirmed what this structure proposed, that values with similar objectives are close and values with conflicting motivational objectives are opposite. The values of self-realization and power were little respected by investors, and it is these values that make up the self-enhancement motivational category.

3.5. Human–Nature Relationship Results

In the second part of the research, we used the Human–Nature Relationships questionnaire, which was developed with the objective of proving that an individual's behavior is linked to the relationship they have with nature. Figure 3 shows the radar chart of the arithmetic mean of the responses, where the gray lines represent the mean values added and subtracted from the standard deviation (σ). By analyzing the results in Figure 3, it can be seen that, on average, respondents demonstrated ecoconstrution characteristics, whereby the majority answered "similar to me" on the nature guardian question.

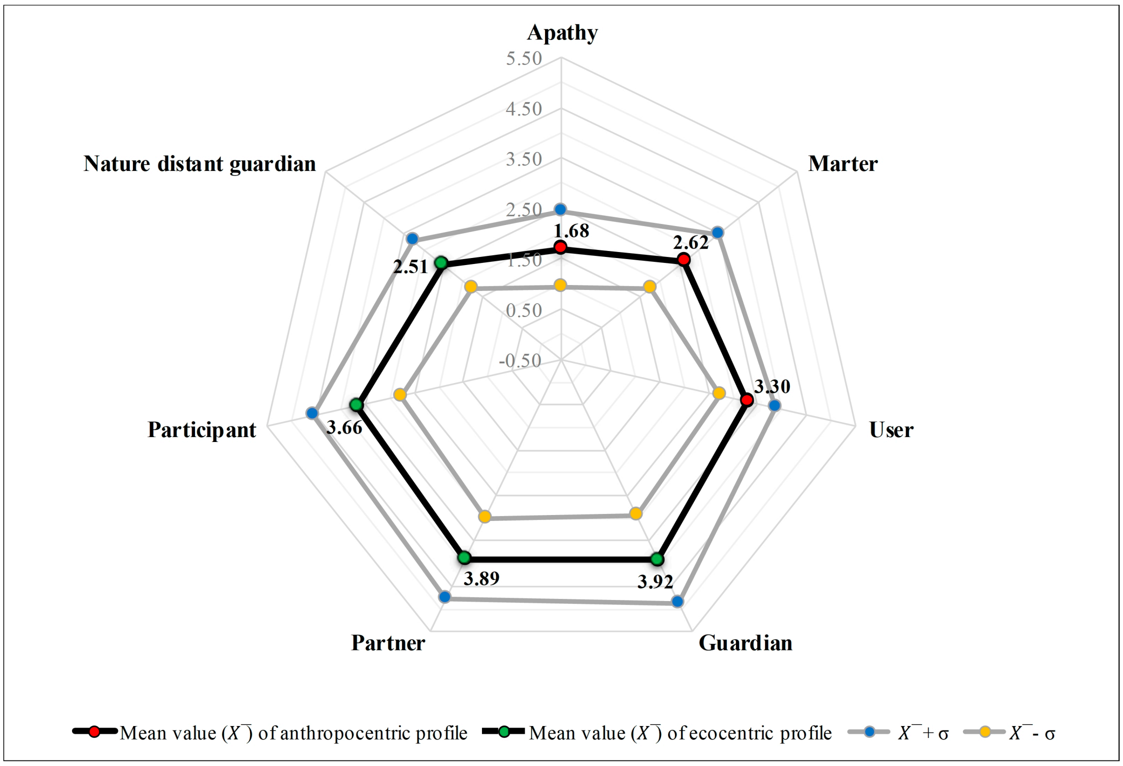

Figure 3. Human–nature relationship profile of respondents.

In this part of the study, investors had a strongly ecocentric profile, which presents values centered on nature. According to Dunlap [63], ecocentrism represents the degree to which one becomes aware of environmental problems and makes an effort to engage personally with environmental issues. Ecocentric people see a strong connection between humans and nature, arguing that nature has its own right to exist independently of human inhabitants' well-being [64]. These people tend to exhibit less apathy for ecological concerns and are more likely to express conservation behavior. Investors feel responsible for nature, and most consider themselves nature guardians. The characteristics of partner and participant were also highlighted in the responses, showing that photovoltaic system investors value their physical and emotional involvement with nature and recognize that they are part of nature and that their actions have impact on it. Therefore, those who had a relationship with the environment and nature tended to play an important role in the decision to save energy and use alternative forms of energy [59,65].

As expected from this study, investors did not fit the anthropocentrism focus. Anthropocentric individuals tend to express more environmental apathy and are less likely to exhibit conservative behavior [66]. They see nature as a resource to explore, valuing the instrumental power that nature offers to improve their quality of life [67]. Faced with this, in opposition to anthropocentrism, investors in photovoltaic energy are ecocentric, since they do not exhibit characteristics of environmental apathy.

3.6. Correlation

The Pearson coefficient was calculated to understand the relationship between the PVQ and HNR variables for the sample ($n = 114$). The objective was to verify if both questionnaires revealed similar links, that is, if specific values were correlated via specific relationships with nature. Table 4 shows the identified correlations; all correlations in bold were considered to be significant, with significance levels of $p < 0.01$ (*), $p < 0.05$ (**), or $p < 0.1$ (***).

Table 4. Correlation between Portrait Value Questionnaire (PVQ) and HNR variables.

Variables		Anthropocentric			Ecocentric			
		Apathy	Master	User	Guardian	Partner	Participant	Distant
Personal focus	Power	−0.017	0.132	0.096	**0.185 ** **	0.141	0.087	**0.176 *** **
	Achievement	0.024	0.031	0.060	**0.273 * **	**0.294 * **	**0.240 *** **	0.084
	Hedonism	−0.010	0.004	**−0.314 * **	**0.437 * **	**0.388 * **	**0.472 * **	**0.194 ** **
	Stimulation	−0.004	−0.044	**−0.204 ** **	**0.434 * **	**0.415 * **	**0.449 * **	0.098
	Self-direction	0.030	**0.257 * **	**−0.216 ** **	**0.598 * **	**0.608 * **	**0.586 * **	0.113
Social focus	Universalism	−0.038	0.073	**−0.454 * **	**0.661 * **	**0.677 * **	**0.619 * **	**0.174 *** **
	Benevolence	0.001	**0.177 *** **	**−0.365 * **	**0.632 * **	**0.586 * **	**0.557 * **	0.148
	Tradition	0.124	0.079	**−0.387 * **	**0.429 * **	**0.397 * **	**0.440 * **	**0.337 * **
	Conformity	0.035	0.075	**−0.225 ** **	**0.378 * **	**0.372 * **	**0.378 * **	**0.183 *** **
	Security	0.004	0.121	**−0.350 * **	**0.565 * **	**0.537 * **	**0.538 * **	**0.264 * **

* $p < 0.01$, ** $p < 0.05$, *** $p < 0.1$.

Table 4 indicates that HNR and the basic values of PVQ were remarkably compatible. The Human–Nature results presented a negative correlation predominantly between the values of social focus, that is, the more the individual regarded themselves as a person of nature, the lower his social focus score. On the contrary, the relationship of guardian of nature presented a positive correlation with the values of the PVQ, and the strongest correlations were associated with the values of self-direction (enjoying thoughts and independent actions), universalism (supporting the well-being of people and nature), benevolence (providing well-being to others), and security (security, harmony, and stability of society). This means that the more a person holds these values in high regard, the more concerned with nature they are; when a person cares about society, guarding nature for the next generations becomes essential for personal self-realization. These same conclusions could be drawn from the HNR partner and participant relationships, which were associated with the ecocentric category.

The higher order variables of the PVQ and HNR values were correlated with the investment motivation variables in photovoltaic energy. Table 5 shows these correlations; all correlations in bold were considered to be significant, with significance levels of $p < 0.01$ (*), $p < 0.05$ (**), or $p < 0.1$ (*).

Table 5. Correlations between PVQ and HNR variables with motivation variables.

	Variables	Investment Opportunity	Low Effort	Neighborhood Effect	Environment Protection	Decentralized Electricity Generation
PVQ	Personal focus	**0.301** *	**0.158** ***	0.101	**0.318** *	**0.282** *
	Social focus	**0.312** *	**0.262** *	**0.191** **	**0.456** *	**0.423** *
HNR	Anthropocentric	0.033	−0.002	0.081	0.011	−0.031
	Ecocentric	**0.189** **	**0.197** **	−0.030	**0.456** *	**0.387** *

* $p < 0.01$, ** $p < 0.05$, *** $p < 0.1$.

Table 5 indicates that some higher order variables of the PVQ and HNR were correlated with at least one motivation variable. The investment opportunity motivation did not correlate with the anthropocentric HNR. That is, even if individual financial gain was motivation, this did not necessarily mean that the investors were apathetic about nature. The neighborhood effect motivation correlated significantly only with social focus, in other words, caring about society increased one's chances of being motivated to invest in photovoltaic energy if cases already existed in the vicinity. The environmental protection motivation correlated with the same intensity as social focus and ecocentrism. This correlation proved that people who considered themselves to be concerned with society and nature had the motivation to invest in photovoltaic energy to truly protect the environment. The decentralized electricity generation motivation was strongly correlated with social focus, therefore, people who expressed values in accordance with social focus had the main motivations of protecting of the environment and decentralizing electricity generation when installing photovoltaic systems.

4. Conclusions

This research has practical importance and long-term economic, social, and environmental benefits throughout the chain of photovoltaic systems because it reflects the investor profile. Hence, this study explored 114 individual profiles who purchased and used household electricity generation systems through photovoltaic systems. We examined the socio-psychological profiles, the human–nature relationships, their motivations for acquiring this technology, and household characteristics. The quantitative approach performed in this study allowed a broad examination of the behavior of these investors. The investor was found to be motivated by the investment opportunity, the low-effort installation, environmental protection, and, above all, the concept of decentralized electricity generation, that is, the possible tariff changes due to a shift toward independent energy generation greatly motivated the investor. The socio-psychological investor profile was self-transcendent, thereby expressing the values of benevolence and universalism, with individuals more likely to show altruistic, cooperative, and environmentally-conscious behavior. These people also had a social focus rather than a personal focus, as observed from the low interest in values such as power and self-realization. Concerning the human–nature relationship, the investor presented a strongly ecocentric profile. These people do not feel entitled to change nature, they seek to be involved with nature, and are not satisfied merely with being a distant guardian of nature.

When we correlated the variables explored by this research, a better understanding of investor thinking was obtained. We verified that the more one considered themselves to be a guardian of nature, the higher their universalism value, whereby they seek the welfare of people and nature. For this reason, the most significant motivation of these investors for social focus values was regarding environmental protection. Consequently, electricity consumption generated by renewable sources was a cause of psychological well-being for investors, as it protects the environment and future generations. This environmental awareness should be explored by stakeholders in the chain photovoltaic solar energy generation, because the market usually explores solely economic benefits. However, we analyzed which environmental benefits were the most influential psychological factors for investors to make decisions themselves. This research identified the PV investor profile; with this knowledge, it is possible to predict the attitudes of potential investors. Therefore, this research could help the stakeholders of this sector, because a more detailed understanding of the preferences that motivate acquisition decisions may contribute to a better design of renewable energy policies and targeted marketing strategies.

This paper is the first model describing the behavior of Brazilian household solar photovoltaic investors. The applied questionnaire presented satisfactory results, and could be applied to other countries and reapplied to future investors in this region, allowing the analysis of potential variation in this demonstrated profile in the future. We suggest replicating the experiment in regions of other developing countries involved in creating energy policies to provide energy and sustainable development. Similar studies in other countries with different cultures would be relevant to confirm and complement the results of this research. The willingness to invest in renewable technologies and contribute to the protection of the environment must come from investors themselves; these are personal decisions. To improve the solar energy market is essential to understand the dominant profiles of individuals who are deciding whether to buy this technology.

Author Contributions: N.G.G. collected the research data. N.G.G., G.R., and P.D.R. did the statistical analyses. N.G.G., G.R., P.D.R., and C.B.R. wrote the article (C.B.R. wrote the introduction and the conclusion, N.G.G. wrote Section 3.1, G.R. wrote Sections 3.2–3.5, and P.D.R. wrote the methodology and Section 3.6). L.M. and J.C.M.S. contributed to reviewing the statistical analysis and the discussion of the results. All authors read and approved the submitted version.

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Appendix A

Portrait Value Questionnaire (English version):

How much applies/does not apply each portrait to you? (5-point Likert Scale: "not like me" to "very much like me")

1. Thinking up new ideas and being creative is important to them. They like to do things in their own original way.
2. It is important to them to be rich. They want to have a lot of money and expensive things.
3. They think it is important that every person in the world should be treated equally. They believe everyone should have equal opportunities in life.
4. It is important to them to show their abilities. They want people to admire what they do.
5. It is important to them to live in secure surroundings. They avoid anything that might endanger their safety.
6. They like surprises and are always looking for new things to do. They think it is important to do lots of different things in life.
7. They believe that people should do what they are told. They think people should follow rules at all times, even when no one is watching.
8. It is important to them to listen to people who are different from them. Even when they disagree with them, they still want to understand them.
9. It is important to them to be humble and modest. They try not to draw attention to themselves.
10. Having a good time is important to them. They like to "spoil" themselves.
11. It is important to them to make their own decisions about what they do. They like to be free and not depend on others.
12. It is very important to them to help the people around them. They want to care for their well-being.
13. Being very successful is important to them. They hope people will recognize their achievements.

14. It is important to them that the government ensures their safety against all threats. They want the state to be strong so it can defend its citizens.
15. They look for adventures and like to take risks. They want to have an exciting life.
16. It is important to them always to behave properly. They want to avoid doing anything people would say is wrong.
17. It is important to them to get respect from others. They want people to do what they say.
18. It is important to them to be loyal to their friends. They want to devote themselves to people close to them.
19. They strongly believe that people should care for nature. Looking after the environment is important to them.
20. Tradition is important to them. They try to follow the custom handed down by their religion or their family.
21. They seek every chance they can to have fun. It is important to them to do things that give them pleasure.

* The questions were applied in a different order, with the aim to verify the answers of the respondents.

Appendix B

Human–Nature Relationship Questionnaire (English version):

How much applies/does not apply each portrait to you? (5-point Likert Scale: "not like me" to "very much like me")

1. In their daily life nature does not play a role.
2. They think they have the right to alter nature.
3. They perceive nature as a provider for products and services.
4. They think their actions may have an impact on nature.
5. Nature is important and enjoyable for them.
6. The physical and emotional bond between self and nature is important for them.
7. Pets, houseplants or urban gardening may substitute for their direct experience in nature.
8. They think they are not dependent on nature to survive.
9. In their opinion natural processes enhance economic welfare.
10. They feel responsible to protect nature.
11. They try to understand natural processes to reflect on their influence on nature.
12. They think that too few humans recognize the power, value and beauty of nature.
13. In their opinion their behavior does not have an impact on nature.
14. Technological progress enables them to control and improve upon nature.
15. They think they have the right to use nature and to enhance natural service provision with technology.
16. They think that mankind can be a threat to nature.
17. According to them technological interventions are okay only if both humans and nature benefit.
18. According to them they do not have the right to use technology to alter nature.
19. Exclusive engagement in nature protection through media is enough for them to connect with nature.
20. They believe they have the right and obligation to protect themselves from natural threats.
21. They feel responsible to protect nature for today's and future generation's welfare.
22. In their opinion humans and nature are of equal value.
23. They would like technological interventions to be regulated to minimize negative effects on nature.
24. They feel as part of nature.

25. They think that engagement for nature should not be given too much weight.
26. An environmentally oriented lifestyle may help them to become part of nature without having to leave the city.

* The questions were applied in a different order, with the aim to verify the answers of the respondents.

Appendix C

Motivation Questionnaire (English version):

How important were the following motivations for your decision to install the photovoltaic system? (5-point Likert Scale: "unimportant" to "very important")

1. PV is a profitable investment with a good return.
2. The installation of a PV plant is simple and quick.
3. A PV plant in my close environment has increased my motivation to have my own PV plant.
4. PV plants reduce pollution burden, save natural resources and thereby actively contribute to environmental protection.
5. With solar power electricity is produced where it is needed and thereby it reduces the dependence on fossil energy sources.

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