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Household Participation in Serbia's Energy Transition: Status and Outlook

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Abstract

This study examines households' willingness to participate in the energy transition, with a particular focus on their readiness to invest in energy efficiency measures and modern heating technologies. The research is based on an empirical survey conducted on a representative sample of 1033 households. The Theory of Planned Behavior (TPB) was used primarily as a conceptual and operational framework for organizing survey questions into three theoretically meaningful groups: attitudes, subjective norms, and perceived behavioral control. These determinants were analyzed as precursors of behavioral intention, which is represented by the households' willingness to invest. The results show that around 30% of households expressed willingness to invest, while the majority were unwilling. The relationships between TPB-related determinants and behavioral intention were examined using chi-square tests, *p*-values, and Cramer's V as a measure of association strength. Among the analyzed determinants, attitude-related indicators—willingness to install rooftop solar panels and readiness to accept a reduction in living standards for environmental protection—showed somewhat stronger associations with behavioral intention. Indicators related to subjective norms were statistically significant but weakly associated with behavioral intention. Within perceived behavioral control, only previous investments in building energy retrofits were statistically significant.

Keywords: household survey; energy transition; energy consumer's perspective; energy behavior; energy efficiency measures; Serbia

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1. Introduction

The ongoing energy transition process, which aims to reduce dependence on fossil fuels through improved energy efficiency and greater use of renewable energy sources (RES), has attracted significant attention worldwide over the last decade [1,2]. As it represents a substantial shift away from traditional and dominant energy usage patterns, it brings various challenges concerning the security of supply, a just transition, economic growth, and sustainable development [3]. Therefore, the strategies and policies behind the energy transition influence not only technological and institutional aspects but also broader social, cultural, and economic dimensions [4].

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The energy transition has been recognized by parts of the international community as a key strategy for ensuring affordable energy prices and creating a system less reliant on energy imports while also tackling the issue of climate change [5]. The European Union (EU) has set ambitious goals according to the European Green Deal, including reducing greenhouse gas (GHG) emissions by at least 55% by 2030 and achieving carbon neutrality by 2050. The European Green Deal is closely connected to the United Nations (UN) Sustainable Development Goals (SDGs); the initiatives are mutually supportive, with shared objectives of promoting sustainable development and affordable and clean energy, reducing GHG emissions, and advancing innovation [6].

Households are considered key players in the energy transition [7]. This sector offers great potential for reducing energy intensity and pollutant and GHG emissions, shifting to RESs, and increasing energy self-sufficiency [8]. This claim is supported by the fact that the average European spends 90% of their time indoors, meaning that a large portion of energy is used to meet the needs of residential or working spaces. According to the European Green Deal, about 97% of EU buildings must be renovated to achieve decarbonization by 2050 [9]. Furthermore, regarding energy consumption in EU member states, the household sector accounts for just over a quarter (around 26%) of the final energy consumption, with the largest portion used for heating residential spaces [10].

Strong and ambitious regulatory frameworks within the "Clean Energy for All Europeans" package [11], introduced in recent years, drive the decision to transition at the macro level, following government regulations. However, this transition occurs at different speeds and reflects changes at the micro level, such as in individual households [12]. Current renovation rates in the EU are too low (around 1% annually) to satisfy the objectives of the European Green Deal. The Renovation Wave strategy suggests that these rates must be at least doubled to align with 2050 decarbonization targets [13]. Electrification of the energy demand, one of the decarbonization measures recognized by the EU, is growing in the heating sector. In 2023, nearly 22 million heat pumps were installed in Europe, but their penetration per country varies, with Norway above 40%, Italy close to 40%, and Germany and Hungary below 5%. Natural gas remains the dominant energy source for space heating in some EU countries, notably Belgium, Germany, Italy, Hungary, the Netherlands and Slovakia, with shares ranging from 15% to around 85%. Solid fossil fuels still play a relatively significant role in space heating in Bulgaria, Czechia, Poland, and Romania [14].

Like in the EU, the household sector in Serbia and other Western Balkan countries is a key area for improving energy efficiency and reducing direct GHG emissions and pollutants. The household sector has a significant share in final energy consumption, often exceeding one-third of total final energy consumption in recent years [15]. Around 50% of households in Serbia rely on outdated and inefficient use of firewood for heating, which is known to contribute to air pollution [16]. Over 80% of residential buildings were built before 2000 [17] and are generally within the lower energy efficiency classes, characterized by higher levels of energy consumption [18]. To address these challenges, Serbia has emphasized building renovation, renewable energy, and efficient technologies to reduce household dependence on conventional and imported energy sources [19]. However, the transition in Serbia has progressed slowly, with limited household participation. Since 2021, the Ministry of Mining and Energy, in cooperation with local governments, has issued several public calls for proposals for various measures to improve energy efficiency. By 2024, 20,000 households, accounting for less than 1% of households in Serbia, had benefited from these subsidies [20].

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The above-mentioned arguments indicate that in the household sectors of European countries (both EU and non-EU), the energy transition process is characterized by a high level of uncertainty regarding its extent and speed [21]. Despite the existence of an advanced regulatory framework, available technologies, and increasing financial incentives, the real pace of the transition in the household sector remains significantly slower than expected. Ambitious policy targets at the EU and national levels do not automatically translate into changes in behavior in individual households. In practice, investment decisions related to building renovation, replacing heating systems, or adopting renewable technologies are often postponed or avoided altogether.

A growing body of research highlights this discrepancy and emphasizes the need for a deeper understanding of the micro-level drivers and barriers that influence household willingness to participate in the energy transition. In this context, it becomes evident that the transition is not purely technical or economic but also behavioral and structural in nature [22,23]. Therefore, formulating adequate approaches to better understand and explain the slow pace of the household energy transition represents a significant research gap, particularly in countries that aim to align their energy systems and regulatory frameworks with EU policies.

In contrast to traditional system-oriented frameworks, which usually focus on macro-level and top-down perspectives and emphasize large-scale systemic changes and institutional dynamics, consumer-oriented approaches pay closer attention to how people actually behave in their everyday lives. Studies that examine real-life decision-making, for example, explore how households make choices in routine situations. These decisions are often shaped by habits, limited access to information, concerns about risk, or a tendency to prioritize short-term costs over long-term benefits. Several studies in the energy transition field show that intentions and the factors influencing them play a crucial role in the adoption of new technologies and behavioral change [24,25]. For this reason, research frameworks increasingly incorporate psychological and sociological dimensions, such as trust in institutions, cultural norms, and pro-environmental attitudes, as important determinants of household intentions and future energy-related decisions [26]. Nevertheless, some authors point out that research in this field remains somewhat fragmented, as many studies examine individual drivers separately and rarely assess their combined and interactive effects on household energy transitions [27].

The main motivation of this study is to expand existing knowledge on household energy consumption patterns and habits to gain deeper insight into how households perceive the energy transition, particularly their intention to support it through willingness to invest in or pay more for more efficient, climate-neutral, and environmentally friendly technologies. In order to develop a comprehensive methodological approach, this study draws on the basic assumptions of the Theory of Planned Behavior (TPB), which states that behavior is driven primarily by behavioral intention. This intention is shaped by three key determinants: attitudes toward the behavior, subjective norms (perceived social expectations), and perceived behavioral control (the feeling that one is able to perform the behavior).

The basic assumption is that more favorable attitudes, stronger perceived social support, and a greater sense of control increase the intention to act; in this case, the intention to invest in energy efficiency measures and modern heating technologies. The specific contribution of this study lies in the use of the TPB as a conceptual and operational framework for organizing survey questions into three groups corresponding to the main TPB determinants. The association between each TPB-related question and behavioral intention was examined using chi-square tests, p-values, and Cramer's V as a measure of association strength. The objective was to identify, based on household responses, which determinants are statistically significant and, more importantly, which show a meaningful association with the development of behavioral intention toward the adoption of cleaner and more efficient technologies. Such insights provide a more accurate assessment of household readiness for the energy transition while also highlighting the limitations of existing policy measures in addressing these underlying barriers. Consequently, the findings can support the design and adjustment of policy interventions that are better aligned with households' actual needs, perceptions, and constraints.

This approach was tested using data from a survey of Serbian households. Serbia is a suitable case study for analyzing the current state and future of household participation in the energy transition in the Western Balkans for several key reasons. First, it is the largest country in the region, both by area and population, making it highly representative of regional trends. Its economic indicators are similar to those of other countries in the region, reflecting a comparable economic situation across Western Balkan nations [28]. In addition, Serbia and other non-EU Energy Community countries face similar challenges regarding energy poverty and low levels of energy efficiency, which further limit household participation in the energy transition [29]. Second, Serbia's climate is similar to that of the continental parts of other Western Balkan countries. Additionally, Serbia faces major environmental issues, including high levels of air pollution during the winter [30]. This is mainly due to outdated heating methods using inefficient stoves that burn firewood and coal, which is a common practice across the entire region [31]. Finally, Serbia's efforts to align with the EU's [32] environmental standards and reduce greenhouse gas emissions make it an important example for studying the energy transition in this part of Europe.

2. Materials and Methods

The practice of collecting data on energy behavior through surveys is widely established. This method enables the precise determination of specific consumer behavior patterns, as well as attitudes toward topics that are directly or indirectly related to energy use, which are crucial for understanding energy transition dynamics. Such information is necessary for formulating policies aimed at changing consumer behavior and effectively implementing new energy technologies.

At the same time, when interpreting survey-based findings, it is essential to carefully distinguish between what people do and what they think or intend to do. Consumer behavior (whether of an individual, household, or company) refers to real actions, while attitudes, perceptions, and subjective norms reflect internal orientations that may not always lead to observable outcomes [33]. Although intentions do not automatically translate into action, this does not reduce their analytical value [34]. When analyzing the likelihood of households participating in the energy transition, researchers often collect data on attitudes, perceptions, and social norms, using them as indicators of intentions and, indirectly, as proxies for potential future behavior.

2.1. Literature Review

Ajzen's Theory of Planned Behavior (TPB) has been widely used in different contexts to assess consumers' behavioral intentions and patterns related to green energy use. The TPB is based on the assumption that behavioral intention is determined through three interconnected determinants [35]:

- Attitude toward behavior—this refers to an individual's (or household's) positive or negative evaluation of engaging in energy transition-related actions, not only to macroeconomic or technological factors.

- Subjective norms—this determinant represents the perceived expectations of others and the social influence that can affect the decision to participate in the energy transition. This is particularly important in the household sector, where decisions are often influenced by local customs and established practices.
- Perceived behavioral control—this reflects an individual's perception of their ability to perform energy transition-related behavior, based on available resources and constraints. In other words, it describes the extent to which households believe they can influence their own energy transition.

The relevance of these three determinants in explaining energy-related intentions has been confirmed in previous empirical research. A meta-analytical review of 35 studies, comprising 148 correlations, showed that attitude was the most important antecedent of behavioral intention toward green energy behavior, followed by subjective norms and perceived behavioral control. This indicates that positive evaluations of green energy behavior often represent the strongest basis for intention formation, although the relative importance of TPB determinants may vary depending on the specific context [36].

Khurshid et al. developed a theoretical model based on the Theory of Planned Behavior. The results showed that attitude had a positive relationship with energy-saving behavior. In other words, attitudes influenced people's motivation to engage in energy-saving practices. Households were more likely to participate actively in electricity saving when they had a favorable attitude toward saving electricity and believed that such behavior was important [37].

Ru, Wang, and Yan [38] empirically tested an extended TPB model using survey data from 450 respondents in eastern China. They examined the determinants of energy-saving intention, finding that perceived behavioral control was the strongest predictor of energy-saving intention, and attitude toward energy-saving was the second most significant determinant. The model was further expanded by including subjective descriptive norms and personal moral norms, which increased its explanatory power. After introducing these additional constructs, the effect of subjective injunctive norms decreased and became statistically non-significant.

A study conducted in Shandong Province, China, investigated rural households' willingness to pay to retrofit their rooftops with solar photovoltaic systems [39]. The authors applied the TPB to identify the key drivers of willingness to pay, and by including extended variables, significantly improved the predictive power of the model [39]. To better predict the WTP, three variables—moral perception, policy perception, and perception of personal interest—were added to the traditional TPB. The results show that perception of personal interest was the most decisive predictor.

Another study applied the TPB framework to a sample of 727 participants, examining the determinants of intention in the context of renewable energy communities [40]. The findings revealed that attitude and subjective norms were strong predictors of intention, while perceived behavioral control had a significant but weaker influence. In this case, the TPB was extended beyond its original structure by incorporating additional contextual factors such as environmental concern, technological innovativeness, pro-environmental behavior, community identity, financial expectations, and homeownership.

Another study, conducted in Pakistan, investigated the psychological factors behind households' intentions and actual energy-saving behavior [41]. The researchers used an online survey to gather data from randomly selected households. The findings confirmed that the core TPB components—attitudes, subjective norms, and perceived behavioral control—had a positive and significant effect on the intention to save energy. In addition, the inclusion of extended variables, namely descriptive norms and moral responsibility, further strengthened the model, highlighting the importance of both social influence and personal ethical considerations in shaping energy-saving intentions [41].

Patel and Paterson [42] examined the motivations and barriers behind municipal renewable energy development using a province-wide survey of municipal decision-makers. The analysis focused on identifying which individual variables or grouped determinants have the strongest influence on the intention to develop renewable energy projects. The results show that perceived economic value—particularly the potential to reduce energy costs—emerges as the most influential motivation, with positive public reception also playing a significant role [42].

Another study extended the TPB to examine the acceptance of solar energy by incorporating several additional variables, including environmental information, environmental concern, attitudes, and perceived solar energy advantages [43]. The aim was to better understand the factors influencing individuals' willingness to adopt solar energy technologies. The results indicate that environmental concern does not always strongly motivate environmentally responsible behavior, as some individuals show only limited concern for environmental protection through green development. In contrast, perceived advantages of solar energy had a clear and significant positive effect on the intention to adopt solar energy. The results also indicate that when individuals feel they have sufficient financial resources, capacity, and control to implement solar technologies, they are more likely to express an intention to adopt them.

Overall, the reviewed studies show that the TPB is frequently used as an initial theoretical framework for examining energy-related intentions and behavior. These studies rely on the three core determinants of intention—attitude, subjective norms, and perceived behavioral control—but apply them to different forms of energy-related decision-making, including household energy-saving behavior [37], energy-saving intention [38], willingness to pay for rooftop photovoltaic retrofitting [39], participation in renewable energy communities [40], intention to save energy [41], municipal renewable energy development [42], and acceptance of solar energy technologies [43]. Researchers frequently extend the basic TPB model by incorporating additional variables (moral norms, descriptive norms, environmental concern, community identity, policy perception, perception of personal interest, perceived economic value, etc.). The common objective of these studies is to identify the key drivers of energy-related intentions and behavior, which may inform the design of targeted policy measures, incentive schemes, communication strategies, and social feedback tools.

However, the reviewed studies do not consistently identify the same determinant as the most important, and their findings are often inconsistent and case-specific. In some studies, perceived behavioral control is identified as the strongest predictor of intention [38], others find it has a significant but weaker effect compared with attitude and subjective norms [40]. In contrast, several studies emphasize attitude as the most influential determinant of behavioral intention [36,37]. However, when additional variables are included, the relative strength of the original TPB constructs may change. For example, perception of personal interest may become the most decisive predictor in the case of willingness to pay for solar photovoltaic retrofitting [39], while perceived economic value may dominate in the case of municipal renewable energy development [42]. Similarly, perceived advantages of solar energy and the perceived availability of financial and practical resources may strongly shape acceptance of solar energy [43]. These findings suggest that TPB constructs do not operate in isolation and often interact with broader economic, social, moral, and institutional factors.

2.2. Conceptual Positioning of the Study

This research begins with the assumption that the TPB framework, in its original form, already provides sufficient conceptual space to generate meaningful insights, provided that its three core determinants are examined in greater depth. Instead of extending the model with numerous additional constructs, this research focuses on a detailed, structured, and extended examination of attitudes, subjective norms, and perceived behavioral control within the specific context of household energy transition. This approach is adopted to reduce the risk of conceptual overlap that may occur when additional variables are introduced into the model. Moreover, the aim of this study is not to test the structural relationships among the TPB constructs or validate the complete TPB model. Rather, the TPB is used as a conceptual framework for organizing and interpreting household-level determinants associated with behavioral intention.

A further conceptual contribution of this study lies in the way behavioral intention is defined. In many studies, energy-related intention is measured using relatively broad or general indicators, such as willingness to use green energy or the intention to save energy. Other studies focus on more specific forms of engagement, such as municipal renewable energy development or the installation of photovoltaic systems. Although such indicators are important, they may either remain relatively abstract or refer to narrower forms of participation that are not equally applicable to all household categories. In this study, household intention is defined more specifically as willingness to invest in modern heating systems and energy efficiency measures. This type of intention is more concrete, financially demanding, and directly connected with household-level decision-making.

Heating and energy efficiency were selected because they are areas in which households can directly influence energy consumption and emissions through their own decisions. Space heating accounts for a substantial share of household energy use, while heating-system replacement and building renovation usually require considerable financial resources. Willingness to invest in these measures therefore provides a practical indicator of household readiness to participate in the energy transition.

This focus also distinguishes such investments from broader electricity-related behavior. Although households can influence their electricity consumption (for lighting, electrical appliances, cooling, and other end uses), they generally have limited control over the electricity generation mix, which is largely shaped by energy companies, market structures, and national policy. By contrast, decisions concerning heating technologies, insulation, windows, and other efficiency measures are more directly under household control.

The conceptual contribution of this study is twofold. First, rather than extending the TPB with additional constructs, the research deepens the operationalization of attitudes, subjective norms, and perceived behavioral control, thereby preserving the theoretical coherence of the original framework while generating richer behavioral insights. Second, the study focuses on a highly concrete and policy-relevant form of behavioral intention—households' willingness to invest in modern heating systems and energy efficiency measures—which represents a capital-intensive decision that is directly under household control and strongly associated with energy transition outcomes.

2.3. Analytical Framework for Examining Household Behavior

The TPB theoretical framework provides a suitable basis for developing an analytical framework focused on the key behavioral determinants of household participation in the energy transition. Its three core determinants—attitudes, subjective norms, and perceived behavioral control—can be operationalized in greater detail depending on the specific research objective and the type of energy-related behavior being examined. Following the conceptual positioning presented in the previous section, behavioral intention in this study was defined according to responses to the following question: "Are you willing to invest in energy efficiency measures and a more modern heating system?" Table 1 presents the operationalization of the TPB framework in the context of household participation in the energy transition. It shows how behavioral intention and the three TPB determinants were translated into specific survey questions, response categories, and indicators based on the literature used to guide their formulation.

Table 1. Operationalization of TPB constructs in the household energy transition survey.

TPB Construct	Survey Question	Response Options	Source
Behavioral intention	Are you willing to invest in energy efficiency measures and more modern heating systems?	Willing to pay more +50%; +40%; +30%; +20%; +10%; not willing (0%) †.	[44,45]
Attitudes	Do you have conditions for installing rooftop solar panels? If yes, are you willing to install solar panels?	Not willing/do not know (DK); have conditions and willing; willing with subsidy.	[46,47]
	Would you immediately replace the heating system in case of a subsidy?	Yes, with subsidy 25%; subsidy 50%; subsidy > 50%; no change despite subsidy ‡	[48,49]
	To what extent are you willing to accept a reduction in living standards to contribute to environmental protection?	Very willing; quite willing; neutral; quite unwilling; DK.	[50,51]
Subjective norms	On a scale from 1 to 5, how much trust do you have in relevant ministries?	Trust scale: 1 = no trust to 5 = complete trust; plus DK.	[52,53]
	On a scale from 1 to 5, how much trust do you have in the local government?	Trust scale: 1 = no trust to 5 = complete trust; plus DK.	[52,53]
	Evaluate the following statement: The interests of the collective should always be more important than individual interests.	Strongly agree; somewhat agree; somewhat disagree; strongly disagree; plus DK.	[52,54]
	Evaluate the following statement: There is no point in doing what I can for the environment if others are not doing the same.	Strongly agree; somewhat agree; somewhat disagree; strongly disagree; plus DK.	[52,55]
Perceived behavioral control	What energy efficiency measures have you implemented in the last 10 years?	Categories: windows replacement; external wall insulation; roof insulation; combined measures; none.	[56,57]
	Which of the following categories best describes your current household income?	Living well; managing; struggling; struggling a lot; DK.	[58,59]
	Question related to current practices in monitoring and reducing energy use.	Regularly; occasionally; never monitor their consumption.	[60,61]

† Recoded into a binary dependent variable: willing to invest vs. not willing to invest. ‡ Recoded into a binary variable: would change with subsidy vs. would not change with subsidy.

The classification of the survey questions within the three TPB determinants reflects the authors' conceptual interpretation of how each indicator relates to household decision-making in the energy transition. Questions concerning willingness to install solar panels, accept subsidies, and tolerate a reduction in living standards were treated as attitude-related indicators because they capture the respondents' evaluations of specific energy and environmental actions and their perceived desirability. Trust in national and local institutions, collectivist orientation, and perceptions of whether individual action is meaningful when others do not participate were categorized as subjective norms, as they reflect the social and institutional contexts that may shape household behavior. Finally, previous energy efficiency investments, household financial capacity, and current energy-monitoring practices were treated as indicators of perceived behavioral control because they represent households' experience, resources, and perceived ability to undertake energy-related measures.

The collected responses were first examined through descriptive analysis, which provided an overview of the distribution of household responses across different TPB-related questions. To move beyond the descriptive interpretation of the collected responses, the analytical framework was further extended by introducing inferential statistical testing. In the next step, the relationship between the behavioral intention variable and each TPB-related indicator was examined using the chi-square test of independence.

The chi-square (χ^2) test of independence is one of the most commonly used non-parametric statistical methods for examining relationships between categorical variables. It is based on a comparison between empirically observed frequencies and expected frequencies that would occur under the assumption that there is no statistically significant association between the variables.

In the context of energy and energy policy research, the chi-square test is frequently used to examine the association between social and economic characteristics of households and their energy-related choices [62], to assess the relevance of specific factors influencing consumer behavior [63], and to compare differences between socioeconomic groups or technological categories [64].

In this study, the chi-square test was applied to examine whether the selected TPB determinants and their corresponding survey-based questions (indicators) are statistically associated with households' willingness to invest in energy efficiency measures and a more modern heating system. The null and alternative hypotheses were defined as follows:

H_0. *The selected TPB determinants and their survey-based indicators are not statistically associated with households' willingness to invest in energy efficiency measures and a more modern heating system.*

H_1. *The selected TPB determinants and their survey-based indicators are statistically associated with households' willingness to invest in energy efficiency measures and a more modern heating system.*

For the purpose of the chi-square analysis, the behavioral intention variable was treated as a binary variable [65], distinguishing between households that expressed willingness to invest in energy efficiency measures and a more modern heating system and those that did not express such willingness.

The chi-square statistic (χ^2) was calculated according to the following equation:

$$\chi^2 = \sum \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \tag{1}$$

where O_{ij} represents the observed frequency in the i-th row and j-th column, while E_{ij} represents the expected frequency under the assumption of independence between the two variables.

The expected frequency was calculated as

$$E_{ij} = \frac{\sum r_i \times \sum c_j}{N} \tag{2}$$

where r_i is the total frequency of the i-th row, c_j is the total frequency of the j-th column, and N is the total sample size.

For each tested relationship, the chi-square value, degrees of freedom, p-value, and Cramer's V were calculated. While the chi-square test indicates whether a statistically significant association exists, Cramer's V was used to assess the strength of the association between the behavioral intention and each TPB-related indicator [66].

2.4. Survey Methodology

The survey was carried out in 2024, from April to June, in the territory of the Republic of Serbia, and data were collected for the following regions: Belgrade, Vojvodina, Šumadija and Western Serbia, and Southern and Eastern Serbia (Figure 1). The questionnaire consisted of 26 closed-ended questions with predefined response categories. The questionnaire was originally developed and administered in Serbian, which is the language of the target population. Therefore, no translation was required during data collection. For reporting purposes, the questionnaire items and response categories presented in the manuscript and Appendix A have been translated into English. All respondents were informed about the purpose of the survey, and the collected data were analyzed and presented only in aggregated statistical form; no personally identifiable data were collected or reported.

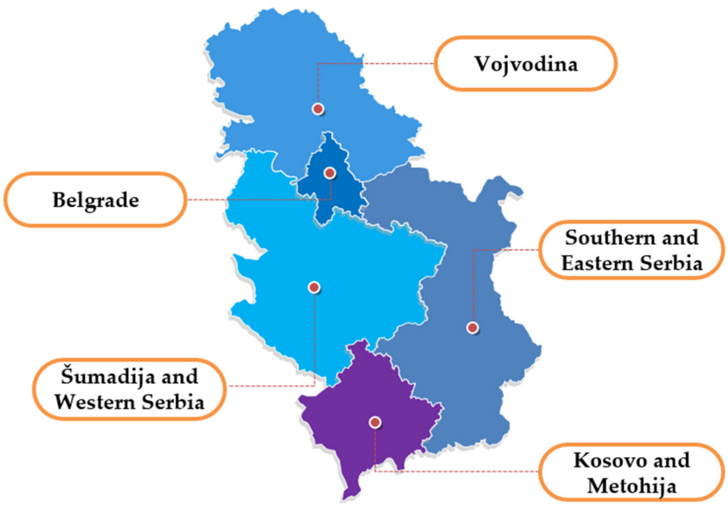

Figure 1. Statistical regions of Serbia.

The unit of observation, i.e., the data source in this survey, is each household selected according to the sampling plan. A household is defined as

- A community of people whose members live together, eat together, and share their income,
- An individual living alone, eating and spending their income independently.

Two-stage stratified sampling was applied. The first-stage units are census districts, which are stratified by settlement type (urban and other) and by territory (four regions, i.e., eight strata). The second-stage units are households. In line with this sampling design, survey weights were derived in a manner consistent with the two-stage stratified sampling design. Primary sampling units (census districts) were selected with probability proportional to the number of households they contained, while households were selected with equal probability by simple random sampling within each selected area. The weights were corrected for unit non-response and adjusted so that the weighted sample reproduced the known national distribution of households by region (territorial domains) and settlement type (urban vs. other). Accordingly, the figures shown in Section 3 represent population estimates rather than unweighted sample proportions.

2.4.1. Sample Realization

A total of 240 census districts and 1200 households were selected for the sample. Of the total number of households planned for the survey, 1033 were successfully surveyed (86%) (Table 2). The sampling frame was based on the 2022 Population Census (Table 1).

Table 2. The number of households categorized by four regions according to the Census and the number of households surveyed.

Region	Number of Households [17]	Number of Completed Surveys
Republic of Serbia (total)	2,589,344	1033
Belgrade	694,818	244
Vojvodina	698,452	293
Šumadija and Western Serbia	671,500	256
Southern and Eastern Serbia	524,574	240

2.4.2. Survey Technique

The survey technique comprised telephone interviews based on a questionnaire. Telephone interviewing was chosen due to the following advantages:

- It allows for surveying a geographically dispersed sample.
- Respondents can keep their opinions confidential, which enhances the quality of the data.
- Travel time and costs for interviewers, as well as security risks, are eliminated.
- At the same time, the limitations of the telephone survey are clearly recognized [16]:
- A phone survey typically involves a shorter conversation with the respondent (e.g., 10–15 min), which limits the number of questions that can be asked.
- Due to the short interview duration, there is less opportunity to ask open-ended questions that could provide deeper insights.
- The use of closed-ended questions may also introduce potential response bias, as respondents are required to choose among predefined response categories.
- Finally, the survey provides a cross-sectional overview of household attitudes and reported behavior at one point in time.

The individuals who participated in the survey (respondents) were the members of each residence who had the best knowledge of energy consumption in their home. Only members of households that had remained in the same home for at least 12 months were interviewed to ensure that the respondents had experience with seasonal energy consumption in their household.

Ethical approval and informed consent procedures were considered in accordance with the non-interventional and anonymous character of the survey. Participation in the survey was voluntary, and the respondents were informed about the purpose of the research before the interview. The survey did not collect sensitive personal data or personally identifiable information, and all responses were processed and reported only in aggregated statistical form.

There is no strict, binding rule when it comes to the number of respondents to surveys related to energy. The sample size primarily depends on the acceptable margin of error and the confidence interval. For a confidence interval of 95% and based on the number of households surveyed, a 3% margin of error is acceptable (Equation (3)).

$$e = z \times \frac{\sigma}{\sqrt{n}} \quad (3)$$

where e is the margin of error, the z value relates to the confidence interval (for a 95% confidence interval, the z-value is = 1.96), σ is the standard error (σ = 0.5), and n is the sample size (n = 1033).

3. Results and Discussion

Behavioral intention was analyzed according to the households' willingness to pay for energy efficiency measures and a more modern heating system. The results indicate a generally low level of readiness to invest in such solutions. As shown in Figure 2, the majority of households, 71%, stated that they would not be willing to pay more for a modern and more efficient heating system. Only 29% of households expressed some degree of willingness to pay more than the cheapest available option. For the purposes of the subsequent statistical analysis, these households were treated as those with a positive behavioral intention toward investing in energy efficiency measures and a more modern heating system. Conversely, households that were not willing to pay more were treated as those without a positive behavioral intention.

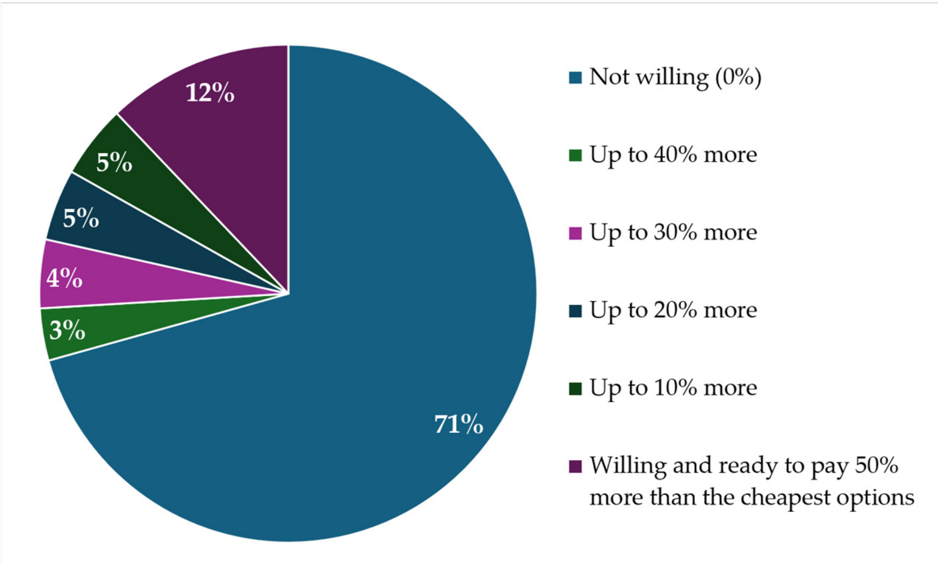

Figure 2. Willingness to invest in energy efficiency measures and a more modern heating system.

3.1. Household Attitudes

This section assesses households' attitudes toward the energy transition, based on their readiness to actively contribute through the adoption of prosumer roles in electricity production by installing solar panels. It also examines their willingness to accept subsidies as an incentive to accelerate the transition, as well as their readiness to accept a reduction in living standards in order to support environmental protection.

Figure 3 shows the structure of households according to whether subsidies would represent an incentive to replace their existing system with a modern heating method. The results indicate that 57% of households would remain unmotivated to change their current heating method, either because they are satisfied with their existing system, do not perceive any issues with their heating method, or because no subsidy would be sufficient to encourage them to invest in replacing their heating system. Only 15% of households would agree to a subsidy of up to 50%, which is commonly offered in support programs. About 28% of households would agree to subsidies exceeding 50%, and this category of households can be characterized as unable to replace their heating method as a direct result of low income.

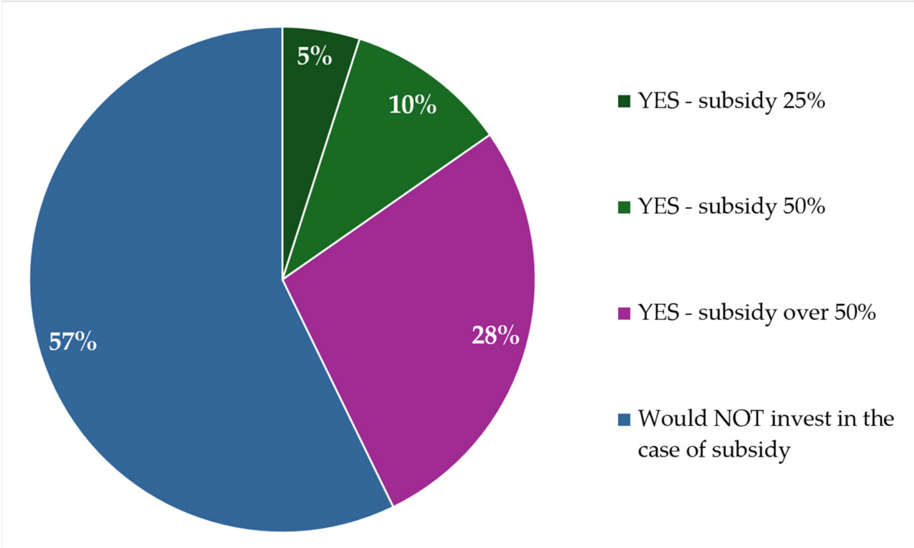

Figure 3. Willingness to accept a subsidy at different percentages for a cleaner and more efficient heating system.

The current situation and prospects regarding households as prosumers of electricity from solar panels were analyzed by assessing their willingness to install panels, their attitudes toward potential subsidies, and their general knowledge of the conditions required for installation (Figure 4). About 19% of households would be willing to install panels either independently or with the help of subsidies for purchasing them. A significant number of households, 81%, stated that they are either unwilling or unsure if they meet the conditions for installation. However, this response category also reflects a limitation of the closed-ended questionnaire, since it does not clearly delineate households that are unwilling to install solar panels and those that are uncertain about whether they meet the technical conditions for installation.

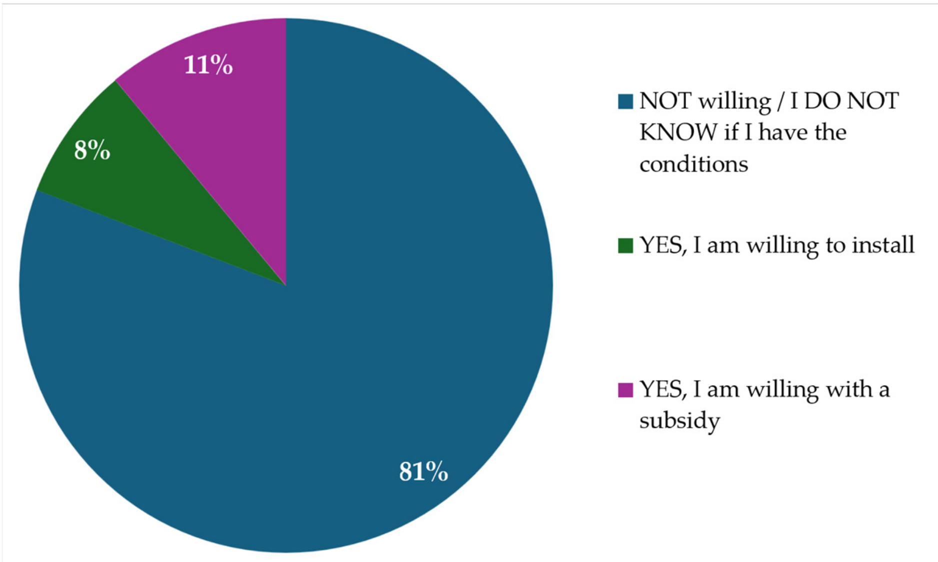

Figure 4. Willingness to install solar panels.

According to studies from other countries, it is estimated that 40–60% of apartments and houses have optimal conditions for panel installation [67], and the number of those who may meet the minimum installation requirements could be even higher. If a similar assumption is made for Serbia, and given that Serbia has better potential compared to northern European countries with a higher number of prosumers, it can be concluded that the primary barrier comprises a lack of funds for the initial investment, a lack of ambition to install panels, and a lack of information rather than the absence of suitable conditions.

When it comes to accepting a reduction in living standards to contribute to environmental protection, households are ambivalent (Figure 5). Just over one-third of the households surveyed (36%) are very willing or quite willing to accept this alternative. Conversely, 17% of households are not willing to accept this alternative. At first glance, it may seem that a clear majority of households are in favor of protecting the environment, even if this means a decline in living standards. However, the other alternatives offered to respondents present a very different picture. A total of 23% of respondents are neither willing nor unwilling to do so, while a further 24% do not know or cannot assess their willingness. Although these two categories are analytically distinct, both indicate the absence of a clearly formed positive or negative position. If they are combined, it can be seen that almost half of households (47%) are essentially undecided.

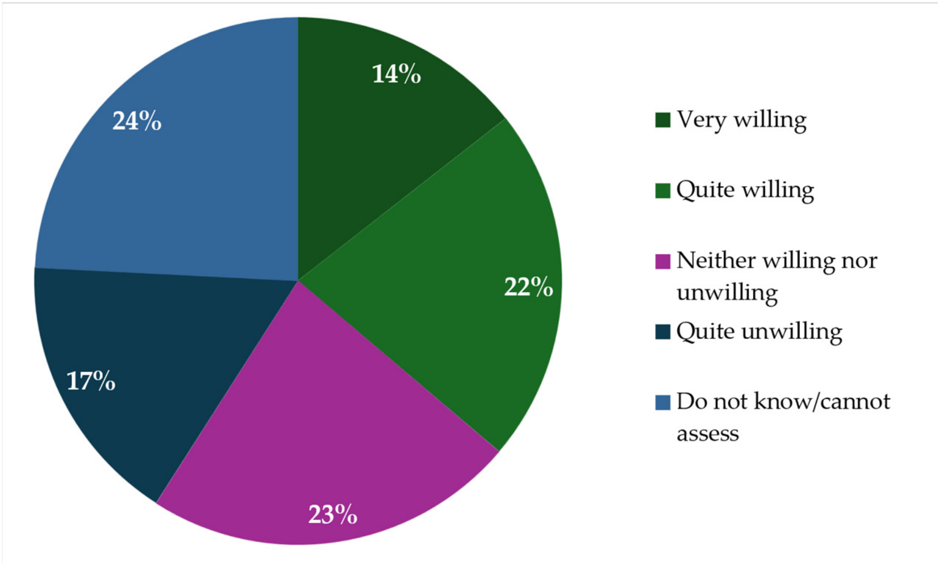

Figure 5. Willingness to accept a reduction in living standards to contribute to environmental protection.

3.2. Household Subjective Norms

This section presents findings related to the households' perceptions of social expectations and the influence of others on their decision to engage in the energy transition. This aspect is examined according to the level of trust in government institutions and local authorities, the degree of collectivism reflected in the willingness to participate in collective or community-based initiatives, and perceptions regarding the environmental impact of other households' energy consumption.

In terms of trust in institutions at the national level (Ministries of Finance, Energy, and Environment), less than one-third (30%) of households have either no (21%) or little trust (9%) in these institutions (Figure 6). Conversely, exactly 34% of respondents have either full trust or some trust in these ministries. A very high proportion of households are either neutral (20%) or uncertain (16%) in this regard. Together, these two groups account for more than one-third of the sample (36%), which can be explained by less direct contact with the ministries and, consequently, a higher proportion of "indeterminate" (neutral or "I don't know") responses.

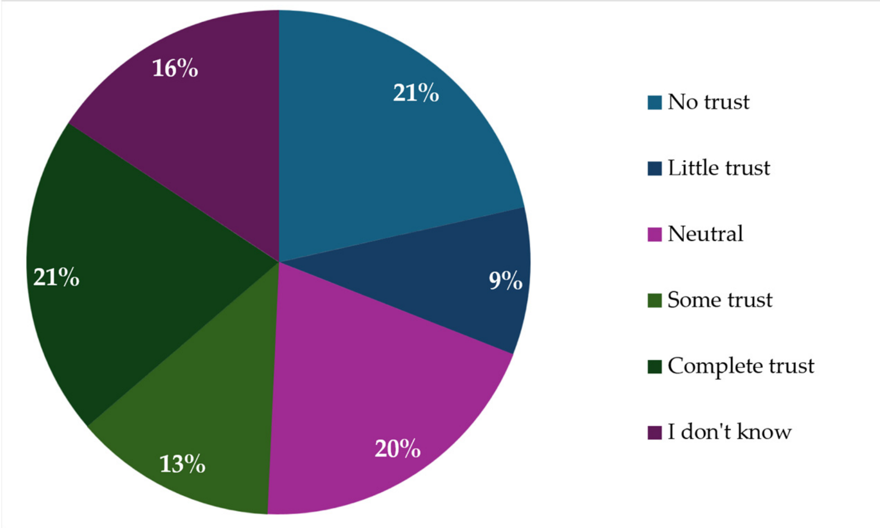

Figure 6. Trust in relevant ministries (finance, energy, and environmental protection).

In terms of trust in local authorities, the results are slightly different, revealing less trust in local than national authorities (ministries) (Figure 7). Two-fifths of respondents (40%) have either no trust (28%) or little trust (12%) in government agencies at the local level, while 10% and 16% of households surveyed (together 26%) have some or complete trust in these institutions, indicating less trust than in ministries.

A different value orientation (collectivism) was well-documented in previous studies conducted in Serbia [68]. Similar results were found in this study (Figure 8). The majority of respondents (53%) strongly agreed with the statement that the interests of the collective should always be more important than the interests of the individual, while another quarter (25%) tended to somewhat agree with this statement. Only 11% disagreed (6% somewhat disagreed and 5% strongly disagreed).

Investment in a household's transition to renewable energy can be viewed as an indicator of its alignment with collective interests, such as environmental protection, and the results suggest a general willingness to engage in such behavior. Nevertheless, value orientations do not necessarily lead to action among all those who expressed support for collective well-being. In the context of this study, the degree of interpersonal trust is, among other factors, one such structural determinant that may influence whether these values translate into concrete actions.

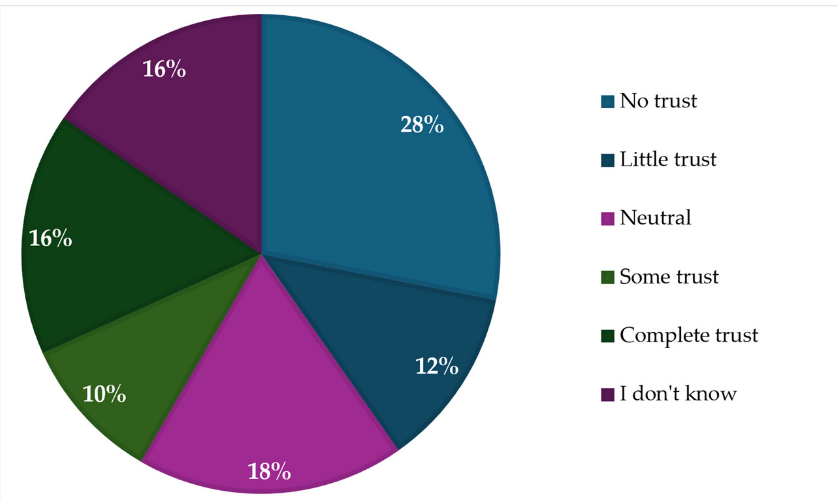

Figure 7. Trust in local authorities.

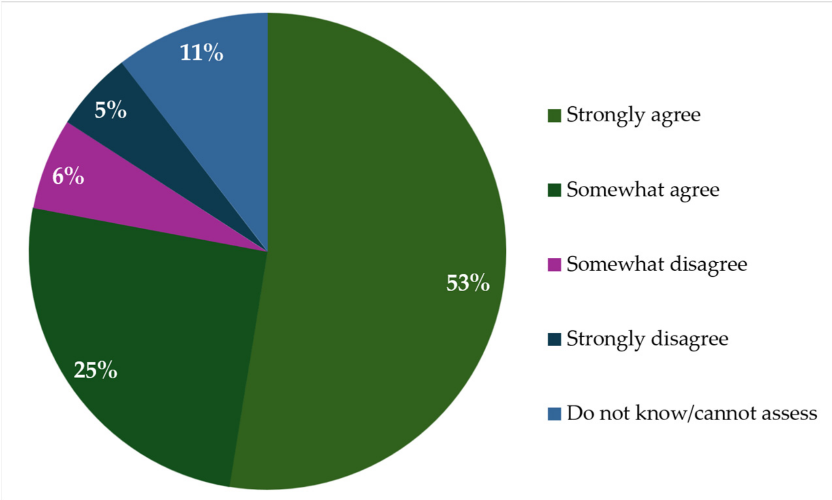

Figure 8. Households' agreement with the statement "The interests of the collective should always be more important than individual interests".

The results point to a possible gap between collectivist value orientations and trust in collective environmental action. More than one-third of households, 38%, agreed with the statement that it is pointless to do something for the environment if others do not do the same, including 21% who strongly agreed and 17% who somewhat agreed (Figure 9). This suggests that, although many respondents support collective interests in principle, a considerable share remain skeptical as to whether other citizens will also act responsibly. Such skepticism may weaken the perceived effectiveness of individual environmental behavior and reduce willingness to participate in the household energy transition.

3.3. Households' Perception of Control

This section presents results regarding the households' perception of their ability to carry out energy transition-related actions, taking into account available resources and constraints. This dimension is assessed through questions focused on previous investments in building energy retrofits, current practices related to monitoring energy use and saving, and the households' current financial capacity to support energy transition investments.

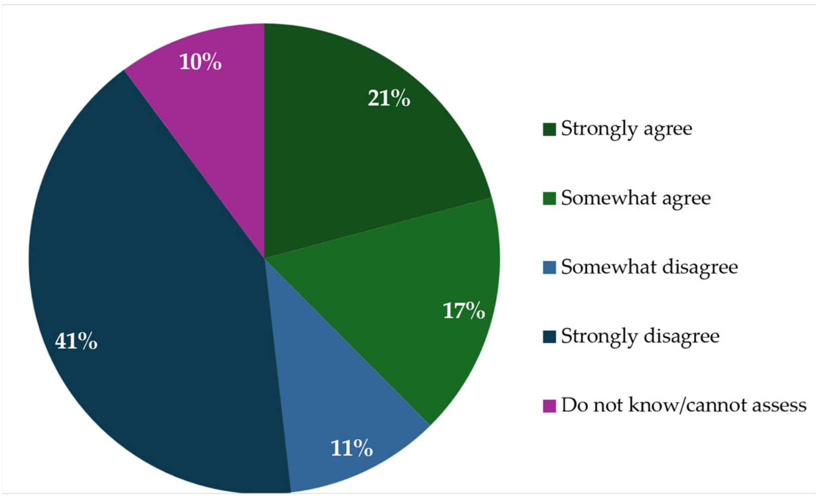

Figure 9. Households' agreement with the statement "There is no point in doing what I can for the environment if others are not doing the same".

Over the past decade, approximately half of the households implemented energy efficiency measures in their homes. Around one quarter reported replacing windows, while another quarter undertook more comprehensive improvements, including insulating external walls and roofs in addition to replacing windows. Although window replacement can contribute to reducing heat losses and improving indoor comfort, it does not represent a complete building energy retrofit. These findings therefore suggest that only a relatively small share of households carried out more comprehensive energy efficiency renovations, while nearly half of the surveyed households did not implement any major energy efficiency measures during the observed period (Figure 10).

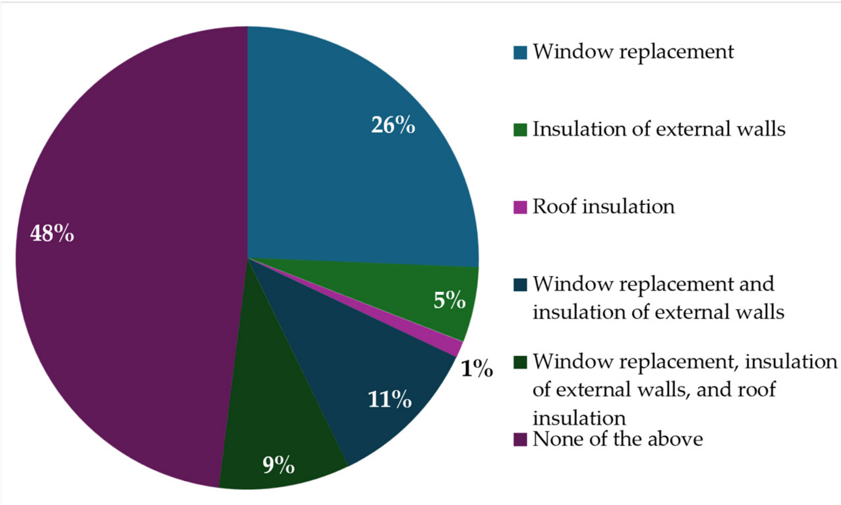

Figure 10. Energy efficiency measures implemented in the last 10 years.

Based on the collected responses regarding the monitoring and management of energy consumption in households, 66% of households claim to monitor their consumption regularly, 27% occasionally, and only 7% never do so. These findings indicate that energy consumption is an issue to which many households pay attention in their everyday practices (Figure 11). Nevertheless, such behavior should be interpreted cautiously, as monitoring consumption does not necessarily imply strong environmental awareness or willingness to invest in energy efficiency and renewable energy measures; it may also be driven by economic motives, particularly the need to control household energy expenditures.

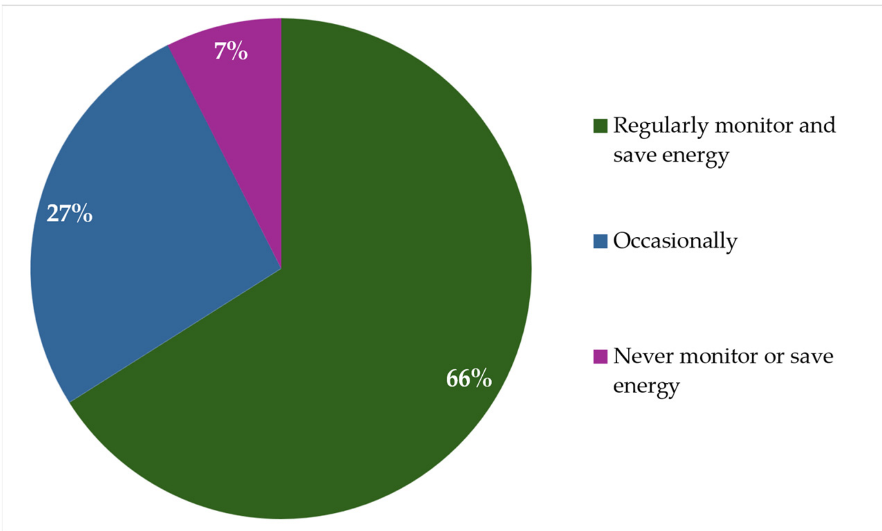

Figure 11. Practices of households in monitoring and managing their energy consumption.

An additional question included in the survey focuses on the households' self-assessment of their current income situation. Self-assessment allows the households to express their perceived financial situation, which can capture aspects of deprivation and hardship that objective income measures may miss [69]. Income appears to be a significant barrier for many households, as only 24% reported living comfortably with their current income, while 5% were unable or unwilling to assess their situation (Figure 12).

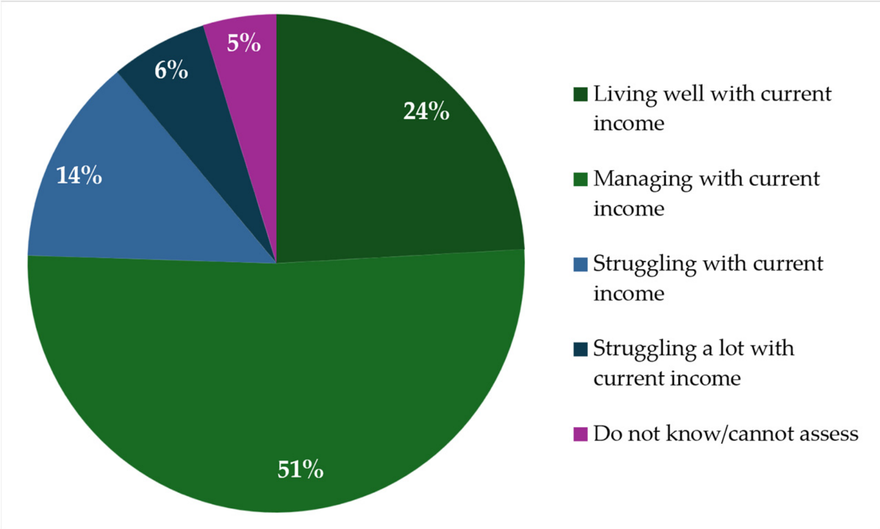

Figure 12. Households' self-assessment of their current income situation.

3.4. Statistical Analysis

Table 3 presents the results of the chi-square tests of independence used to examine whether each TPB-related indicator is statistically associated with behavioral intention, defined as households' willingness to invest in energy efficiency measures and a more modern heating system. The table also reports Cramer's V values to assess the strength of these associations.

Table 3. Statistical significance and strength of association between TPB-related determinants and behavioral intention (willingness to invest).

TPB Determinant	TPB-Related Indicator	χ^2	df	*p*-Value	Cramer's V
Attitudes	Willingness to accept subsidies	14.50	1	0.000140	0.12
	Willingness to install rooftop solar panels	100.48	2	1.52×10^{-22}	0.31
	Readiness to accept a reduction in living standards	48.82	4	6.36×10^{-10}	0.22
Subjective norms	The level of trust in government institutions	32.14	5	0.000006	0.18
	The level of trust in local authorities	22.86	5	0.000359	0.15
	Orientation toward collective interests	14.88	4	0.004956	0.12
	Perceptions about the impact of other households on the environment	24.56	4	0.000062	0.15
Perceived control	Previous investments in building energy retrofits	25.96	5	0.000091	0.16
	Current practices in monitoring energy consumption	1.90	2	0.386589	0.04
	The household's self-assessment of current financial capacity	4.97	4	0.290077	0.07

The results show that most of the TPB-related indicators are statistically significant. Within the attitude dimension, all three indicators are significantly associated with behavioral intention: willingness to accept subsidies, willingness to install rooftop solar panels, and readiness to accept a reduction in living standards for environmental protection. Among these, willingness to install rooftop solar panels shows the strongest association among the examined indicators with behavioral intention (Cramer's V = 0.31), followed by readiness to accept a reduction in living standards (Cramer's V = 0.22). This suggests that households with more favorable attitudes toward concrete energy transition actions are also somewhat more likely to express willingness to invest in modern and more efficient heating solutions.

The indicators related to subjective norms are also statistically significant, including trust in government institutions, trust in local authorities, orientation toward collective interests, and perceptions regarding the environmental impact of other households. However, the strength of these associations is weaker than for previously mentioned indicators of attitudes, with Cramer's V values ranging from 0.12 to 0.18. This indicates that social and institutional factors are relevant, but their direct association with willingness to invest is weaker than that observed for attitude-related indicators. In practical terms, this suggests that trust, collective values, and perceptions of other households' behavior may create a supportive social environment, but each of these factors is individually only weakly associated with household investment intention.

The perceived control dimension shows mixed results. Previous investments in building energy retrofits are statistically significantly associated with behavioral intention and represent the strongest association within this determinant (Cramer's V = 0.16). This may indicate that households with previous experience in improving the energy performance of their homes are somewhat more prepared to consider further investments. In contrast, current practices in monitoring energy consumption and the household's self-assessment of current financial capacity are not statistically significant. The non-significant result for monitoring energy consumption suggests that everyday saving or control practices do not necessarily translate into readiness to invest. Similarly, the lack of statistical significance for self-assessed financial capacity may reflect the fact that financial constraints are widespread across the sample and therefore do not clearly distinguish households willing to invest from those unwilling to invest. In the context of Serbia and the wider Western Balkan region, where household purchasing power is generally low and energy-related investments often represent a substantial financial burden, limited financial capacity may function more as a common structural barrier than as a differentiating factor between groups.

Overall, the results indicate that behavioral intention is more consistently associated with attitude-related indicators than with the other dimensions examined, particularly with willingness to install rooftop solar panels. Nevertheless, statistically significant associations were also identified for all subjective-norm indicators and for previous investments in building energy retrofits. However, the Cramer's V values range from 0.04 to 0.31, indicating predominantly weak associations, with the strongest association reaching a moderate level. This suggests that no single indicator provides a dominant explanation of behavioral intention. Rather, the findings point to the combined relevance of several attitudinal, social, institutional, and experiential factors, each contributing to a limited extent. This finding is consistent with previous TPB-based evidence in the field of green energy behavior, where attitude was found to be the strongest antecedent of behavioral intention toward green energy behavior, followed by subjective norms and perceived behavioral control [36]. In the context of this study, the observed pattern suggests that willingness to invest in energy efficiency measures and modern heating systems is part of a broader pro-transition orientation among households. In other words, households that positively evaluate efficient and modern energy solutions are also more likely to value participation in the energy transition through the prosumer role. A similar interpretation applies to the acceptance of subsidies: households that already have a positive intention to invest may be more inclined to perceive subsidies as a useful instrument, since such support can accelerate or facilitate an investment they are already willing to consider. By contrast, for households that are neither willing nor financially able to invest, subsidies may be insufficient to change their decision. These forms of readiness therefore appear to move in the same direction, reflecting a more general awareness of and openness toward household-level energy transition.

3.5. Policy Implications

For the purpose of deriving policy implications, as shown in Table 4, the empirical findings were translated into broader categories of policy-relevant barriers. While the TPB framework is useful for explaining household intentions through attitudes, subjective norms, and perceived behavioral control, policy design usually requires the identification of concrete barriers that can be addressed through specific instruments. Accordingly, the main weaknesses identified in the survey were grouped into financial, informational, social, institutional, and technical barriers [70]. This translation provides a more practical basis for identifying intervention priorities and selecting appropriate policy measures.

The financial barriers represent the most significant constraint to household participation in the energy transition. These barriers arise through limited household income, insufficient savings available for investment, restricted access to affordable financing, and long investment payback periods. This indicates that subsidy programs alone may not be sufficient for a large share of households and that complementary financing instruments should be considered, including mechanisms that can cover the full investment costs for the most vulnerable households. In addition, technical assistance is necessary to support households in implementing building retrofits and installing modern heating systems.

Table 4. Policy-relevant interpretation of empirical findings.

TPB Determinant	Observed Weakness	Policy-Relevant Barriers	Case-Specific Policy Measure Type
Attitude	Low willingness to invest in modern and efficient heating systems (71%); 57% of households stated that they would not replace their heating system even if a subsidy were offered.	Financial barrier	Higher subsidy rates for low- and middle-income households or zero-interest loans; full-cost or near-full-cost support for vulnerable households; co-financing models.
Attitude	Low interest in rooftop solar panels and uncertainty about technical conditions for installation (81%).	Informational and economic barriers	Information campaigns; technical advisory services; demonstration projects; free technical pre-assessment of roofs.
Subjective norm	More than one-third of households (38%) believe that environmental action is pointless unless others act as well.	Social and behavioral barriers	Community-based programs; neighborhood demonstration projects; social norm campaigns.
Subjective norm	Trust in authorities is relatively low, with 40% of respondents expressing little or no trust in local institutions.	Institutional barrier	Stakeholder engagement; transparent local calls; citizen information meetings; involvement of local energy offices.
Perceived behavioral control	No major building energy efficiency measures implemented (48%).	Technical and financial barriers	Building renovation programs; technical assistance; full-cost or near-full-cost support for vulnerable households.

The findings also highlight the importance of informational and behavioral barriers. The low level of interest in rooftop solar systems and the uncertainty regarding installation requirements suggest that many households lack the knowledge needed to evaluate available energy transition options. At the same time, the relatively high share of respondents who are influenced by the behavior of others indicates that social norms and community-level engagement may play an important role in accelerating adoption.

Finally, institutional barriers should not be overlooked. The relatively low level of trust in authorities may reduce the effectiveness of locally implemented energy transition measures. Strengthening communication, transparency, and stakeholder participation could therefore be an important prerequisite for improving policy acceptance and implementation.

4. Conclusions

Since the promotion of the "Clean Energy for All Europeans" package, and even before that, it has been evident that the energy transition in the household sector has its own specific direction and pace, making it more difficult to define a universal mechanism for mass participation. This study was conducted to address some of the key challenges related to the potential involvement of households in the energy transition by analyzing empirical data collected through a structured survey.

The main empirical contribution of this manuscript is that it provides a structured and nationally relevant assessment of household readiness to participate in the energy transition, using behavioral intention as the central analytical category. This study combines descriptive survey evidence with inferential statistical testing in order to identify which behavioral, social, institutional, and perceived control-related factors are associated with willingness to invest, thereby contributing to a better understanding of the behavioral preconditions for household energy transition in Serbia and in the Western Balkan context more broadly, where low purchasing power and delayed modernization of the residential energy sector remain important constraints.

The results show a generally low level of readiness among households to invest in more efficient and modern energy solutions. Only 29% of households expressed willingness to pay more than the cheapest option available for a modern and more efficient heating system, while 71% were not willing to do so. This indicates that positive behavioral intention only exists among a small share of households. At the same time, 57% of households stated that they would not replace their current heating system even if a subsidy were available, suggesting that partial financial support alone may not be sufficient to trigger investment decisions for a substantial share of households. These findings point to a substantial gap between policy ambitions related to household energy transition and the current willingness or ability of households to participate in it.

The statistical analysis also confirms that household willingness to invest cannot be explained solely by economic rationality. Attitude-related indicators showed the strongest associations with behavioral intention, particularly willingness to install rooftop solar panels and readiness to accept a reduction in living standards for environmental protection. This suggests that households that are more open to concrete energy transition actions are also more likely to express willingness to invest in modern and efficient heating systems. In this sense, willingness to invest, openness to the prosumer role, and readiness to undertake other energy transition-related actions appear to reflect a broader pro-transition orientation among households. However, several indicators related to subjective norms and perceived behavioral control were also statistically significant, although with weaker associations. Therefore, willingness to invest should be understood as the outcome of a combination of attitudes, perceived social influences, institutional trust, previous experience, and contextual constraints rather than as the result of a single determinant.

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From a policy perspective, the findings indicate that the household energy transition cannot be accelerated through uniform subsidy schemes alone. This is particularly important in Serbia and the wider Western Balkan region, where low purchasing power makes energy efficiency improvements, heating system replacement, and rooftop solar installation financially demanding for many households. Therefore, financial support should be combined with targeted grants for vulnerable households, advisory services, technical pre-assessments, simplified procedures, community-level demonstration projects, and measures aimed at strengthening trust in local institutions.

This study also highlights the importance of the institutional and social dimensions of the transition. The relatively low level of trust in authorities may reduce the effectiveness of locally implemented support schemes, especially if households perceive procedures as unclear, selective, or unreliable. At the same time, skepticism regarding the behavior of other households suggests that social norms and visible examples of collective participation may influence the perceived value of individual action. Policy instruments should therefore not only reduce financial and technical barriers but also create a social and institutional environment in which household participation becomes more visible, credible, and practically achievable.

Several limitations should be acknowledged. First, the study relies on self-reported intentions, attitudes, and perceptions, which may be affected by response bias, social desirability bias, or differences in how respondents interpret survey questions. Although behavioral intention is widely used as a predictor of future behavior, it does not necessarily translate into actual investment decisions (intention–behavior gap). Second, the use of a structured questionnaire with predefined response categories limits the interpretation of some determinants. Third, the telephone survey captures the current distribution of household attitudes and intentions, but it cannot indicate whether these intentions will remain stable over time or whether they will lead to actual adoption of energy efficiency measures, modern heating systems, or rooftop solar panels.

Future research can address these limitations by combining repeated survey waves with indicators of actual household behavior. This would make it possible to assess whether policy measures lead to measurable shifts in household readiness and investment behavior. Future studies could also extend the TPB-based framework by incorporating complementary behavioral theories, such as Diffusion of Innovations and Value–Belief–Norm theory. Diffusion of Innovations could help explain how modern heating technologies, rooftop solar panels, and energy efficiency measures spread among households over time, including the role of social networks, perceived relative advantage, compatibility, and complexity. Value–Belief–Norm theory could further contribute by capturing stronger environmental values, personal norms, and moral responsibility for environmental protection. Overall, the present study provides a useful empirical baseline for understanding household readiness for the energy transition and for designing more targeted, socially acceptable, and context-sensitive policy interventions.

Author Contributions: Conceptualization, funding acquisition, writing—review and editing, D.I.; methodology, investigation, writing—original draft preparation, B.P.; formal analysis, writing—review and editing, M.Ž. and D.M.; visualization, project administration, M.C. and A.M. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: Ethics Commission of the Faculty of Mining and Geology in Belgrade approved this research on 5 October 2022, with No. 1756.

Informed Consent Statement: Verbal informed consent was obtained from all participants before conducting the telephone survey. As the survey was conducted entirely by telephone, obtaining written consent was not practicable. Verbal informed consent was therefore considered the appropriate form of consent for participation. Before the interview began, participants were informed about the purpose of the research, the voluntary nature of their participation, the anonymous treatment of their responses, and the use of the collected data exclusively for scientific research and aggregated statistical analysis.

Data Availability Statement: The original contributions presented in this study are included in the article. Further inquiries can be directed to the corresponding author, subject to restrictions required to preserve the anonymity of survey respondents and to comply with applicable privacy and ethical considerations.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

DHS	District heating systems
EU	European Union
GHG	Greenhouse gas
RES	Renewable energy source
UN	United Nations

Appendix A. Survey Results

Table A1. Survey Results.

No.	Question
1	Type of residential building you live in?
a	House
b	Building
c	Building in a row
2	Surface area of the residential unit that is HEATED (m^2)
a	to 40
b	41–60
c	61–80
d	81–120
e	120+
f	I don't know
3	Energy source used for heating (if more than one, select the dominant one)?
a	Firewood
b	District heating
c	Electricity (boiler, storage heater, heaters, etc.)
d	Natural gas

Table A1. Cont.

No.	Question
e	Pellets
f	Coal
g	Heat pumps—Electricity
h	Fuel oil
i	Other
4	According to the configuration, the heating system is?
a	Local heating devices (heater, fireplace, stove, etc.)
b	Central heating
5	Household heating system classification
a	Solid fuel stoves
b	Solid fuel boilers
c	Electric heaters
d	Electric boilers
e	Natural gas boiler
f	Natural gas stoves
g	Pellet boilers
h	Pellet stoves
i	District heating
j	Heat pumps
k	Liquid fuel boilers
6	Age of the heating system in use?
a	1–5
b	6–10
c	11–15
d	16–20
e	20+
7	In addition to the basic source of energy for heating, is electricity also used for additional heating and approximately how many days a year?
a	Do not use
b	15 days
c	30 days
d	60 days
e	More than 60 days
8	How would you characterize the thermal comfort of the current heating system?
a	Insufficiently warm
b	Normal
c	Overly warm

Table A1. Cont.

No.	Question
9	Do you have a cooling system (air conditioner) in your house/apartment?
a	YES
b	NO
10	How many days per year do you use the cooling system?
a	Do not use
b	Up to 30 days
c	30–60 days
d	60–90 days
e	90–120 days
11	Do you monitor and save energy consumption?
a	Regularly
b	Sometimes
c	Never
12	What energy efficiency measures have you implemented in the last 10 years?
a	Window replacement
b	Insulation of external walls
c	Roof insulation
d	Window replacement and insulation of external walls
e	Window replacement, insulation of external walls, and roof insulation
f	None of the above
13	Do you have conditions for installing solar panels (physical availability of roof and south-facing roof)? If yes, are you willing to install solar panels?
a	NOT willing/Do not know if I have the conditions
b	YES, have conditions and WILLING
c	YES, have conditions and WILLING in case of a subsidy for panel purchase
14	In case of changing the heating method, are you willing to invest in energy efficiency measures and a more modern heating system (based on renewable energy sources, e.g., biomass (briquettes, pellets) or to install a heat pump)?
a	Willing and ready to pay 50% more than the cheapest fossil fuel installation
b	Up to 40% more
c	Up to 30% more
d	Up to 20% more
e	Up to 10% more
f	Not willing (0%)
15	Would you immediately replace the heating system for an environmentally friendly option in case of a subsidy? If YES, what percentage should the subsidy be?
a	YES—subsidy 25%
b	YES—subsidy 50%
c	YES—subsidy over 50%
d	Would NOT change the heating method in case of subsidy

Table A1. Cont.

No.	Question
16	To what extent are you willing to accept a reduction in living standards to contribute to environmental protection?
a	Very willing
b	Quite willing
c	Neither willing nor unwilling
d	Quite unwilling
e	Do not know/cannot assess
17	Which of the following categories best describes your current household income?
a	Living well with current income
b	Managing with current income
c	Struggling with current income
d	Struggling a lot with current income
e	Do not know/cannot assess
18	In your opinion, how much does environmental pollution impact your daily life and your surroundings?
a	Very strong impact
b	Moderate
c	Weak
d	No impact
e	Do not know/cannot assess
19	Which of these approaches in Serbia (in your opinion) would be the best way to encourage individuals and families to protect the environment?
a	Big fines for people who pollute the environment
b	Reward people who protect the environment through tax relief
c	Provide better information and education about the benefits of protecting the environment
d	Do not know/cannot decide
20	On a scale from 1 to 5, how much trust do you have in relevant ministries (finance, energy, and environmental protection)? (1—no trust, 5—complete trust)
a	1
b	2
c	3
d	4
e	5
f	I don't know
21	On a scale from 1 to 5, how much trust do you have in the local government? (1—no trust, 5—complete trust)
a	1
b	2
c	3

Table A1. Cont.

No.	Question
d	4
e	5
f	I don't know
22	Evaluate the following statement: The interests of the collective should always be more important than individual interests.
a	Strongly agree
b	Somewhat agree
c	Somewhat disagree
d	Strongly disagree
e	Do not know/cannot assess
23	Evaluate the following statement: In most cases, I actively plan my future and the future of my household.
a	Strongly agree
b	Somewhat agree
c	Somewhat disagree
d	Strongly disagree
e	Do not know/cannot assess
24	Evaluate the following statement: There is no point in doing what I can for the environment if others are not doing the same.
a	Strongly agree
b	Somewhat agree
c	Somewhat disagree
d	Strongly disagree
e	Do not know/cannot assess
25	Evaluate the following statement: Many claims about environmental threats are exaggerated.
a	Strongly agree
b	Somewhat agree
c	Somewhat disagree
d	Strongly disagree
e	Do not know/cannot assess
26	Evaluate the following statement: There are more important things in life than protecting the environment.
a	Strongly agree
b	Somewhat agree
c	Somewhat disagree
d	Strongly disagree
e	Do not know/cannot assess

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