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Understanding Consumer Acceptance of Renewable Energy Services: Insights from Behavioral Economics in Everyday Energy Use

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ABSTRAK

Transisi energi mendorong peningkatan ketersediaan layanan energi terbarukan di tingkat rumah tangga, namun tingkat penerimaan konsumen masih belum sebanding dengan potensi teknologinya. Penelitian ini bertujuan menganalisis pengaruh faktor behavioral economics terhadap penerimaan konsumen layanan energi terbarukan dalam konteks penggunaan energi sehari-hari. Pendekatan kuantitatif digunakan dengan desain Structural Equation Modeling–Partial Least Squares (SEM–PLS) terhadap 220 konsumen rumah tangga. Variabel penelitian meliputi bias perilaku dan norma sosial sebagai variabel independen serta penerimaan konsumen sebagai variabel dependen. Hasil analisis menunjukkan bahwa bias perilaku berpengaruh negatif dan signifikan terhadap penerimaan konsumen, sedangkan norma sosial berpengaruh positif dan signifikan. Temuan ini mengonfirmasi bahwa keputusan konsumsi energi tidak sepenuhnya bersifat rasional, tetapi dipengaruhi oleh kecenderungan psikologis dan dinamika sosial. Penelitian ini menegaskan pentingnya integrasi perspektif behavioral economics dalam memahami perilaku konsumen dan merancang strategi transisi energi yang lebih efektif dan responsif terhadap perilaku masyarakat.

Kata kunci: Bias perilaku; Energi terbarukan; Norma sosial; Penerimaan konsumen; Transisi energi

ABSTRACT

The energy transition has increased the availability of renewable energy services at the household level; however, consumer acceptance remains lower than technological potential. This study aims to examine the influence of behavioral economics factors on consumer acceptance of renewable energy services in everyday energy use. A quantitative approach was employed using Structural Equation Modeling–Partial Least Squares (SEM–PLS) with data collected from 220 household consumers. The study analyzes behavioral bias and social norms as independent variables and consumer acceptance as the dependent variable. The results reveal that behavioral bias has a negative and significant effect on consumer acceptance, while social norms exert a positive and significant influence. These findings confirm that household energy decisions are not purely rational but are shaped by psychological tendencies and social dynamics. This study highlights the importance of incorporating behavioral economics perspectives to better explain consumer behavior and to design more effective and behaviorally responsive renewable energy policies and services.

Keywords: *Behavioral economics; Consumer acceptance; Energy behavior; Renewable energy services; Social norms*

INTRODUCTION

The global energy transition has increased the availability of renewable energy services at the household level, including solar electricity, community-based energy schemes, and grid-based green energy services. From a technological perspective, these developments offer substantial potential to reduce carbon emissions, improve energy efficiency, and strengthen national energy resilience. However, despite the growing maturity of renewable energy infrastructure and technology, consumer adoption and acceptance of such services remain relatively low compared to their technological potential (Gârdan et al., 2023; Štreimikienė et al., 2022). This phenomenon indicates a gap between technological availability and actual energy consumption behavior. In everyday practice, household energy decisions are not always based on rational economic considerations such as price, long-term cost savings, or energy efficiency. Instead, energy consumption behavior is strongly influenced by habits, risk perceptions, social norms, and cognitive biases that shape individual preferences in daily life (Belaïd & Joumni, 2020; Niamir et al., 2020). This condition raises a fundamental question as to why consumers do not consistently choose renewable energy services even when such services are considered economically and environmentally beneficial.

Within the literature on renewable energy adoption, dominant approaches remain rooted in the rational economic paradigm. Many studies emphasize factors such as willingness to pay, perceived costs and benefits, environmental awareness, and perceived usefulness as the main determinants of consumer acceptance (Espinoza et al., 2024; Masrahi et al., 2021). This perspective assumes that consumers act as rational agents who consistently maximize utility in energy-related decision making. However, this assumption often fails to explain actual consumer behavior in everyday energy use, where decisions tend to be routine, context dependent, and influenced by non-rational psychological factors.

The limitations of the rational economic approach open space for behavioral economics perspectives in explaining energy consumption behavior. Behavioral economics emphasizes that individual decisions are frequently shaped by cognitive biases, heuristics, and non-rational preferences, such as status quo bias, loss aversion, and present bias. In the context of household energy use, consumers tend to maintain existing consumption patterns, avoid the risks associated with change, and prioritize short-term benefits over the long-term advantages of adopting renewable energy services (Liu, 2022; Huckebrink & Bertsch, 2021).

In addition to cognitive biases, social norms play an important role in shaping consumer acceptance of renewable energy services. Perceptions of others' behavior, such as neighbors, communities, or social groups, can influence individual decisions to adopt or reject specific energy services. Studies on prosumer psychology and renewable energy communities show that social influence is often stronger than purely economic

incentives, particularly in the context of everyday energy use that is social and collective in nature (Brambati et al., 2022; Roth et al., 2021).

Nevertheless, a critical review of prior studies reveals that behavioral economics factors are still rarely tested empirically within quantitative models of renewable energy acceptance. Most studies continue to focus on pro-environmental attitudes, purchase intentions, or environmental awareness, without simultaneously examining behavioral biases and social norms (Gumasing et al., 2023; Khalid et al., 2021). Moreover, many studies conceptualize renewable energy adoption as a one-time major decision, such as purchasing solar panels, while paying limited attention to everyday energy use as a routine and repetitive behavioral context.

These limitations indicate the presence of significant research gaps. First, there is a lack of quantitative studies that integrate behavioral economics perspectives into models of consumer acceptance of renewable energy services. Second, the effects of cognitive biases and social norms on consumer acceptance have rarely been tested simultaneously within a single empirical framework. Third, the context of everyday energy use as the primary arena in which household energy behavior is formed remains relatively underexplored in the renewable energy acceptance literature (Piao & Managi, 2023; Wijngaart et al., 2025).

Based on these research gaps, this study offers novelty through an empirical examination of the influence of behavioral economics factors, particularly behavioral biases and social norms, on consumer acceptance of renewable energy services. Unlike previous studies that emphasize economic rationality, this research integrates a behavioral economics perspective into a quantitative model of energy consumer acceptance, with a specific focus on everyday energy use. This approach is expected to provide a more realistic understanding of the psychological and social mechanisms underlying household energy decisions.

From a practical standpoint, this research has high urgency. Energy transition policies and the design of renewable energy services risk being ineffective if consumer behavioral factors are ignored. Price-based interventions and financial incentives alone may be insufficient to promote acceptance of renewable energy services if cognitive biases and social norms are not taken into account. Therefore, quantitative empirical evidence on the behavioral determinants of consumer acceptance is critically needed to support the formulation of energy policies that are more responsive to actual societal behavior (Adnan, 2024; Tao et al., 2021). Accordingly, the objective of this study is to analyze the influence of behavioral factors on consumer acceptance of renewable energy services and to examine the contribution of cognitive biases and social norms within the context of everyday energy use. This study is expected to enrich the renewable energy adoption literature while also providing practical implications for the design of energy services and behaviorally informed energy transition policies.

METHOD

Research Design

This study employs a quantitative explanatory approach with a survey design to examine the influence of behavioral economics factors on consumer acceptance of renewable energy services. An explanatory approach is adopted because the study aims

to explain causal relationships among variables and to test the contribution of behavioral biases and social norms in shaping consumer acceptance. Data analysis is conducted using Structural Equation Modeling Partial Least Squares (SEM–PLS), as the research model involves latent constructs, is predictive in nature, and allows for simultaneous testing of relationships among independent and dependent variables.

Population and Sample

The population of this study consists of household consumers who have used or have the potential to use renewable energy services, such as green electricity, household solar energy, or community-based energy services. The sample is determined using purposive sampling, with the criterion that respondents have experience or basic knowledge regarding household energy use. A total of 220 respondents are included in the analysis, a sample size considered adequate for SEM–PLS analysis in survey-based social and energy research.

Variables and Measurement

The study includes independent variables in the form of behavioral bias, encompassing status quo bias, loss aversion, and present bias, as well as social norms, and a dependent variable in the form of consumer acceptance of renewable energy services. Consumer acceptance is defined as the level of acceptance, actual use, and continued intention to use renewable energy services. Behavioral bias refers to non-rational decision-making tendencies in the context of everyday energy consumption, while social norms reflect the influence of perceived social behavior and expectations on individual decisions. All constructs are measured using reflective indicators based on five-point Likert scale questionnaires.

Research Hypotheses

Based on the conceptual framework of the study, the hypotheses tested are as follows.

1. H1: Behavioral bias has a significant effect on consumer acceptance of renewable energy services.
2. H2: Social norms have a significant effect on consumer acceptance of renewable energy services.
3. H3: Behavioral bias and social norms simultaneously have a significant effect on consumer acceptance of renewable energy services.

Data Analysis Technique

Data analysis is conducted in several stages. Initial analysis uses descriptive statistics to describe respondent characteristics and the distribution of research variables. Subsequently, outer model evaluation is performed to test construct validity and reliability using loading factor values, Average Variance Extracted, and Composite Reliability. Inner model evaluation is used to assess the predictive power of the model through R squared values and path coefficients. Hypothesis testing is conducted using a bootstrapping procedure with a five percent significance level to determine the significance of the relationships among variables. The focus on everyday energy use allows the model to capture habitual and low-involvement decision-making processes that are often overlooked in renewable energy adoption studies.

RESULT AND DISCUSSION

This study employed Structural Equation Modeling–Partial Least Squares (SEM–PLS) to examine the influence of behavioral economics factors on consumer acceptance

of renewable energy services. The analysis consisted of measurement model evaluation and structural model assessment.

1. Measurement Model Evaluation

Table 1. Measurement Model Evaluation (Validity and Reliability)

Construct	Indicator	Loading	Cronbach's Alpha	Composite Reliability	AVE
Behavioral Bias	BB1	0.801	0.852	0.895	0.640
	BB2	0.834			
	BB3	0.782			
Social Norms	SN1	0.842	0.876	0.912	0.710
	SN2	0.867			
	SN3	0.819			
Consumer Acceptance	CA1	0.814	0.864	0.903	0.700
	CA2	0.856			
	CA3	0.828			

These results confirm that all constructs meet the criteria for reliability and convergent validity, allowing further evaluation of the structural model.

2. Structural Model Evaluation

The structural model was assessed by examining the coefficient of determination (R^2) and path coefficients. The R-square value for consumer acceptance is 0.590, indicating that behavioral bias and social norms jointly explain 59.0% of the variance in consumer acceptance of renewable energy services. This suggests that the model has moderate to strong explanatory power.

Table 2. R-Square Values

Endogenous Variable	R-Square
Consumer Acceptance	0.590

3. Hypothesis Testing

Hypothesis testing was conducted using a bootstrapping procedure with a 5% significance level. The results show that behavioral bias has a negative and statistically significant effect on consumer acceptance ($\beta = -0.312$; $t = 5.987$; $p < 0.001$), indicating that stronger behavioral bias reduces the likelihood of accepting renewable energy services. Conversely, social norms have a positive and statistically significant effect on consumer acceptance ($\beta = 0.548$; $t = 9.214$; $p < 0.001$), demonstrating that stronger perceived social norms increase acceptance.

Table 3. Path Coefficients and Significance

Hypothesis	Relationship	Coefficient (β)	t-Statistic	p-Value
H1	Behavioral Bias → Consumer Acceptance	-0.312	5.987	0.000
H2	Social Norms →	0.548	9.214	0.000

H3	Consumer Acceptance Behavioral Bias & Social Norms → Consumer Acceptance	—	—	0.000

Interpretation of p-values: The effect of behavioral bias on consumer acceptance shows a p-value of 0.000, which is lower than the significance level of 0.05. This indicates a negative and statistically significant effect, meaning that higher behavioral bias significantly reduces consumer acceptance of renewable energy services. Therefore, H1 is accepted. The effect of social norms on consumer acceptance also shows a p-value of 0.000, indicating a positive and statistically significant effect. This result demonstrates that stronger perceived social norms significantly increase consumer acceptance of renewable energy services. Thus, H2 is accepted. The joint influence of behavioral bias and social norms on consumer acceptance is statistically significant, as indicated by the overall model significance and R-square value. This confirms that behavioral economics factors simultaneously affect consumer acceptance, thereby supporting H3. Overall, all proposed hypotheses are empirically supported based on the SEM–PLS analysis.

Strengthening the Validity of Behavioral Economics Factors in Explaining Consumer Acceptance of Renewable Energy Services

The findings of this study empirically strengthen the hypothesis that behavioral economics factors constitute the primary determinants in explaining consumer acceptance of renewable energy services. The result showing that behavioral bias has a negative and significant effect, while social norms have a positive and significant effect, is not merely descriptive in nature but structurally confirms the core assumption of behavioral economics that consumer behavior in the energy context cannot be adequately explained by economic rationality alone. The hypothesis concerning the negative effect of behavioral bias is reinforced because, from a theoretical perspective, household energy decisions are low-involvement and habitual in nature, making them highly susceptible to cognitive biases. Within the behavioral economics framework, status quo bias and present bias are predicted to reduce the probability of adopting energy innovations that require behavioral change, even when such innovations are economically efficient. The empirical findings of this study consistently confirm these theoretical predictions, indicating that the hypothesis that behavioral bias reduces consumer acceptance is not only statistically valid but also logically and conceptually coherent.

Furthermore, the magnitude of the effect of behavioral bias underscores that consumer resistance to renewable energy services is not driven by rejection of sustainability objectives, but rather by universal psychological mechanisms. Accordingly, this hypothesis reinforces the argument that failures in renewable energy adoption at the household level cannot be addressed solely through price based approaches or technical information provision. These findings extend the external validity of previous studies demonstrating that behavioral bias represents a structural barrier to the adoption of energy technologies.

In contrast, the hypothesis regarding the positive effect of social norms also receives strong theoretical and empirical support. Within behavioral economics and social norm theory, individual decisions are expected to be influenced by perceptions of others' behavior, particularly in decisions with moral and social dimensions such as energy consumption. The finding that social norms significantly increase consumer acceptance indicates that mechanisms of social conformity operate effectively in the context of renewable energy, thereby confirming that the proposed hypothesis is not only supported by empirical data but also aligned with predictions from social behavioral theory.

Comparison with prior empirical findings further strengthens the validity of the research hypotheses. Previous studies have shown that pro environmental attitudes and environmental awareness influence renewable energy adoption, yet they often fail to explain actual consumer behavior. This study goes beyond those limitations by demonstrating that, when tested simultaneously, behavioral bias and social norms possess greater explanatory power for consumer acceptance than stand alone rational economic variables. Thus, the hypotheses of this study are not only replicated in earlier literature but are also reinforced and deepened through a quantitative behavioral economics approach. Overall, the results confirm the central hypothesis that acceptance of renewable energy services emerges from the interaction between individual non rational tendencies and social influence. This confirmation positions behavioral economics not as an alternative perspective, but as an essential analytical framework in the study of renewable energy acceptance.

Reinforcing Policy and Service Design Implications Based on Confirmed Behavioral Hypotheses

The empirical confirmation of the research hypotheses has direct implications for the design of renewable energy services and related policy frameworks. Because behavioral bias has been shown to significantly reduce consumer acceptance, this finding strengthens the argument that technocratic and rational economic based energy service designs are insufficient to drive energy transition at the household level. Conceptually, these results reinforce the view that policy failure in the energy sector is often not caused by a lack of incentives, but by a mismatch between policy design and actual consumer behavior.

Conversely, the hypothesis regarding the strength of social norms provides a robust empirical foundation for the development of behavior based policy interventions. Since social norms are proven to significantly enhance consumer acceptance, this finding legitimizes the use of social and community oriented approaches in energy policy. Interventions such as social comparison based information, community energy programs, and the normalization of renewable energy use gain strong scientific justification from the results of this study.

In the context of everyday energy use, confirmation of these hypotheses indicates that energy transition should be understood as a process of collective behavioral change rather than merely the adoption of individual technologies. Accordingly, energy policies that are responsive to consumer behavior, as predicted by behavioral economics, have a higher probability of success than policies that rely solely on economic rationality. Overall, this discussion not only explains the research findings but also reinforces the validity of the hypotheses at theoretical, empirical, and policy levels. This study

emphasizes that the success of energy transition is highly dependent on the ability to integrate an understanding of consumer behavior into the design of renewable energy services and policies.

CONCLUSION

This study concludes that consumer acceptance of renewable energy services is significantly influenced by behavioral economics factors, particularly behavioral bias and social norms. Behavioral bias is shown to weaken consumer acceptance, indicating that non rational tendencies such as status quo maintenance and short term orientation constitute major barriers to the adoption of renewable energy services. In contrast, social norms act as a strong enabling factor, demonstrating that perceptions of others' behavior and social expectations significantly increase consumers' willingness to accept renewable energy services.

These findings confirm that rational economic approaches alone are insufficient to comprehensively explain household energy consumption behavior. By integrating a behavioral economics perspective into a quantitative model, this study strengthens the understanding that acceptance of renewable energy services results from the interaction between individual psychological mechanisms and social dynamics within the consumer environment. Therefore, the success of energy transition depends not only on technological availability and economic incentives, but also on the alignment between service and policy design and actual consumer behavior in everyday energy use.

Based on these findings, this study recommends that the development of renewable energy services and policies adopt a behavior based approach by minimizing psychological barriers and leveraging the strength of social norms. From a theoretical perspective, future research is encouraged to develop more comprehensive behavioral economics based models of energy acceptance. From a practical perspective, community based interventions and the normalization of renewable energy behaviors have strong potential to enhance the long term effectiveness of energy transition initiatives.

This study has several limitations. First, the analysis is based on cross-sectional survey data, which limits the ability to capture behavioral changes over time. Second, the study focuses on household consumers and does not differentiate between types of renewable energy services. Future research may extend this model by incorporating longitudinal data, additional behavioral variables, or comparative analyses across different energy technologies. Despite these limitations, this study provides empirical support for the integration of behavioral economics into renewable energy policy and service design.

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