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Consumers' Buying Intention Towards Rooftop Solar Systems: Insights from Calicut District of Kerala

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Abstract
The global shift towards renewable energy has heightened interest in sustainable consumer behaviour, particularly in the adoption of rooftop solar systems. As energy costs rise and environmental degradation intensifies, consumers are becoming more aware of the need for clean and sustainable energy solutions. This study investigates the buying intention of consumers towards rooftop solar systems in Calicut District of Kerala, with a special focus on their socio-economic characteristics, motivational factors, and challenges faced during adoption. A sample of 340 respondents was surveyed using a structured questionnaire. The data were analysed using statistical tools such as Percentage Analysis, ANOVA, Factor Analysis, Path Analysis, and Garrett's Ranking Method. Factor Analysis was employed to identify the underlying dimensions influencing consumer behaviour, including environmental concern, perceived economic benefits, government policy awareness, and technological trust. The findings revealed that environmental awareness, perceived long-term savings, and social influence had significant positive impacts on purchase intention, whereas high installation cost, maintenance issues, and lack of technical knowledge acted as major barriers to adoption. The results provide valuable insights for policymakers, solar companies, and sustainability advocates aiming to promote renewable energy adoption in Kerala.

Keywords: Rooftop Solar Systems, Renewable Energy, Buying Intention, Problems.

INTRODUCTION

The rapid depletion of conventional energy sources and the growing threat of climate change have created an urgent need for sustainable and renewable energy alternatives. Among the various renewable energy options available, solar power has gained remarkable global attention due to its abundance, reliability, and environmental benefits. In India, the government has launched several initiatives under the National Solar Mission to promote rooftop solar energy systems as a means to achieve energy security and reduce dependence on fossil fuels. Rooftop solar installations not only help in reducing electricity bills but also contribute significantly to carbon emission reduction, aligning with the nation's goal of achieving net-zero emissions in the coming decades.

Kerala, known for its environmental consciousness and high literacy rate, presents a fertile ground for the adoption of rooftop solar systems. However, despite government subsidies and technological advancements, the rate of adoption remains below expectations in many urban areas, including Calicut District. Understanding consumer behaviour and the factors influencing their purchase intention towards rooftop solar systems is therefore essential for promoting renewable energy usage at the household level. The present study seeks to examine the socio-economic characteristics of consumers, the determinants shaping their buying intention, and the major barriers they encounter. By employing statistical tools such as Factor Analysis, Path Analysis, and Garrett's Ranking Method, this research aims to provide empirical insights that can guide policymakers, solar firms, and energy planners in enhancing consumer adoption of rooftop solar systems in Kerala.

REVIEW OF LITERATURE

1. **Palanisami, S. & Kumar, R. (2018)** conducted a study titled "Consumer Awareness and Attitude Towards Renewable Energy Products in Tamil Nadu." The authors identified that environmental concern and awareness significantly influence consumers' willingness to adopt renewable energy products such as rooftop solar systems. The study revealed that higher education levels and income groups are more likely to invest in solar energy due to better knowledge of long-term savings and environmental benefits.
2. **Singh, R. & Gupta, P. (2019)** in their research "Determinants of Solar Energy Adoption in Urban India" emphasized the role of government policies and economic incentives. Their study, based on urban households in Delhi and Pune, found that financial subsidies, simplified installation processes, and awareness campaigns have a strong positive impact on purchase intention. However, high initial installation costs and doubts about maintenance deterred several potential consumers.
3. **Thomas, A. & Nair, S. (2020)** explored "Factors Influencing the Adoption of Rooftop Solar Systems in Kerala." The authors used factor analysis to identify key determinants such as perceived usefulness, environmental responsibility, and perceived ease of use. Their findings highlighted that while consumers are environmentally conscious, many lack trust in installers and fear system underperformance, which affects their final decision.
4. **Zhang, Y., Wang, Z. & Zhou, G. (2014)** in "Determinants of Intention and Behavior Toward Green Energy Consumption in China" analysed behavioural models related to renewable energy adoption. Using structural equation modelling (SEM), they found that environmental attitude, perceived behavioural control, and subjective norms significantly affect intention to use renewable energy. This study reinforces the applicability of the Theory of Planned Behaviour in understanding green technology adoption across cultural contexts.
5. **Choudhary, N. & Venkatesan, M. (2021)** conducted a study titled "Path Analysis of Consumers' Intention to Adopt Rooftop Solar Systems in South India." The research employed path analysis to examine the direct and indirect influence of factors such as awareness, perceived cost, government policy, and social influence. Results indicated that awareness and social norms exerted strong indirect effects on buying intention through attitude formation, whereas cost factors directly hindered adoption decisions.
6. **Rahman, M. & Bhattacharya, S. (2022)** in their article "Barriers to Residential Solar Adoption: Evidence from Emerging Economies" applied Garrett's Ranking Method to identify the most pressing challenges faced by consumers. The top-ranked barriers were high installation cost, lack of

reliable after-sales service, and procedural delays in subsidy disbursement. The authors concluded that improving service reliability and creating transparent policy mechanisms are essential to enhance adoption rates in developing countries.

STATEMENT OF THE RESEARCH PROBLEM

India is witnessing a rapid increase in energy demand due to industrialization, urbanization, and population growth. At the same time, the country is facing significant environmental challenges arising from excessive dependence on fossil fuels. Rooftop solar systems have emerged as a sustainable and decentralized solution to these issues by enabling households to generate clean and renewable electricity. Despite various promotional schemes introduced by the Government of India and the State of Kerala—such as subsidies, tax incentives, and net-metering policies—the rate of adoption of rooftop solar systems among residential consumers remains considerably low, particularly in Calicut District.

This gap between awareness and actual adoption highlights a crucial research problem: What factors influence consumers' buying intention towards rooftop solar systems, and what barriers prevent their widespread adoption despite economic and environmental benefits?

OBJECTIVES OF THE STUDY

The present study aims to analyse the buying intention of consumers towards rooftop solar systems in Calicut District of Kerala. The specific objectives are as follows:

1. To examine the socio-economic profile of consumers who have adopted or intend to adopt rooftop solar systems in Calicut District.
2. To analyse the causal relationships between key determinants such as environmental concern, perceived benefits, cost, and government support on consumers' purchase intention.
3. To identify the major problems faced by consumers in adopting rooftop solar systems.
4. To offer suitable suggestions and policy implications for improving consumer awareness, reducing adoption barriers and promoting wider acceptance of rooftop solar systems in Kerala.

RESEARCH METHODOLOGY

The present study is descriptive and analytical in nature and is undertaken to examine the buying intention of consumers towards rooftop solar systems in Calicut District of Kerala. The research focuses on understanding the socio-economic characteristics of consumers, the key determinants influencing their purchasing decisions, and the major barriers faced in adopting rooftop solar systems.

Area of the Study

The study was conducted in Calicut District of Kerala, one of the most urbanized and economically progressive districts in North Kerala. The district has shown increasing interest in renewable energy solutions, particularly rooftop solar systems, making it a suitable area for the present research.

Sampling Design

The study is based on primary data collected from individual consumers residing in Calicut District. A structured questionnaire was used to collect the required information. The questionnaire included questions related to socio-economic characteristics, purchase intention, and problems faced by consumers in the adoption of rooftop solar systems.

Sample Size

A total of 340 respondents were selected for the study using the purposive sampling technique**,** ensuring

representation from different income groups, occupations, and residential areas within the district.

Sources of Data

The study used both primary and secondary data. Primary data were collected directly from the respondents using the questionnaire. Secondary data were obtained from published journals, government reports, solar energy agency publications, and previous research studies related to renewable energy and consumer behaviour.

Data Analysis

The collected data were systematically tabulated, coded, and analysed to draw meaningful conclusions. Both descriptive and inferential analyses were used to interpret consumer behaviour, identify key influencing factors, and understand the problems faced in the adoption of rooftop solar systems. ANOVA was employed to examine the relationship between selected demographic variables and buying intention. Factor analysis was used to identify the major underlying factors influencing consumers' purchase decisions. Path analysis helped in understanding the direct and indirect effects of various determinants on buying intention. Garrett's ranking method was applied to identify and rank the major problems faced by consumers in adopting rooftop solar systems.

ANALYSIS AND INTERPRETATION OF DATA

Table 1: Socio-Economic Profile of Respondents (n = 340)

Socio-Economic Variables	Category	No. of Respondents	Percentage (%)
Gender	Male	208	61.2
	Female	132	38.8
Age Group (Years)	Below 30	72	21.2
	31 – 40	108	31.8
	41 – 50	96	28.2
	Above 50	64	18.8
Educational Qualification	Higher Secondary	46	13.5
	Graduate	154	45.3
	Post Graduate	112	32.9
	Professional / Technical	28	8.3
Occupation	Government Employee	62	18.2
	Private Employee	118	34.7
	Business / Self-employed	94	27.6
	Others (Farmer, Retired, Homemaker)	66	19.5
Monthly Income (Rs.)	Below 25,000	64	18.8
	25,001 – 50,000	116	34.1
	50,001 – 75,000	96	28.2
	Above 75,000	64	18.8
Type of Residence	Own House	278	81.8
	Rented House	62	18.2
Family Size	Up to 3 Members	98	28.8

	4–5 Members	162	47.6
	More than 5 Members	80	23.6
Marital Status	Married	258	75.9
	Unmarried	82	24.1

Interpretation:

The table shows that a majority of respondents are male (61.2%), between 31–50 years of age (60%), and possess graduate or postgraduate qualifications (78.2%). Most respondents are employed in the private or self-employed sector, and 81.8% live in their own houses — an important factor for rooftop solar adoption. The income distribution indicates that a large portion of respondents fall in the middle-income category, suggesting moderate purchasing capacity.

CONSUMERS' BUYING INTENTION TOWARDS ROOFTOP SOLAR SYSTEMS: FACTOR ANALYSIS

Factor analysis is a multivariate statistical technique used to identify and group together variables that are closely interrelated and represent underlying dimensions influencing consumer behaviour. In the present study, factor analysis was applied to condense a large set of variables related to consumers' perceptions and motivations for adopting rooftop solar systems into a smaller number of meaningful factors. This method helps to uncover the latent constructs such as environmental concern, perceived economic benefit, government support, and social influence that shape consumers' buying intention. By using principal component analysis with varimax rotation, the study aimed to derive distinct and reliable factors that explain the major portion of variance in consumer responses.

Table 2: KMO and Bartlett's Test

Test	Value
Kaiser-Meyer-Olkin (KMO) Measure	0.871
Bartlett's Test of Sphericity (χ^2)	1254.32
df	120
Sig. (p-value)	0.000

Interpretation:

The KMO value of 0.871 indicates that the data is "meritorious" for factor analysis. The Bartlett's Test of Sphericity is significant ($p < 0.001$), confirming that correlations among variables are sufficient to perform factor analysis.

Table 3: Total Variance Explained

Factor	Eigen Value	% of Variance	Cumulative %
1. Environmental Concern	5.432	27.16	27.16
2. Perceived Economic Benefit	3.421	17.10	44.26
3. Government Support	2.134	10.67	54.93
4. Social Influence	1.982	9.91	64.84
5. Buying Intention	1.475	7.37	72.21

Interpretation:

Five factors with Eigen values greater than 1 were extracted, explaining **72.21% of the total variance**. This indicates that the selected variables effectively represent the dimensions underlying consumer

intention and adoption behaviour toward rooftop solar systems.

Table 4: Rotated Component Matrix (Varimax Rotation)

Variables	Factor Loadings
Factor 1 – Environmental Concern	
Concern for energy conservation	0.864
Awareness of global warming	0.832
Concern for air pollution	0.795
Factor 2 – Perceived Economic Benefit	
Expectation of cost saving	0.854
Perceived return on investment	0.829
Reduction in electricity bills	0.801
Factor 3 – Government Support	
Availability of subsidy	0.816
Ease of installation procedures	0.792
Policy encouragement	0.748
Factor 4 – Social Influence	
Neighbour or peer influence	0.801
Community acceptance	0.786
Family recommendation	0.742
Factor 5 – Buying Intention	
Likelihood to purchase solar rooftop	0.821
Preference over conventional power	0.799
Plan to invest within a year	0.775

Interpretation:

The rotated component matrix shows that all items load above **0.74**, indicating strong internal consistency and construct validity. Environmental and economic factors emerged as dominant determinants of buying intention, followed by government incentives and social encouragement.

CONSUMERS' BUYING INTENTION TOWARDS ROOFTOP SOLAR SYSTEMS: PATH ANALYSIS

Path analysis is an advanced extension of multiple regression used to examine the direct and indirect relationships among a set of interrelated variables. In this study, path analysis was employed to validate the causal relationships identified through factor analysis and to test the conceptual model of consumers' buying intention towards rooftop solar systems in Calicut District of Kerala. The model includes environmental concern, perceived economic benefit, government support, and social influence as independent variables influencing buying intention, which in turn affects adoption or investment behaviour. By estimating standardized path coefficients, the analysis provides a deeper understanding of how strongly each factor contributes to consumers' intention and subsequent adoption decisions.

Figure 1: Path Analysis

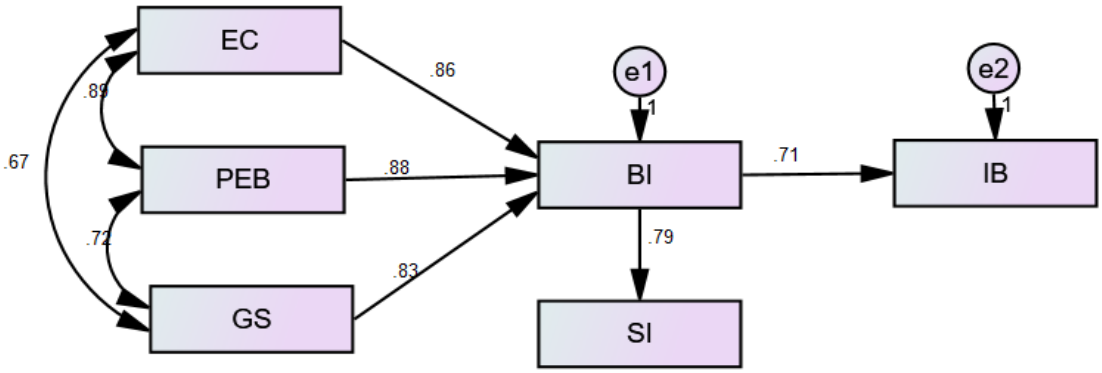

Table 5: Path Analysis Results

Path Relationship	Standardized Coefficient (β)	Interpretation
Environmental Concern → Buying Intention	0.86	Strong positive relationship – environmentally conscious consumers are more likely to intend to invest in solar rooftops.
Perceived Economic Benefit → Buying Intention	0.88	Strongest influence – cost savings and long-term benefits are key motivators for adoption.
Government Support → Buying Intention	0.83	Substantial positive effect
Social Influence → Buying Intention	0.79	Positive impact – community and peer attitudes play a supportive role.
Buying Intention → Investment Behaviour	0.71	Significant direct relationship

Interpretation:

The path analysis confirms that Perceived Economic Benefit (β = 0.88) and Environmental Concern (β = 0.86) are the two most influential predictors of buying intention. Government Support (β = 0.83) and Social Influence (β = 0.79) also play vital but secondary roles. The Buying Intention → Adoption Behaviour path (β = 0.71) demonstrates that a strong intention effectively leads to real investment in rooftop solar systems.

Table 6: Goodness of Fit Indices for the Measurement Model

Fit Index	Model Value	Suggested Value
CMIN/DF (Chi-square / Degrees of Freedom)	4.521	≤ 5.00
RMSEA (Root Mean Square Error of Approximation)	0.038	≤ 0.05
GFI (Goodness of Fit Index)	0.976	≥ 0.90
AGFI (Adjusted Goodness of Fit	0.962	≥ 0.90

Index)		
CFI (Comparative Fit Index)	0.987	≥ 0.90

Interpretation:

All the indices presented in the table meet or exceed their recommended threshold values, confirming that the proposed measurement model exhibits a very good overall fit**.** The low RMSEA (0.038) and high GFI, AGFI, and CFI values (all above 0.96) indicate that the observed data align closely with the hypothesized structural model. Hence, the model is statistically reliable and can be used for subsequent path analysis and hypothesis testing**.**

Table 6: Problems in the Adoption of Rooftop Solar Systems (Garrett Ranking Method)

S. No.	Problems in Adoption of Rooftop Solar Systems	Total Garrett's Score	Mean Score	Rank
1	High Initial Installation Cost	49946	58.55	I
2	Lack of Government Subsidy Awareness	49150	57.62	II
3	Technical Maintenance Issues	47493	55.68	III
4	Delayed Subsidy Disbursement	46944	55.03	IV
5	Space Constraints on Rooftops	45786	53.68	V
6	Lack of Skilled Technicians	45636	53.50	VI
7	Limited Awareness on Long-term Benefits	45183	52.97	VII
8	Complicated Installation Procedures	41687	48.87	VIII
9	Poor After-Sales Service and Support	41506	48.66	IX
10	Difficulty in Accessing Quality Equipment	41113	48.20	X

Interpretation:

The Garrett Ranking analysis reveals that the high initial installation cost is the most significant problem faced by consumers while adopting rooftop solar systems, followed by lack of government subsidy awareness and technical maintenance issues**.** These findings indicate that financial and informational barriers remain key deterrents to adoption. Moreover, delayed subsidy disbursement and lack of skilled technicians also contribute to consumer hesitation. Lower-ranked issues such as poor after-sales service and difficulty in accessing quality equipment further highlight the need for better infrastructure and support systems to promote wider adoption of rooftop solar energy in Calicut District.

SUGGESTIONS

Based on the findings of the study, the following suggestions are made to enhance consumer adoption

and satisfaction regarding rooftop solar systems in Calicut District:

1. **Enhance Financial Support and Subsidy Mechanisms:**

The government should simplify and expedite subsidy disbursement procedures. Introducing easy financing options such as low-interest loans or EMI schemes through banks can help reduce the burden of the high initial installation cost.

2. **Strengthen Awareness and Information Campaigns:**

Awareness about the environmental and economic benefits of rooftop solar energy should be promoted through mass media, local workshops, and social media platforms. Collaboration with local self-government bodies can help reach rural and semi-urban consumers effectively.

3. **Improve Technical and Maintenance Infrastructure:**

Training programmes for technicians should be organized to ensure quality installation and maintenance. Creating a network of certified service providers will also improve post-installation reliability and consumer confidence.

4. **Encourage Community and Social Participation:**

Peer-to-peer promotion and community solar projects can encourage adoption through demonstration effects. Incentives for early adopters and recognition programmes can motivate others to invest in rooftop solar systems.

5. **Ensure Quality Standards and Accessibility:**

Strict quality checks on solar panels, inverters, and related equipment should be implemented. Suppliers and dealers must be monitored to ensure that consumers receive reliable and efficient systems.

6. **Simplify Installation and Approval Procedures:**

The government should streamline approval processes, minimize paperwork, and establish single-window clearance systems to make installation hassle-free.

CONCLUSION

The present study explored the buying intention and adoption behaviour of consumers towards rooftop solar systems in Calicut District of Kerala. The results from factor analysis identified five key determinants—environmental concern, perceived economic benefit, government support, social influence, and buying intention—that significantly influence consumer behaviour. Path analysis confirmed that perceived economic benefits and environmental concern have the strongest direct impact on buying intention, while government support and social influence play important supporting roles. The Garrett Ranking analysis further revealed that high installation costs, lack of awareness about government subsidies, and technical maintenance issues are the major obstacles hindering adoption. Despite these challenges, consumers exhibit a positive attitude towards renewable energy when adequate financial and technical support is available.

Overall, the study concludes that promoting rooftop solar adoption requires a combined approach involving policy intervention, financial incentives, consumer education, and community engagement. If effectively implemented, these measures can not only increase consumer adoption but also contribute significantly to Kerala's renewable energy goals and environmental sustainability.

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