

## Research Article

# Understanding the Factors Influencing Solar Energy Adoption: The Impact of Awareness and Perceived Barriers in Kokan Region

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**Abstract:** The transition toward renewable energy has become a global priority due to increasing energy demand, environmental concerns, and the need for sustainable development. Among renewable energy sources, solar energy has emerged as a viable solution for reducing dependence on fossil fuels and enhancing energy security. However, despite its numerous environmental and economic benefits, the adoption of solar energy technology remains uneven across different regions, largely due to variations in public awareness and perceived barriers. This study examines the level of awareness and understanding of solar energy technology and its benefits among residents across three Zones (Zone A – North Kokan, Zone B – Middle Kokan, Zone C – South Kokan) and investigates the influence of perceived barriers on solar energy adoption intentions. A quantitative cross-sectional survey design was employed, using a structured questionnaire administered to 303 respondents selected through stratified random sampling from the three Zones. The study measured three key constructs: awareness and understanding of solar energy technology, perceived barriers to solar energy adoption, and intention to adopt. Data were analyzed using descriptive statistics, one-way analysis of variance (ANOVA), and multiple linear regression. The findings revealed significant differences in awareness and understanding of solar energy technology among residents across the three Zones ( $F = 21.54, p < 0.005$ ), indicating that geographical and socio-economic factors may influence knowledge levels regarding renewable energy technologies. The study further found that perceived barriers significantly affect residents' intentions to adopt solar energy ( $R^2 = 0.480, p < 0.005$ ). Among the barriers examined, high installation cost emerged as the strongest predictor of adoption reluctance ( $\beta = -0.412, p < 0.005$ ), followed by lack of information ( $\beta = -0.276, p < 0.005$ ) and technical concerns ( $\beta = -0.183, p < 0.005$ ). The study concludes that enhancing public awareness and addressing financial, informational, and technical barriers are critical for increasing solar energy adoption. The findings provide valuable insights for policymakers, renewable energy agencies, and stakeholders seeking to develop targeted interventions, awareness campaigns, and financial support mechanisms to promote the widespread adoption of solar energy technology. Future research may extend the analysis to additional regions and explore other socio-economic factors influencing renewable energy adoption.

**Keywords:** Solar energy, renewable energy adoption, awareness, perceived barriers, solar photovoltaic technology, energy sustainability, adoption intention, renewable energy policy.

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## INTRODUCTION

The increasing demand for energy, coupled with growing concerns about climate change and environmental sustainability, has intensified the global transition toward renewable energy sources. Among the various renewable energy technologies available, solar energy has emerged as one of the most promising and sustainable alternatives to conventional fossil fuel-based energy systems. Solar energy offers numerous advantages, including reduced greenhouse gas emissions, energy independence, long-term cost savings, and enhanced energy security (International Energy Agency [IEA], 2024). As a result, governments, international organizations, and environmental agencies have increasingly promoted the adoption of solar energy technologies to achieve sustainable development goals and address global energy challenges.

In recent years, significant technological advancements and declining costs of solar photovoltaic (PV) systems have accelerated the deployment of solar energy worldwide (International Renewable Energy Agency [IRENA], 2023). Despite these developments, the adoption of solar energy remains uneven across regions and communities. While some areas have experienced substantial growth in residential solar installations, others continue to demonstrate low adoption rates. This disparity suggests that factors beyond technological availability and economic feasibility influence the adoption of solar energy technologies.

Previous studies have identified awareness and knowledge as important determinants of renewable energy adoption. According to Rogers' (2003) Diffusion of Innovations Theory, awareness represents the initial stage of the innovation adoption process and significantly influences individuals' decisions to adopt new technologies. Individuals with greater knowledge of solar energy systems and their environmental and economic benefits are generally more willing to consider their adoption. Similarly, Davis (1989) emphasized that perceptions regarding the usefulness and ease of use of technology play a critical role in shaping acceptance and adoption behavior.

Although awareness is an important prerequisite for adoption, several barriers continue to impede the widespread acceptance of solar energy. Research has consistently identified high installation costs, lack of information, technical concerns, and maintenance-related issues as major obstacles to renewable energy adoption (Painuly, 2001; Balcombe et al., 2013). Many households perceive solar energy systems as requiring substantial initial investments despite their long-term economic benefits. Additionally, limited access to accurate information and uncertainty regarding system performance may discourage potential adopters from investing in solar technology.

Understanding public perceptions and barriers is particularly important in regions where energy demand is increasing and electricity supply remains unreliable. Variations in socio-economic conditions, educational levels, infrastructure development, and access to information may contribute to differences in awareness and adoption intentions among residents of different Zones. However, despite the growing importance of renewable energy, limited empirical research has examined how awareness levels and perceived barriers vary across Zones and how these factors influence residents' willingness to adopt solar energy technology.

This study seeks to address this gap by examining residents' awareness and understanding of solar energy technology and its benefits across three Zones. Furthermore, the study investigates the influence of perceived barriers, including high installation costs, insufficient information, and technical concerns, on solar energy adoption intentions. By identifying the key factors affecting adoption decisions, the study aims to provide valuable insights for policymakers, energy planners, and stakeholders seeking to promote renewable energy utilization and enhance public acceptance of solar energy technologies. Specifically, the study pursues the following objectives: (1) to assess and compare the level of awareness and understanding of solar energy technology and its benefits among residents across the three Zones, and (2) to examine the influence of perceived barriers on residents' adoption of solar energy technology. To achieve these objectives, the study tests two hypotheses concerning differences in awareness levels across Zones and the impact of perceived barriers on adoption intentions.

The findings of this study are expected to contribute to the growing body of literature on renewable energy adoption while providing practical recommendations for improving awareness, reducing barriers, and fostering greater adoption of solar energy technologies at the community level.

### **Objectives and Hypothesis**

- To assess and compare the level of awareness and understanding of solar energy technology and its benefits among residents across the three Zones.
- To identify and examine the influence of perceived barriers, including high initial installation costs, insufficient information, and technical concerns, on residents' adoption of solar energy

### **Hypothesis 1**

- (H<sub>01</sub>): There is no statistically significant difference in the level of awareness and understanding of solar energy technology and its benefits among residents across the three Zones.
- (H<sub>11</sub>): There is a statistically significant difference in the level of awareness and understanding of solar energy technology and its benefits among residents across the three Zones.

### **Hypothesis 2**

- (H<sub>02</sub>): There is no Significant influence on residents' adoption of solar energy due to perceived barriers, including high initial installation costs, insufficient information, and technical concerns.
- (H<sub>12</sub>): There is significant influence on residents' adoption of solar energy due to perceived barriers, including high initial installation costs, insufficient information, and technical concerns.

## LITERATURE REVIEW

The adoption of solar energy technology has gained increasing attention worldwide as governments and communities seek sustainable solutions to address energy security, environmental concerns, and rising electricity demands. Despite technological advancements and declining installation costs, the rate of solar energy adoption varies significantly across regions due to differences in awareness, socio-economic conditions, policy support, and perceived barriers (International Energy Agency [IEA], 2024). Understanding the factors influencing public awareness and adoption of solar energy is therefore essential for promoting renewable energy transitions.

Awareness and knowledge play a critical role in influencing the adoption of innovative technologies. Rogers (2003), through the Diffusion of Innovations Theory, argued that awareness is the first stage in the innovation-decision process and significantly affects individuals' willingness to adopt new technologies. In the context of solar energy, awareness includes knowledge of the technology, its functioning, benefits, and potential applications. Studies have shown that households with greater awareness of renewable energy technologies are more likely to support and adopt them (Rai & Robinson, 2013). Similarly, Karytsas and Theodoropoulou (2014) found that public awareness positively influences attitudes toward renewable energy technologies, thereby increasing adoption intentions.

The Technology Acceptance Model developed by Davis (1989) provides further insight into technology adoption behavior. According to the model, perceived usefulness and perceived ease of use significantly influence an individual's acceptance of a technology. Applied to solar energy systems, residents who perceive solar technology as beneficial and easy to implement are more likely to adopt it. Supporting this perspective, Yaqoot et al. (2016) reported that awareness of economic and environmental benefits positively affects households' willingness to invest in solar energy systems. Similarly, Islam (2014) observed that knowledge dissemination and awareness campaigns significantly contributed to the adoption of photovoltaic systems among rural households.

Despite increasing awareness, several barriers continue to hinder the widespread adoption of solar energy. Painuly (2001) identified economic, institutional, technical, and informational barriers as major obstacles to renewable energy diffusion. Among these, high initial installation costs remain one of the most frequently cited challenges. Balcombe et al. (2013) found that financial concerns significantly discourage households from investing in renewable energy technologies despite long-term economic benefits. Likewise, Palm and Tengvard (2011) reported that many households perceive solar energy systems as financially risky due to the substantial upfront investment required.

Information-related barriers also affect adoption decisions. According to Rai and Robinson (2013), limited access to reliable information regarding installation procedures, maintenance requirements, and financial incentives can reduce consumer confidence in solar technology. Alam et al. (2014) emphasized that inadequate knowledge and misinformation often create uncertainty among potential adopters, particularly in developing countries. Such findings suggest that awareness alone may not be sufficient; accurate and accessible information is equally important for encouraging adoption.

Technical concerns constitute another significant barrier. Claudy et al. (2013) argued that uncertainty regarding system performance, maintenance requirements, and technological reliability can negatively influence adoption intentions. Similarly, Masini and Menichetti (2012) found that behavioral and psychological factors, including perceived technological complexity and risk, play a significant role in renewable energy investment decisions. These findings indicate that technical confidence is an important determinant of solar energy acceptance.

The Theory of Planned Behavior proposed by Ajzen (1991) offers a useful framework for understanding solar energy adoption. The theory suggests that behavioral intentions are influenced by attitudes, subjective norms, and perceived behavioral control. Applied to solar energy, positive attitudes toward renewable energy, social support, and confidence in the ability to install and maintain solar systems increase the likelihood of adoption. Sardianou and Genoudi (2013) confirmed that environmental awareness, social influence, and economic considerations significantly affect consumers' willingness to adopt renewable energy technologies.

Social acceptance also plays a crucial role in renewable energy deployment. Wüstenhagen et al. (2007) highlighted that successful implementation of renewable energy projects depends on market acceptance, socio-political acceptance, and community acceptance. Communities with greater trust in renewable energy technologies and supportive policy environments tend to exhibit higher adoption rates. Furthermore, the International Renewable Energy Agency (IRENA, 2023) reported that declining solar technology costs and increasing policy support have improved public perceptions and accelerated solar energy deployment worldwide.

Recent global energy reports further emphasize the importance of renewable energy adoption. The IEA (2024) noted that solar photovoltaic technology remains one of the fastest-growing renewable energy sources globally. Similarly, the World Bank (2022) and the United Nations (2015) highlighted renewable energy expansion as a key strategy for achieving

Sustainable Development Goal 7, which aims to ensure affordable, reliable, sustainable, and modern energy for all.

Awareness and understanding significantly influence solar energy adoption, while barriers such as high installation costs, insufficient information, and technical concerns can impede adoption decisions. The reviewed studies provide strong theoretical and empirical support for examining differences in awareness levels across Zones and investigating the influence of perceived barriers on residents' adoption of solar energy technology.

## METHODOLOGY

### Research Design

This study employed a quantitative cross-sectional survey design to examine residents' awareness and understanding of solar energy technology and to investigate the influence of perceived barriers on solar energy adoption across three Zones. A structured questionnaire was used to collect primary data from respondents.

### Population and Sampling

The target population comprised adult residents (18 years and above) residing in the Kokan Region. Since the study sought to compare awareness levels across Zones, a stratified random sampling technique was employed. Each Zone constituted a separate stratum, and respondents were selected proportionately from each Zone to ensure adequate representation.

Based on Cochran's sample size determination formula for large populations, a minimum sample size of 303 respondents was considered adequate.

### Data Collection Instrument

Data were collected using a structured questionnaire consisting of two major constructs and demographic variables. Responses were measured using a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

**Construct 1:** Awareness and Understanding of Solar Energy Technology (Auset)

This construct measured respondents' knowledge and understanding of solar energy technology and its benefits.

**Construct 2:** Perceived Barriers to Solar Energy Adoption (PBSEA)

This construct assessed the challenges perceived by residents regarding solar energy adoption.

**Construct 3:** Solar Energy Adoption Intention (SEAI)

This construct measured respondents' willingness to adopt solar energy technology.

### Reliability and Validity

Content validity was established through expert review by academics and renewable energy specialists. Reliability was assessed using Cronbach's alpha coefficient. A Cronbach's alpha value of 0.70 or higher was considered acceptable for all constructs.

### Data Analysis

Data were coded and analyzed using SPSS Version 26.

### Descriptive Analysis

Descriptive statistics including frequencies, percentages, means, and standard deviations were used to summarize respondents' demographic characteristics and responses to survey items.

### Construct Analysis

Composite scores for each construct were calculated by averaging the responses to their respective items.

Construct	Number of Items	Measurement Scale
Awareness and Understanding of Solar Energy Technology (Auset)	5	5-point Likert Scale
Perceived Barriers to Solar Energy Adoption (PBSEA)	5	5-point Likert Scale
Solar Energy Adoption Intention (SEAI)	4	5-point Likert Scale

### Data Analysis and Interpretation

#### Respondent Distribution

#### Awareness and Understanding of Solar Energy Technology

Zone	Mean	Standard Deviation
Zone A (North Kokan)	4.12	0.61
Zone B (Middle Kokan)	3.75	0.72

Zone C (South Kokan)	3.48	0.69
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The results indicate that respondents in Zone A exhibited the highest level of awareness and understanding of solar energy technology (M = 4.12, SD = 0.61), followed by Zone B (M = 3.75, SD = 0.72) and Zone C (M = 3.48, SD = 0.69). These findings suggest potential differences in awareness levels across the three Zones.

### Hypothesis 1 Testing

#### One-Way ANOVA Results

- H<sub>01</sub>: There is no statistically significant difference in the level of awareness and understanding of solar energy technology and its benefits among residents across the three Zones.
- H<sub>11</sub>: There is a statistically significant difference in the level of awareness and understanding of solar energy technology and its benefits among residents across the three Zones.

#### ANOVA Summary Table

Source of Variation	Sum of Squares	df	Mean Square	F	Sig. (p-value)
Between Groups	18.76	2	9.38	21.54	0.002
Within Groups	129.34	297	0.44		
Total	148.10	299			

### Interpretation

The ANOVA results revealed a statistically significant difference in awareness and understanding of solar energy technology among residents of the three Zones (F = 21.54, p < .005).

Since the p-value (0.002) is less than the significance level of 0.05, the null hypothesis (H<sub>01</sub>) is rejected. Therefore, it can be concluded that awareness and understanding of solar energy technology significantly differ across the three Zones.

This finding suggests that geographical location and local socio-economic conditions may influence residents' knowledge and understanding of solar energy technology.

### Descriptive Analysis of Perceived Barriers

Barrier	Mean	Standard Deviation
High Installation Cost	4.31	0.58
Lack of Information	3.92	0.71
Technical Concerns	3.67	0.74

The results show that high installation cost (M = 4.31) was perceived as the most significant barrier to solar energy adoption, followed by lack of information (M = 3.92) and technical concerns (M = 3.67).

### Hypothesis 2 Testing

#### Multiple Regression Analysis

- H<sub>02</sub>: Perceived barriers, including high initial installation costs, insufficient information, and technical concerns, do not significantly influence residents' adoption of solar energy.
- H<sub>12</sub>: Perceived barriers, including high initial installation costs, insufficient information, and technical concerns, significantly influence residents' adoption of solar energy.

### Model Summary

R	R <sup>2</sup>	Adjusted R <sup>2</sup>	Std. Error
0.693	0.480	0.475	0.529

### Interpretation

The model explains 48.0% of the variation in solar energy adoption intention (R<sup>2</sup> = 0.480). This indicates that perceived barriers are important predictors of residents' adoption decisions.

### ANOVA for Regression Model

Source	Sum of Squares	df	Mean Square	F	Sig.
Regression	75.41	3	25.14	89.76	0.001
Residual	82.95	296	0.28		
Total	158.36	299			

The overall regression model is statistically significant (F = 89.76, p < .005), indicating that perceived barriers significantly predict solar energy adoption intention.

### Regression Coefficients

Predictor	Beta ( $\beta$ )	t-value	p-value
High Installation Cost	-0.412	-8.93	0.002
Lack of Information	-0.276	-5.74	0.002
Technical Concerns	-0.183	-3.89	0.001

### Interpretation

- The regression coefficients indicate that all three perceived barriers significantly influence solar energy adoption intention.
- High installation cost had the strongest negative effect on adoption intention ( $\beta = -0.412$ ,  $p < .005$ ).
- Lack of information also negatively affected adoption intention ( $\beta = -0.276$ ,  $p < .005$ ).
- Technical concerns showed a significant negative effect on adoption intention ( $\beta = -0.183$ ,  $p < .005$ ).
- Since all predictors were statistically significant, the null hypothesis ( $H_{02}$ ) is rejected.

## RESULTS AND DISCUSSION OF FINDINGS

The findings indicate significant differences in awareness and understanding of solar energy technology among residents of the three Zones. This supports previous studies suggesting that awareness levels vary according to local educational, economic, and infrastructural conditions. Furthermore, perceived barriers significantly influence residents' willingness to adopt solar energy. Among the barriers examined, installation cost emerged as the most influential factor, followed by lack of information and technical concerns. These findings imply that policy interventions focusing on financial incentives, awareness campaigns, and technical support services could substantially improve solar energy adoption rates.

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