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A Study on the Effectiveness of Solar Energy Utilization and Consumer Satisfaction

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***Abstract* – The increasing demand for energy has contributed to the growing adoption of solar energy among households, businesses, and agricultural users. Solar energy helps consumers reduce electricity costs and provides environmental benefits by reducing carbon emissions and dependence on fossil fuels. However, the effectiveness of solar energy utilization depends on consumer awareness, proper installation, regular maintenance, government support, and customer satisfaction. This study examines the effectiveness of solar energy utilization among consumers and identifies the factors influencing customer satisfaction. The study adopted a descriptive research design and collected primary data from 87 customers through a structured questionnaire. Secondary data were collected from research journals, books, government reports, and other relevant sources. Convenience sampling was used to select the respondents based on their accessibility and willingness to participate. The collected data were analysed using appropriate statistical tools. The findings indicate that most respondents are satisfied with their solar energy systems and appreciate the reduction in electricity expenses. Consumers also recognize the environmental benefits of solar energy and consider it a worthwhile investment. Statistical analysis revealed that customer satisfaction does not differ significantly based on gender or age, indicating relatively similar perceptions across demographic groups. The study concludes that greater consumer awareness, proper installation, effective after-sales support, regular maintenance, and increased government incentives can encourage wider adoption of solar energy. The findings provide useful insights for policymakers, solar-energy companies, and researchers seeking to promote sustainable and environmentally friendly energy solutions.**

***Keywords* – Solar Energy, Renewable Energy, Customer Satisfaction, Energy Utilization, Solar Photovoltaic Systems, Chi-Square Test, One-Way ANOVA Sustainable Development.**

I. INTRODUCTION

The world needs energy and this need is growing. At the time using fossil fuels is bad for the environment. So, people are looking for ways to get energy that are cleaner. One of the options is solar energy. It is good for the environment. There is a lot of it. New technology has made solar energy better and cheaper. Governments are also helping by making rules that support energy. This is why many people, businesses and industries are starting to use energy to make electricity.

Solar energy is very important for making sure we have a future. It helps reduce things in the air and makes us less dependent on energy sources that will run out. Many countries are spending a lot of money on energy to make sure they have energy and to stop climate change. India is also doing a lot to promote energy. They have programs like the National Solar Mission. Rooftop solar programs that help people use solar energy.

Even though solar energy is getting better and easier to use there are still things that affect how well it works. How well the system is installed how it is maintained how well it works what the government does to help how much people know about it. How much money is invested all matter. So, it is very important to understand what people who use energy think about it. This will help make rules for energy and improve the quality of service.

This study looks at how people who already use solar energy are doing. It checks if they are happy with their energy system if they are saving money on electricity if they are helping the environment if they know about government help and what made them decide to use solar energy. The study also uses statistics to see if things like age and where people live affect how happy they are with energy.

This research will help us understand what people think about energy. The results will help people who make rules about energy make decisions. It will also help companies that sell energy products and services get better. It will be useful for people who want to study energy in the future. Solar energy is an important topic and this study will contribute to the discussion about solar energy and how to make it better. The goal is to make solar energy work, for everyone who uses it and that includes people who use solar energy systems.

II. REVIEW OF LITERATURE

The review of literature gives us an understanding of what we are trying to do with solar energy. We are looking at

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what other people have found out about using energy, how happy customers are with it and what kinds of technology are being used. Some people who did studies before found out that because of technology help from the government people being more aware of the environment and money savings more and more people are using solar energy all around the world. But they also found out that there are some problems like it costs a lot to start it needs to be taken care of. Not many people know about it which makes it hard for everyone to use solar energy.

David et al. (2025) examined the application of solar panels in residential, commercial, and industrial settings. The study highlighted improvements in solar-panel efficiency, battery-storage technologies, and smart energy-management systems. These technological developments were found to improve energy utilization and user satisfaction. The authors concluded that technological innovation can make solar energy systems more efficient, reliable, and suitable for wider adoption.

Duque Oliva and Atherton Santamaría (2025) investigated the factors influencing solar-energy adoption in developing countries. The study found that consumer awareness, government support, financing facilities, and technical assistance significantly encourage adoption. It emphasized that financial accessibility and reliable technical support are important for overcoming barriers to solar-energy use. The authors recommended stronger cooperation between governments and private organizations to increase solar-energy accessibility.

Francisco-Hernandez et al. (2025) Looked at the ways renewable energy is being used especially combining solar and geothermal energy. They found out that using than one kind of renewable energy makes the energy more reliable and helps the environment. They said we need to keep making technology to make renewable energy work better. Pandey et al. (2022) examined the growth of solar energy generation and technological development in India. The study highlighted the important role of government initiatives, particularly the National Solar Mission, in promoting solar energy adoption. It found that policy support and solar energy projects have contributed significantly to the expansion of renewable energy. The authors also emphasized the need for better infrastructure, public awareness, and continued investment to sustain the growth of solar energy in India.

Obsidian et al. (2023) studied the global use of solar energy and its contribution to sustainable development. The study found that solar energy can provide clean electricity, support climate-change mitigation, and contribute to sustainable urban development. The authors emphasized that continuous investment in renewable energy technologies is necessary to reduce environmental impacts. The study concluded that solar energy has an important role in achieving long-ter+m environmental and economic sustainability.

Subburaj, et al. (2026) examined the effect of digital marketing strategies on consumer purchasing behaviour in the Indian market. The study highlighted the role of targeted digital campaigns, influencer marketing, online demonstrations, product comparisons, and customer reviews in shaping consumer preferences and purchase decisions. It demonstrated how digital-first initiatives can improve customer engagement and conversion. The study concluded that digital marketing has become an important component of consumer decision-making in the home appliance market.

Packiyam Subburaj (2025) conducted an empirical study on the factors influencing consumers' online purchasing behaviour and the challenges faced when shopping on e-commerce platforms. The study found that convenience, product availability, technological advancements, and customer satisfaction significantly encourage online shopping adoption among consumers. It also identified issues such as trust, security concerns, and delivery-related problems that impact purchasing decisions. The findings highlighted that understanding consumer preferences and behavioural patterns allows online retailers to formulate effective marketing strategies, improve service quality, and enhance customer satisfaction in the competitive digital marketplace.

Sathyanarayan, D. K., & Subburaj, P. (2021). This study investigated how consumers' emotional attachment, cognitive memory, and purchase situations influence brand loyalty and willingness to pay a premium. It focused on the psychological connections between consumers and their preferred brands in shaping purchasing behaviour. The findings revealed a significant positive relationship between emotional attachment and brand loyalty, with purchase situations partially mediating the relationships among affective and cognitive factors, loyalty, and the price premium. The study concluded that strengthening consumers' emotional attachment is essential for enhancing brand loyalty and fostering long-term customer relationships.

Purushothaman and Subburaj (2014) The study examined consumer perceptions and satisfaction levels regarding Aavin milk and its products. It highlighted the importance of product quality, price, availability, freshness, packaging, and distribution in influencing customer satisfaction. The study provided useful insights into consumer preferences and the factors that affect purchasing decisions in the dairy market. The findings emphasized the need for organizations to continuously understand customer expectations and improve product and service quality to maintain customer satisfaction and loyalty.

Overall, the studies show that solar energy is getting better and is a way to make energy without hurting the environment. Most of the studies say that new technology, help from the government caring about the environment and being happy with the service are all important for people to decide to use energy. Problems, like the cost of installing it taking care of it and not many people knowing about it are

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still there. These findings help us understand what we need to do for our study, which looks at how solar energy is working for the people who use it.

III. OBJECTIVES OF THE STUDY

General Objective

The main goal of this study is to see how well people are using energy. To know if people are happy with energy how they use it what they think is good about it and what makes them want to use it.

Specific Objectives

1. To learn about the people who are using energy systems.
2. To understand how people are using energy systems.
3. To find out if people are happy with how solar energy systems work how they are. How they are maintained.
4. To know what makes people want to use energy.
5. To see if people think they are saving money and helping the environment by using energy.
6. To find out if men and women are equally happy with energy systems.
7. To see if older people and younger people have opinions about how well solar energy systems work.
8. To give some advice on how to make people happier, with energy systems and how to get more people to use them.

IV. RESEARCH METHODOLOGY

The study adopted a descriptive research design to examine the effectiveness of solar energy utilization, consumer experiences, and satisfaction. Primary data were collected from 87 solar energy users through a structured questionnaire, while secondary data were obtained from books, research journals, government reports, and reliable energy-related sources. A convenience sampling technique was used to select respondents based on their availability and willingness to participate. The questionnaire consisted of demographic information and questions relating to solar-energy usage, electricity savings, installation, maintenance, environmental benefits, and customer satisfaction using a five-point Likert scale.

Data were collected voluntarily, checked for completeness, and entered into Microsoft Excel before being analysed using IBM SPSS Statistics. Percentage analysis, Chi-Square test, and One-Way ANOVA were used to examine respondent characteristics and differences in customer satisfaction across gender and age groups. The results were presented through tables and charts with appropriate statistical interpretations to facilitate clear understanding of the findings.

Hypotheses of the Study

Hypothesis 1

- H_0: There is no connection between gender and how happy people with solar energy.
- H_1: There is a connection between gender and how happy people with solar energy.

Hypothesis 2

- H_0: There is no difference in how solar energy works for different age groups.
- H_1: There is a difference in how solar energy works for different age groups.

V. RESULTS AND DISCUSSION

Introduction

This section is about what we found out from the people who are using energy systems. To get data from 87 customers who have installed and are using energy systems. We used IBM SPSS Statistics to analyse the data. Too looked at the demographics of the people who answered our questions. To use tests like the Chi-square test and One-Way ANOVA to see if our ideas were right. To know if solar energy systems are working well for these customers and what they thSink about them.

Demographic Profile of Respondents

The characteristics of the people who answered our questions. Out of the 87 people 53 were men and 34 were women. So, most of the people who answered our questions were men. Too looked at the age of the people. Most of the people 34.5% were between 26 and 35 years old. The next biggest group was people between 46 and 55 years old which was 23%. Then we had people between 36 and 45 years which was 20.7%. To also had people under 25 years which was 19.5% and people over 55 years old which was 2.3%. This tells us that young and middle-aged adults are the ones using energy systems the most.

The biggest group was government employees, which was 23%. Then we had employees, which was 19.5%. We also had occupations, business owners, self-employed people and farmers. When we looked at how money people made, to found out that most of them 31%, made between ₹25,000 and ₹50,000 per month. This tells us that solar energy systems are popular among middle-income households. We also found out that most of the people 46% lived in areas. Some people lived in areas, which was 27.6% and some lived in semi-urban areas, which was 26.4%. This tells us that people who live in areas are using solar energy systems more than people who live in other areas.

The demographic profile of respondents gives us details, about who they're. This includes their gender, age, education, job, income and where they live. Knowing these things helps us understand the results better.

- Too looked at the data using numbers and percentages to show how it is spread out.
- This helps in interpreting the findings effectively.
- The analysis is presented using frequency and percentage distributions.

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Chi-Square Analysis

To know if there was a connection between the gender of the people and how happy they were with their energy systems. To use a test called the Chi-square test to find out. The test told us that there was no difference between men and women. This means that men and women were equally happy with their energy systems.

RESULT:

TEST	VALUE
Pearson Chi-Square	3.235
Degrees of Freedom (do)	2
Asymptotic Significance (p-value)	0.198
Number of Valid Cases	87

SOURCE: Primary Data

Results:

- The Pearson Chi-Square test gave us a value of 3.235.
- The Degrees of Freedom is 2.
- The Significance or p-value is 0.198.

Interpretation:

- The p-value of 0.198 is than 0.05. So, we accept the hypothesis.
- This means that the Pearson Chi-Square test found no significant association between gender and overall satisfaction among the respondents.
- The Pearson Chi-Square test shows that the satisfaction levels are similar, for both female respondents.
- The gender of the respondents does not seem to affect their satisfaction levels according to the Pearson Chi-Square test.

One-Way ANOVA

To know if the age of the people affected how well their solar energy systems worked. To use another test called the One-Way ANOVA to find out. The test told us that there was no difference between the different age groups. This means that people of all ages were equally happy with their energy systems.

RESULT:

Dependent Variable: Mean score of Q12–Q25 (Effectiveness of Solar Energy Utilization)
Factor: Age Group

Hypotheses:

- **H_0:** There is no difference in the mean effectiveness scores among different age groups.
- **H_1:** There is a difference in the mean effectiveness scores among different age groups.

Results:

F-value = 0.705
Significance (p-value) = 0.591

Interpretation:

- The p-value is 0.591. This number is than 0.05. So, we accept the hypothesis. This means there is no difference in effectiveness scores among age groups. People, from age groups think similarly, about how well solar energy utilization works.

Discussion

Most of the people were happy with how their systems worked. They saved money on their electricity bills. They also liked that solar energy is good for the environment. We found out that solar energy systems are popular among people who're active and working especially those between 26 and 55 years old and those who make a middle income. To found out that people who live in areas are using solar energy systems more than people who live in other areas.

The tests we did told us that people from demographics are equally happy with their solar energy systems. This means that solar energy systems are working well for everyone. Even though people are happy with their systems we still need to improve some things like how the systemiser installed and maintained and how much people know about them. To need the government to help promote the use of energy. If we do these things we can make energy even better and more people will use it.

Overall solar energy is a way to make electricity. It is good for the environment. It saves people money. If we keep improving the technology and helping people understand how it works, we can get more people to use energy. This will be good for everyone and, for the planet.

VI. FINDINGS

The study on energy usage among customers had some interesting results. Here are the main points from the study on the effectiveness of energy utilization among customers:

1. The study found that most of the people who took part in the study were men, sixty-point nine percent of them were male. This shows that men are more likely to use energy systems.
2. Most of the people who took part in the study were between twenty-six and thirty-five years old, which is about thirty-four-point five percent. This means that young and middle-aged people are the ones who use energy systems the most.
3. A lot of the people who took part in the study had jobs either with the government or with companies. This suggests that people who have an income are more likely to invest in solar energy.
4. Thirty-one percent of the people who took part in the study had a family income between twenty-five thousand and fifty thousand rupees per month. This shows that people with incomes are starting to use solar energy systems because they save money in the long run.
5. Forty-six percent of the people who took part in the study lived in cities. This means that more people in

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cities use energy than people in rural or semi urban areas.

6. The study found that there was no difference in how happy men and women were with their solar energy systems. This means that both men and women are about equally happy with energy.
7. The study also found that people of ages were about equally happy with their solar energy systems. This means that people of all ages think that solar energy systems work well and are good for them.

VII. CONCLUSION

The study examined the effectiveness of solar energy utilization from the perspective of customers. It focused on customer satisfaction, willingness to use solar energy, electricity savings, and factors influencing adoption. The study recognized that understanding consumer perceptions is important for promoting renewable energy. Most respondents reported positive experiences with their solar energy systems. They indicated that solar energy helped reduce their electricity expenses and provided financial benefits. Respondents also appreciated the environmental advantages of solar energy and its contribution to reducing pollution. The findings suggest that solar energy is an attractive option for households and small businesses.

The statistical analysis showed that customer satisfaction did not differ significantly between male and female respondents. Similarly, satisfaction levels did not vary significantly across different age groups. These findings indicate that solar energy is generally accepted across different demographic categories. However, the study identified certain barriers to wider adoption, particularly the high initial installation cost. Limited awareness about government incentives and financial assistance was another important concern among consumers. Regular maintenance and proper technical support were also considered necessary for effective system performance.

Improved financing facilities, greater consumer awareness, quality installation, and efficient after-sales services can encourage adoption.The findings provide useful insights for policymakers, solar-energy companies, and researchers interested in renewable-energy development. However, the study is limited by its geographical coverage and relatively small sample size of 87 respondents. Future studies can include larger samples, different geographical locations, and additional factors influencing long-term consumer adoption.Overall, the study concludes that solar energy is a reliable, economical, and environmentally friendly energy option with significant potential for a cleaner and more sustainable future.

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