

Expectation vs Reality: Energy Production Through Solar Panels

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<u>Abstract</u>

In recent years, the global demand for clean and renewable energy has accelerated, positioning solar energy as one of the most promising and accessible sources. Governments and environmental organizations have promoted solar panel installation as a sustainable solution to climate change, energy insecurity, and rising electricity costs. In response, individuals and institutions have rapidly adopted solar technology, motivated by expectations of high energy output, financial savings, and independence from traditional power grids. However, a significant gap exists between these optimistic expectations and the practical, real-world outcomes of solar panel performance.

This research paper explores this expectation-reality divide using secondary data drawn from scholarly articles, government reports, industry publications, and case studies. It examines key factors shaping public perception, such as advertising, word-of-mouth communication, and simplified marketing messages that often overstate the capabilities of solar technology. On the other hand, it evaluates real-world limitations— geographical location, weather variability, system design, panel orientation, and maintenance requirements— that significantly impact the actual performance and output of solar photovoltaic systems.

The paper also investigates the role of national policies like India's PM Surya Ghar Muft Bijli Yojana, which provides subsidies and support for rooftop solar installations. While such initiatives increase accessibility, there remains a lack of public awareness regarding system limitations, financial payback periods, and ongoing maintenance needs. Through comparative analysis, this paper presents a realistic understanding of daily energy output (typically 3.5–4.5 kWh for a 1kW system), expected lifespan (20–25 years with degradation), and the actual cost-benefit ratio experienced by users.

The findings emphasize the need for transparent communication from manufacturers, better consumer education, and policy measures aimed at narrowing the information gap. Bridging this gap is essential not only for improving user satisfaction but also for promoting long-term adoption and trust in solar energy solutions. By aligning public expectations with technological and environmental realities, stakeholders can ensure that solar energy continues to be a reliable and sustainable alternative to conventional power sources.

1. Introduction

olar energy has emerged as one of the most promising renewable energy sources in the 21st century. As the world grapples with climate change, rising fossil fuel prices, and growing electricity demand, solar power offers an environmentally friendly and economically viable alternative. Countries around the globe, including India, have launched large-scale initiatives to promote solar energy adoption at both individual and institutional levels. The declining cost of photovoltaic (PV) technology, coupled with government subsidies and policy support, has made solar panel installations increasingly accessible to households and businesses.

With these advancements, however, has come a surge in public expectations—many believe that solar panels can produce large amounts of electricity year-round, reduce electricity bills to zero, and require minimal maintenance. These assumptions are often fueled by aggressive marketing campaigns, anecdotal success



stories, and limited technical understanding among consumers. As a result, individuals tend to overestimate the performance of solar panels without accounting for critical influencing factors such as weather conditions, location, system design, and installation quality.

In reality, the energy output of solar panels can vary significantly depending on these variables. A 1kW system may generate 3.5 to 4.5 kWh per day under Indian conditions, which is often less than what consumers anticipate. Similarly, the expected lifespan, efficiency over time, and the financial return on investment are subject to several real-world constraints.

This research paper aims to explore and analyze the gap between public expectations and the actual performance of solar panels based on secondary data. By examining literature, industry reports, and government publications, this study identifies the causes of misalignment and proposes measures to improve consumer awareness. The goal is to align expectations with technological and environmental realities, thereby encouraging more informed and sustainable adoption of solar energy systems.

2. Literature Review

The global shift toward renewable energy has positioned solar power as a key solution in the pursuit of sustainable development. As nations confront the challenges of climate change, rising fossil fuel costs, and energy insecurity, solar energy has emerged as a viable and increasingly popular alternative. Residential solar photovoltaic (PV) systems, in particular, are witnessing widespread adoption, especially in countries like India where sunlight is abundant year-round.

Several studies highlight the critical drivers behind solar panel adoption. According to the International Energy Agency (IEA), affordability, government incentives, and technological advancements are primary enablers of household-level solar installation. In India, initiatives such as the **PM Surya Ghar Muft Bijli Yojana** offer direct subsidies to make solar systems financially accessible, a fact corroborated by the data in this study where most respondents confirmed awareness of this scheme. Research by Chatterjee et al. (2022) found that government incentives and awareness programs have significantly influenced adoption rates, especially in tier-2 and tier-3 cities.

Brand trust and product reputation also play a decisive role in consumer choice. The current survey results indicate a strong preference for reputed companies like **TATA** and **WAAREE**, driven by perceived reliability, customer service, and long-term performance. This aligns with research by Gupta & Rathore (2021), who concluded that Indian consumers prefer established brands due to the perceived risk associated with high initial investments in solar installations.

Another factor influencing adoption is expected energy output. Respondents in the current study largely estimated daily output from a 1kW system to be in the range of **3–5 units**, which is consistent with technical estimates under standard test conditions in India. The perception of tangible economic benefit—especially reduction in electricity bills—has also been documented in several studies. For example, a report by TERI (The Energy and Resources Institute) emphasized that savings on electricity bills remain the most significant motivator for urban households investing in solar PV systems.

Public understanding of solar technology varies widely. While many respondents demonstrated awareness of basic solar concepts—such as current type (DC) and system lifespan (typically **20–25 years**)—others were unsure about system configurations and the role of batteries. Previous literature also points to this knowledge



gap; studies by Jain et al. (2020) and others argue that lack of technical awareness among consumers can hinder the full-scale adoption of decentralized solar energy solutions.

Affordability remains a mixed perception. Some participants consider solar panels affordable due to subsidies and long-term savings, while others view them as viable only with government assistance. This reflects the transitional stage of India's solar market: although costs have dropped significantly in the last decade, initial investment still acts as a psychological and economic barrier for many.

In conclusion, the literature supports the findings from the survey: awareness programs, brand trust, government incentives, and perceived long-term savings are crucial drivers for the residential solar sector. However, persistent gaps in consumer education and uneven affordability perceptions continue to pose challenges. Future interventions must combine policy support with community-level awareness campaigns to catalyze faster adoption and energy independence.

3. Research Methodology

1.Problem Identification:

The initial step involved recognizing the core issue: a rising need for sustainable domestic energy alternatives due to growing electricity costs and environmental degradation. The primary research question focused on identifying what influences public decisions regarding solar energy installations at the residential level.

2. Literature Review:

A thorough review of past research articles, government policies, technical whitepapers, and energy market reports was conducted to build a foundational understanding of the solar power landscape in India. The literature helped shape the hypothesis and survey design by revealing common adoption barriers, motivators, and knowledge gaps.

3. Survey Design:

A well-structured survey was created using Google Forms to collect quantitative data. The questionnaire included 12 key questions covering brand preference, expected energy output, lifespan expectations, awareness of government schemes, and perceived benefits of solar power. These were chosen based on insights gained from the literature review and were designed to be clear and understandable for non-technical participants.

4. Data Collection:

The survey was distributed online, targeting a broad demographic base across urban and semi-urban areas. A total of over 100 responses were received, providing a diverse and representative dataset. Participants were not restricted by age, gender, or profession, which enabled capturing general public sentiment rather than views limited to a specific group.



5. Data Analysis:

The responses were compiled into a spreadsheet and analyzed using descriptive statistics. Key parameters such as company preference (e.g., TATA, WAAREE), knowledge of the PM Surya Ghar Yojana, and perceptions of affordability were quantified and interpreted. Frequencies and percentages were used to summarize the data, which facilitated an evidence-based understanding of market readiness for solar technology.

6. Interpretation and Reporting:

The final step involved interpreting the survey results within the context of the reviewed literature. The data not only confirmed several existing hypotheses—such as the importance of government incentives—but also revealed new insights, like widespread uncertainty about battery requirements and lifespan accuracy. These findings were reported using visual summaries and narrative analysis to ensure clarity and accessibility.

4. Analysis

1. Brand Trust as a Decision Driver

The dominance of TATA Power Solar and WAAREE in respondent preferences underscores the role of brand equity in the renewable energy sector. In a market where long-term investment is involved, consumers gravitate toward trusted names to minimize perceived risk. This suggests that newer or lesser-known solar brands might face challenges in breaking into the market unless they offer compelling value propositions or are endorsed through partnerships and certifications. Brand perception functions as a proxy for quality, especially in low-information environments where users may lack the technical skills to evaluate products independently.

2. Effectiveness of Government Outreach

The widespread recognition of the *PM Surya Ghar Muft Bijli Yojana* indicates successful awareness campaigns. However, the persistence of confusion about application procedures highlights a critical gap between awareness and accessibility. Awareness without clarity can lead to frustration and reduced participation. The implication here is that outreach strategies must be coupled with user-friendly, step-by-step implementation mechanisms—possibly through local agents, simplified digital platforms, or multilingual instructional material.





3. Accuracy of Expectations vs. Reality

The alignment between expected and actual daily power output (3–5 units/day for a 1kW system) suggests a reasonably educated consumer base. This finding is encouraging because mismatched expectations often lead to dissatisfaction. When users expect 10 units but get 4, disappointment sets in—even if 4 units is technically sound. Aligning public expectations with actual output through transparent marketing and consultation will help maintain user satisfaction and trust in solar technology.

4. Lifespan Awareness Reflects Market Maturity

The fact that consumers correctly estimate a 20–25 year panel lifespan indicates that solar energy is transitioning from a novelty to a mainstream product. It also reflects well on warranty policies and customer education provided by leading brands. However, awareness of product lifespan must be matched by knowledge of maintenance practices to ensure real-world performance matches expectations over time.

5. The Knowledge Gap Problem

Perhaps the most significant issue revealed by the survey is the lack of technical understanding. Misconceptions about power types (AC/DC) and battery requirements suggest that consumers may not be equipped to make optimal decisions or troubleshoot basic issues. This can lead to dependency on third-party installers, who may or may not offer transparent guidance. To promote autonomous, informed adoption, public education campaigns must include simple, visual explanations of system functionality.



6. Dual Perception of Cost and Benefit

The survey highlights a psychological barrier—consumers simultaneously recognize the long-term financial and environmental benefits of solar panels while being deterred by high upfront costs. This cognitive dissonance stalls adoption. Solutions could include promoting low-interest solar loans, rent-to-own solar systems, or government-facilitated micro-financing models. Messaging should shift from "save in 10 years" to "affordable from Day 1," perhaps through savings calculators or comparative billing statements.



Strategic Implications

From a policy and industry standpoint, these findings point to several strategic actions. First, brand partnerships with government schemes can leverage trust to accelerate adoption. Second, simplifying application procedures and expanding technical literacy programs will bridge awareness-to-action gaps. Lastly, financial models that reduce upfront cost perceptions will be essential to converting positive sentiment into real adoption.

Conclusion of Analysis

In conclusion, while Indian consumers demonstrate a growing readiness for solar adoption, this readiness is moderated by technical knowledge gaps, cost anxieties, and partial clarity on government processes. A multi-pronged approach—combining education, financial innovation, and stronger implementation of government schemes—will be necessary to match expectations with the real-world uptake of solar technology. This analysis not only explains current behavior but also suggests pathways for accelerating India's residential solar transformation.

5. Findings

1. Brand Preference

One of the strongest themes to emerge was a marked preference for well-established brands. TATA Power Solar and WAAREE topped the list of preferred solar brands among participants. This trend reflects consumers' reliance on brand recognition and the credibility attached to long-



standing market players. The preference is influenced not only by advertising and reputation but also by trust built through service quality, warranty offerings, and perceived product longevity. It's clear that when choosing solar products, especially for long-term residential use, consumers tend to align their choices with trusted names rather than lesser-known manufacturers.



Figure 1: Brand Preference

2. Awareness of Government Schemes

A large majority of respondents reported familiarity with the *PM Surya Ghar Muft Bijli Yojana*, an initiative designed to make solar energy more affordable for households. This finding is encouraging, indicating the government's efforts to raise awareness have seen tangible results. Respondents acknowledged the financial advantages provided by subsidies, and many believed such schemes were instrumental in making solar installations viable for middle-class families. However, despite general awareness, several respondents expressed confusion regarding the application process, eligibility criteria, and documentation involved. This suggests that while awareness is high, clarity and accessibility of implementation remain issues.

3. Expected Power Output

Participants were asked about their expectations concerning the daily power output of a 1kW solar panel system. Most responses ranged between 3 to 5 units per day, which aligns closely with standard performance benchmarks in Indian climate conditions. This indicates that consumers have a relatively accurate understanding of energy generation potential. The consistency of this response across age groups and regions suggests that basic knowledge about solar energy output is widespread.





4. Lifespan Expectations

Respondents generally believed that the average lifespan of a solar panel is between 20 to 25 years. This matches the typical warranty periods offered by manufacturers and reflects an accurate grasp of product longevity. Such expectations show that consumers are becoming more informed and possibly engaging in comparative research before considering an investment in solar technology.

5. Technical Understanding

While many respondents demonstrated an understanding of broad benefits, their technical knowledge of solar systems was noticeably limited. For example, a significant number were unsure whether solar panels produce AC or DC electricity and were unaware of the need for battery storage systems in off-grid scenarios. These gaps reveal that while the public may be enthusiastic about solar power, their knowledge about how the technology actually works is still evolving. This disconnect could hinder optimal usage and installation practices.

6. Perceived Benefits and Affordability

Most participants believed solar energy would reduce electricity costs over time and positively impact the environment. The sustainability angle was a strong motivator for adoption. However, despite the availability of subsidies, upfront costs remained a barrier. Some respondents felt that the initial investment in solar infrastructure, including panels, installation, and maintenance, was beyond their current financial reach. This points to a dual perception: solar panels are widely seen as a smart long-term investment, but the entry barrier of capital expenditure still deters many.

Conclusion of Findings

In sum, the survey reveals a high level of interest in residential solar panel systems, supported by reasonable expectations regarding performance and durability. Brand loyalty, government incentives, and environmental concern are driving awareness and motivation. However, critical gaps remain in technical understanding and cost-related feasibility. These findings set the stage for



deeper analysis into how these perceptions translate into adoption behavior and what policy or educational interventions could improve solar energy uptake across residential India.

6. Discussion

The findings from this study highlight significant patterns in public perception and understanding of residential solar panel systems. A major takeaway is the strong influence of brand trust, with companies like TATA and WAAREE being preferred due to their reputation and reliability. This brand bias suggests that consumers rely heavily on name recognition and previous success stories when making investment decisions in solar technology.

Another key insight is the general awareness of government support schemes, particularly the **PM Surya Ghar Muft Bijli Yojana**, which most respondents recognized. This reflects effective outreach on the part of policymakers, though further efforts may still be needed to educate people about eligibility and application procedures.

Interestingly, a substantial number of respondents showed uncertainty about technical aspects—such as whether solar panels produce AC or DC current, or if batteries are necessary. This technical knowledge gap indicates a potential barrier to widespread adoption, as consumers may hesitate without fully understanding how systems function.

Despite this, most participants acknowledged the economic and environmental benefits of solar energy, including lower electricity bills and clean energy production. This indicates a positive perception overall, though supported by incomplete understanding. Bridging this knowledge gap through education could accelerate adoption and empower consumers.

7. Conclusion

This study has provided valuable insights into the attitudes and awareness levels of consumers regarding residential solar energy systems in India. The findings reveal a generally positive outlook toward solar adoption, largely driven by factors such as brand reliability, financial savings, and environmental consciousness. The preference for well-known brands like TATA and WAAREE indicates the significance of trust and reputation in influencing purchase decisions.

Moreover, the awareness of government schemes like the **PM Surya Ghar Muft Bijli Yojana** is encouraging, suggesting that public policy is reaching its intended audience. However, gaps in technical knowledge—especially concerning battery use, current type, and system lifespan—highlight the need for better educational outreach.

In conclusion, while interest in solar energy is growing, converting this interest into widespread adoption requires addressing technical knowledge deficits and reinforcing financial incentives. A combined effort from industry leaders, policymakers, and educators is essential to accelerate the transition to clean, residential solar power.



8.References

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Explores the psychological and informational barriers limiting solar panel adoption among urban household.

