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"Public Perception and Acceptance of Solar Energy in the Suburban Areas of Mumbai"

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I. Introduction

The global shift toward renewable energy is a critical step in addressing climate change and achieving sustainable development. Among various renewable energy sources, solar energy has emerged as a leading solution due to its environmental benefits, scalability, and potential for widespread adoption. India, with its vast solar potential of approximately 5,000 trillion kWh annually, has embraced solar power as a cornerstone of its energy transition. Initiatives such as the National Solar Mission (NSM) aim to position the country as a global leader in solar energy, contributing to both energy security and climate mitigation goals.

In Maharashtra, the solar energy sector has gained momentum, supported by abundant sunlight and government initiatives. Despite this progress, the adoption of solar energy technologies in urban areas like Mumbai suburbs remains uneven. Barriers such as lack of awareness, high initial costs, and infrastructural challenges hinder the widespread adoption of solar energy. This study examines public perceptions and acceptance of solar energy in Mumbai suburbs, exploring the factors influencing adoption and proposing strategies to overcome barriers.

II. Literature Review

The transition toward renewable energy sources, particularly solar energy, has become essential due to the environmental and economic implications of conventional energy consumption. Numerous studies have explored the development, adoption, and impact of solar energy products across global and Indian contexts.

Sharma, Tiwari, and Sood (2012) examined the strategic importance of solar energy in India, emphasizing its role in environmental conservation, economic growth, and energy security. Their study highlighted the significance of policy frameworks and technological advancements in facilitating solar adoption. Similarly, Dawn et al. (2016) noted that rising electricity demand and supply constraints necessitate a shift toward sustainable energy sources, with solar energy being central to achieving balance in India's energy ecosystem.

Focusing on market dynamics, Kar, Sharma, and Roy (2016) evaluated the development of the solar energy sector in India, identifying challenges such as grid integration, investment barriers, and limited consumer awareness. They advocated for improved infrastructure, policy reforms, and domestic manufacturing to overcome these obstacles. Complementing this, Raina and Sinha (2019) provided an in-depth analysis of India's solar policies, emphasizing the need for technological innovation, financial support, and targeted public outreach to improve solar adoption rates.

Ali and Alabid (2022) presented a global perspective on solar energy, linking it to job creation, sustainable development, and environmental protection. Their work underscored the versatility of solar applications and its transformative potential in the global energy landscape.

At the micro level, Chavan and Welling (2016) investigated the impact of product availability on the use of solar technologies in Mumbai. Their research revealed that easy access to solar products such as solar water heaters significantly influenced consumer adoption. Conversely, products like solar inverters and LED lights suffered from lower awareness and availability, hampering their uptake. The study advocated for strong government intervention and public education to boost solar energy utilization in urban India.

Forecasting solar energy production is also critical for operational efficiency. Mohanty et al. (2017) explored forecasting methods applicable to India's energy planning, citing the importance of predictive tools for grid integration and energy management. Sharma (2011) emphasized the economic potential of solar energy, framing it as a lucrative investment opportunity amid the declining viability of fossil fuels.

Together, these studies illustrate that while the potential for solar energy adoption in India is vast, its actualization depends on overcoming infrastructural, financial, and informational barriers. This review provides the foundation for further investigation into the socio-economic and cultural factors influencing solar energy

adoption in Mumbai's suburbs, with a focus on evaluating government interventions and community awareness strategies.

III. Research Methodology

This study adopts a **mixed-methods approach**, combining both quantitative and qualitative research techniques to gain comprehensive insights into public perception and acceptance of solar energy in the Mumbai suburbs.

1.ResearchDesign:

A **descriptive and exploratory research design** was used to capture detailed information about awareness levels, attitudes, and barriers associated with solar energy adoption. The design facilitates a deeper understanding of both statistical trends and contextual narratives.

2.Sampling Technique and Population:

The target population comprises residents from various socio-economic backgrounds within the suburban areas of Mumbai. A **stratified random sampling** method was employed to ensure diverse representation across demographics such as age, income, education, and occupation.

3. Data Collection Tools:

- **Quantitative Data** was collected through structured questionnaires administered both online and offline, focusing on awareness, attitudes, myths, and willingness to adopt solar energy.
- **Qualitative Data** was gathered using **in-depth interviews** and **focus group discussions** with residents, community leaders, and local officials involved in solar energy advocacy.

4.DataAnalysisTechniques:

Quantitative responses were analysed using statistical tools such as SPSS to identify trends, correlations, and significant factors affecting solar energy perception. Thematic analysis was applied to qualitative data to uncover underlying sentiments, misconceptions, and behavioural drivers.

5.Scope of Reliability and Validity:

The tools were pre-tested through a pilot survey to ensure clarity, relevance, and consistency. Adjustments were made based on feedback to enhance the reliability and validity of the instrument.

6. Ethical Considerations:

All participants were informed about the purpose of the study, and their consent was obtained prior to data collection. Anonymity and confidentiality were strictly maintained throughout the research process.

Data Analysis

The survey included 61 respondents from Mumbai suburbs. The demographic distribution is as follows:

Table 1

Demographic Factor	Category	Percentage (%)
Age	18-30	27.9
	31-42	29.9
	43-55	27.9
	56-68	14.3
Gender	Male	45.9
	Female	54.1
Employment Status	Fully Employed	32.8
	Part-time Employed	18.0
	Unemployed	21.3
	Retired	13.1
	Student	14.8
Household Income (₹)	Below 20,000	36.1
	20,000–50,000	32.8
	50,000–1,00,000	23.0
	Above 1,00,000	8.2

Awareness and Perceptions

The survey revealed high awareness of solar energy among respondents. Around 70% were familiar with the concept, predominantly through informal channels such as friends and family. Formal educational sources were notably underutilized.

Table 2

How Respondents Learned About Solar Energy	Percentage (%)
Friends and Family	27.9
Advertisements	26.2
Online Research	26.2
News Outlets	19.7

Adoption Rates and Intentions
The data showed that 26.2% of respondents had already installed solar panels, while 52.5% expressed a willingness to consider installing them. Of the remaining, 35% rated their likelihood of installing solar panels in the next five years at 4 or 5 (on a scale of 1 to 5).

Key Barriers to Adoption
Respondents identified several barriers to adopting solar technology, with lack of information being the most cited factor.

Table 3

Barrier	Percentage (%)
Lack of Information	57.4
High Initial Costs	44.3
Concerns About Reliability	44.3
Insufficient Infrastructure	38.0

Factors Influencing Adoption
Respondents ranked various factors on a scale of 1 (least important) to 7 (most important) for influencing solar adoption.

Table 4

Factor	Weighted Average Score
Cost Savings on Energy Bills	4.84
Environmental Concerns	4.39
Government Schemes/Subsidies	4.43
Technological Advancements	3.48
Availability of Infrastructure	3.26
Reliability of Solar Panels	3.03
Aesthetic Compatibility	2.21

Awareness of Government Initiatives
While 45.9% of respondents were unaware of government subsidies, the remaining respondents primarily recognized the **PM KUSUM Scheme** and **PM Surya Ghar Murti Bijli Yojana**.

Table 5

Government Initiative	Awareness (%)
PM KUSUM Scheme	68.5
PM Surya Ghar Murti Yojana	31.5

Table 6: Factors Influencing Solar Energy Adoption (Scale 1–7)

Factor	1	2	3	4	5	6	7	Total Responses	Weighted Average
Cost savings on energy bills	7	3	2	10	14	9	16	61	4.84
Environmental concerns	4	8	5	10	15	15	4	61	4.39
Government schemes and subsidies	4	5	11	10	11	12	8	61	4.43
Technological advancements	5	10	11	25	7	2	1	61	3.48
Availability of infrastructure	9	11	20	7	8	2	4	61	3.26
Reliability and durability	12	17	11	8	7	3	3	61	3.03
Aesthetics & home design compatibility	27	12	14	2	4	0	2	61	2.21

Table 7: Support for Solar in Community Development Projects (Scale 1–5)

Rating	Percentage of Respondents
4 or 5	67%
1 to 3	33%

Table 8: Participation in Solar Energy Educational Programs

Response	Percentage of Respondents
Never participated	62.3%
Participated (any time)	8–10%

Table 9: Common Myths/Misconceptions About Solar Panels

Myth/Misconception	Heard By Many Respondents
Only effective in sunny regions	✓
Unreliable during cloudy days	✓
Panels require frequent maintenance	Partial
Installation is too complex	Partial

Table 10: Ways to Dispel Solar Energy Myths

Proposed Method	Popular Among Respondents
Real-life success stories	✓
Government awareness campaigns	✓
Addressing local resident concerns	✓
Technical workshops and demonstrations	Partial

Table 11: Factors Encouraging Solar Adoption

Encouraging Factor	% of Respondents
Awareness and proper knowledge	24.6%
Positive experiences/testimonials	21.3%
Low installation cost	19.7%
Government subsidies/initiatives	16.4%
Other (e.g., peer influence, media)	Remainder

Table 12: Perceived Societal Benefits of Solar Adoption

Benefit	Selected by Respondents
Helps mitigate climate change	✓
Provides energy independence	✓
Reduces dependence on fossil fuels	✓
Enhances community resilience	Partial

Interpretation of Results

- **Demographic Insights:** Awareness levels and interest in solar energy adoption were higher among respondents in the 31-42 age group, reflecting their financial stability and environmental consciousness.
- **Awareness Gaps:** Despite significant awareness of solar energy, many respondents lacked knowledge about available subsidies, pointing to an information dissemination issue.
- **Barriers to Adoption:** The upfront cost remains a significant hurdle, underscoring the need for financial incentives.
- **Key Motivators:** Cost savings and environmental benefits are the primary drivers of solar adoption. Awareness campaigns should emphasize these aspects to maximize impact.
- **High Awareness, Moderate Engagement**: While awareness of solar energy is relatively high in Mumbai's suburbs, actual participation in educational initiatives remains limited.
- **Economic Viability Drives Adoption**: The most compelling motivator is cost savings, followed by environmental concerns and government incentives.
- **Knowledge Gaps & Misconceptions Persist**: Misbeliefs about solar efficiency, especially in non-sunny conditions, are prevalent and need targeted correction.
- **Infrastructure & Design Limitations**: Space constraints, particularly in urban areas, and concerns about aesthetics present adoption barriers.
- **Peer Influence & Social Proof Matter**: Testimonials from early adopters and community-led initiatives can drive greater acceptance.
- **Cultural & Social Norms Play a Role**: Perceptions of status and energy-related cultural attitudes influence how renewable solutions are received.
- **Environmental Motivation Is Growing**: A significant portion of respondents see solar as a clean, responsible alternative to fossil fuels, reinforcing its relevance in sustainable development.

IV. Conclusion:

The findings highlight a promising yet complex landscape for solar energy adoption in Mumbai's suburbs. While awareness is notably high—particularly among the financially stable and environmentally conscious 31–42 age group—engagement and actual adoption lag due to several persistent barriers. Chief among these are the high upfront costs, limited knowledge of government subsidies, and lingering misconceptions about solar efficiency. Urban infrastructure constraints and aesthetic concerns further complicate the decision-making process for potential adopters.

However, the strong influence of economic viability, growing environmental awareness, and the power of social proof present clear opportunities. By addressing information gaps, correcting misconceptions, and leveraging community-led advocacy, stakeholders can significantly accelerate solar adoption. Tailored awareness campaigns that emphasize cost savings, environmental benefits, and available incentives, especially when communicated through trusted social networks, can help bridge the gap between interest and implementation. Ultimately, a multi-faceted approach that combines financial support, education, and cultural alignment is essential for scaling sustainable energy solutions in the region.

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