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IN-DEPTH STUDY ON ADOPTION DYNAMICS OF SOLAR ENERGY AND ANALYSING FACTORS INFLUENCING RESIDENTIAL AND COMMERCIAL SECTORS IN AHMEDABAD CITY

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Abstract

The adoption of solar energy in residential and commercial sectors marks a significant advancement toward sustainable energy solutions. This study examines key factors driving adoption, such as financial savings, environmental benefits, and government initiatives, while also addressing barriers like high installation costs and limited public knowledge. Using survey data and secondary research, the report underscores the importance of government programs like the Solar Rooftop Scheme and PM-KUSUM in boosting adoption rates. Highlighting regional leaders like Gujarat and major solar projects across India, the findings reveal growing interest fuelled by economic and environmental incentives. Challenges persist in affordability, awareness, and policy implementation. The study concludes with strategies for accelerating solar adoption through technology improvements, financial support, and public awareness campaigns, aligning with India's renewable energy targets.

Keywords: *Solar energy, Residential Areas, Commercial areas, Renewable energy.*

INTRODUCTION

The global solar energy industry is witnessing rapid growth, fuelled by advancements in technology, declining costs, and favourable government policies. In India, solar energy has become a cornerstone of the national energy agenda, contributing significantly to environmental preservation and energy security. With the country's installed solar capacity reaching 75 GW by mid-2024, initiatives like the National Solar Mission have driven remarkable progress, supported by contributions from states such as Gujarat, Rajasthan, and Tamil Nadu. This research explores the adoption of solar energy in residential and commercial sectors, focusing on factors that promote or hinder its uptake. Long-term financial benefits, environmental advantages, and government incentives act as enablers, while high upfront costs, intermittency, and limited awareness pose challenges. Based on survey data and secondary insights, the study identifies current trends, obstacles, and opportunities within the sector. The report also assesses the effectiveness of government policies, highlights major solar projects like Badla and Rewa Solar Parks, and examines Gujarat's leadership in rooftop solar installations. It aims to provide actionable recommendations for enhancing solar adoption, contributing to India's vision of achieving 450 GW of renewable energy capacity by 203

LITERATURE REVIEW

Wei S. , Temitope E. (2024), suggested in their study *"Adoption of solar grid-tied PV-system adopted in a residential building"* that the economic and environmental benefits of a solar grid-tied system installed in a three-bedroom home in Auckland, New Zealand. Using a 4.5 kW photovoltaic panel, the property minimized its reliance on traditional energy sources. The integration of energy-efficient materials further enhanced cost savings, highlighting the practicality and sustainability of solar systems paired with modern technologies.

Dixit S. (2018), reviewed in their paper *"Role of solar energy and issues in its implementation in the Indian context"*

that India's solar sector struggles with high costs and limited subsidies. Expanding eligibility criteria and streamlining policies could boost adoption rates. Recommendations focus on practical measures for stakeholders.

Shaughnessy E. (2023), in their paper *"Impacts of non-residential solar on residential adoption decisions"* reviewed that the solar systems on commercial properties can encourage nearby residential adoption. This approach promotes community-wide uptake and highlights the cumulative impact of non-residential solar installations.

Sahu G. (2022), in their study on *"Determinants of residential adoption of solar energy system: A survey of rural India"*, examined that rural India's solar adoption is driven by government policies, awareness, and enabling infrastructure. Behavioural factors and perceived benefits play critical roles in shaping intentions to adopt solar technology.

Chand A. (2019), in their paper *"Adoption grid-tie solar system at residential scale"*, examined the Pacific Island Countries, residential grid-tie PV systems reduce grid reliance by 20 kWh monthly. They align with sustainability goals through lower costs and greenhouse gas emissions.

Dalal R. (2021), in their study *"Bridging the energy gap of India's residential buildings by using rooftop solar PV systems for higher energy stars"*, suggested that a 3-kWp solar PV system improves energy ratings for Indian homes with a 3–7 year payback. The findings emphasize financial and environmental advantages, encouraging rooftop solar adoption.

Kant K. (2020), in their study *"Renewable energy policies and their effectiveness in promoting solar energy adoption in India"*, suggested that India's renewable energy policies effectively promote solar energy. Challenges in implementation persist, but state-level efforts play a pivotal role in driving adoption.

Gande Acosta G. (2020), in their study *"Boosting energy efficiency and solar energy inside the residential, commercial and public services sectors in Mexico"*, suggested that solar energy adoption in Mexico could significantly cut emissions and save costs, although it requires large investments. The study recommends exploring more efficiency measures.

Kiray V. (2019), in their study "*Feasibility study for utilization of solar energy in the arctic areas"*, reviewed that a PV system with a dual-axis tracker and Gazebo design enhances aesthetics and energy performance. It demonstrates cost efficiency and appeals to residential users.

Jain M. (2022), in their paper *"Solar energy for commercial buildings sector: Recommendations for the Indian Scenario"*, reviewed that Off-grid solar systems in commercial buildings face policy-related hurdles. Simplified processes and improved subsidy programs can drive adoption in the Indian market.

Saxena A. (2020), in their study "*Solar energy policy India: an overview"*, suggested that Government incentives and competitive bidding drive solar energy growth in India. Rooftop solar projects and supportive policies contribute significantly to sustainability goals.

RESEARCH METHODOLOGY

Research Statement:

In-depth study on adoption dynamics of solar energy and analysing factors influencing residential and commercial sectors in Ahmedabad city.

Research Objective:

- To examine the main obstacles and challenges encountered by residential and commercial entities in implementing solar energy solutions.
- To evaluate how effective current government schemes and policies are in encouraging the adoption of solar energy.

Research Design:

The research design serve as a blueprint for data collection, measurement, and analysis. The **'Descriptive research design'** is used in this study.

Sampling Plan:

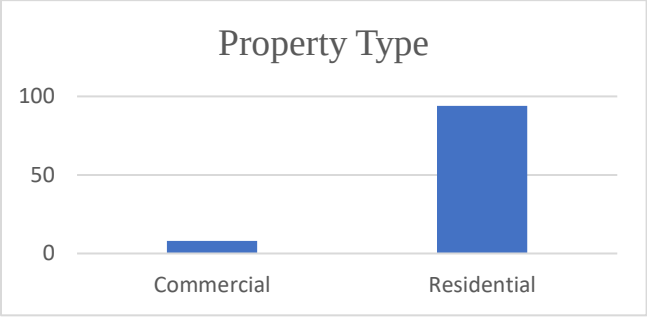
- **Sampling Size:** 102
- **Sampling Technique:** The sampling method used is non-probability "**convenience sampling**,".
- **Sampling Method:** This study employs the non-probability sampling method.
- **Sampling Unit:** Ahmedabad (North).
- **Data Collection Method:** Questionnaire bases through google form.

DATA ANALYSIS

Gender:

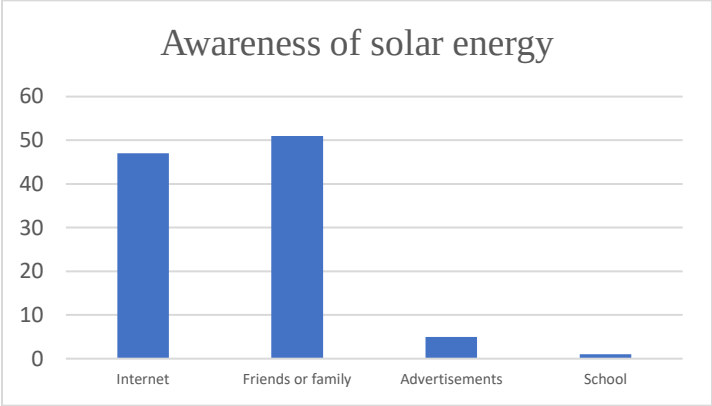
Gender	Respondent	Percentage (%)
Female	46	45
Male	56	55
Total	102	100

Property Type:



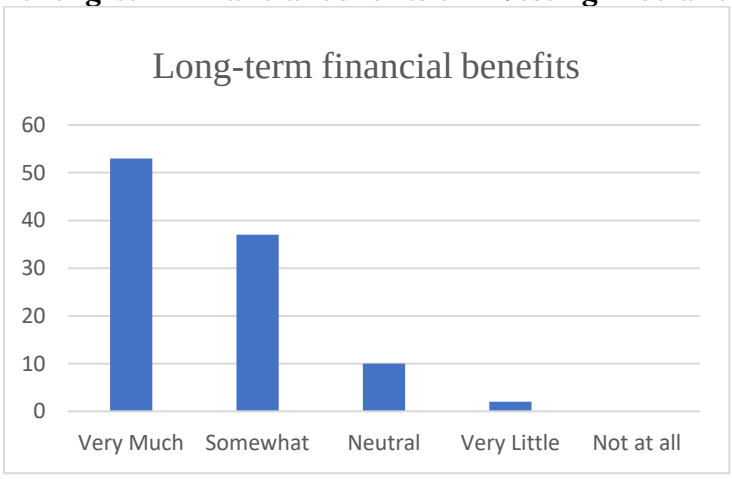
The data shows that 8 out of 102 respondents (8%) were focused on commercial properties, while 94 respondents (92%) were primarily concerned with residential properties. This highlights a strong inclination towards residential properties among the majority of the participants.

How did you initially become aware of solar energy?



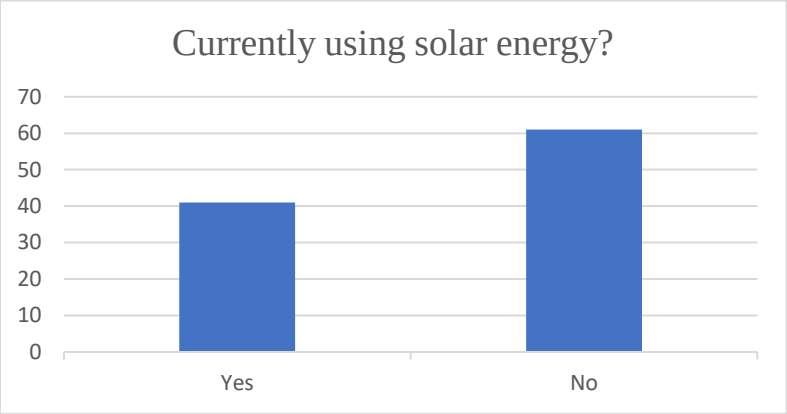
Approximately 47% use the internet as a primary source of information because of its accessibility. Personal connections, such as friends and family, are favored by 50%, emphasizing trust. Only 4% rely on advertisements for information. Schools are the least preferred source, with just 1%, likely reflecting the survey's demographics.

How much do you value the long-term financial benefits of investing in solar energy?



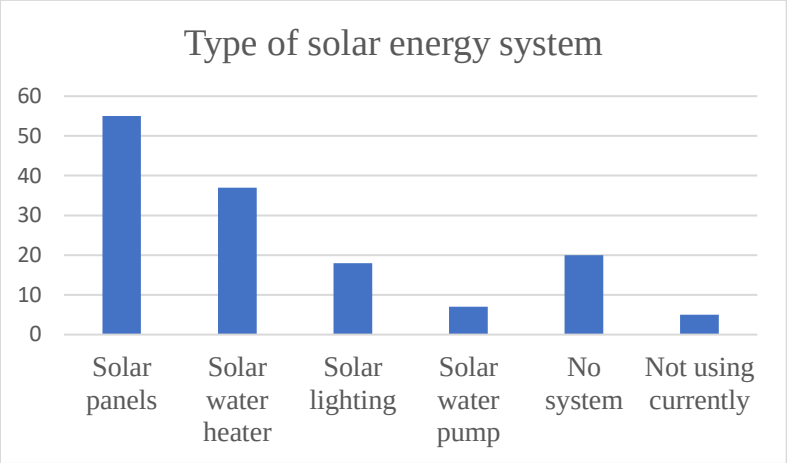
A majority of respondents (52%) strongly recognize the financial benefits of solar energy.
Around 36% have a somewhat positive outlook, acknowledging these advantages to a degree.
Neutral opinions account for 10%, while 2% perceive minimal financial value.
Notably, none completely dismiss the benefits, with 0% in the "Not at all" category.

Do you currently use solar energy at your property?



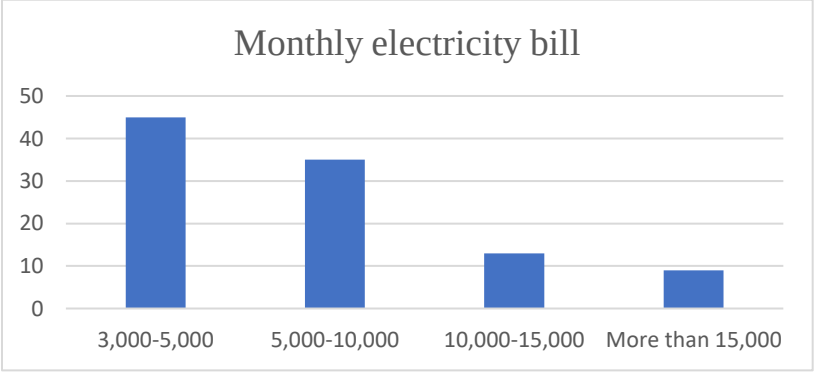
Among the respondents, 40% (41 individuals) stated that they use solar energy at their property, while 60% (61 individuals) reported that they do not have solar energy installed at their property.

If yes, what type of solar energy system do you have installed?



Among the respondents, 55 have solar panels installed, and 37 have a solar water heater. Solar lighting is used by 18 respondents, while 7 have installed a solar water pump. Interestingly, 20 respondents indicated using solar energy but do not have any specific solar system in place. Additionally, 5 respondents mentioned they are not currently utilizing any solar energy system, despite previously indicating that they do use solar energy.

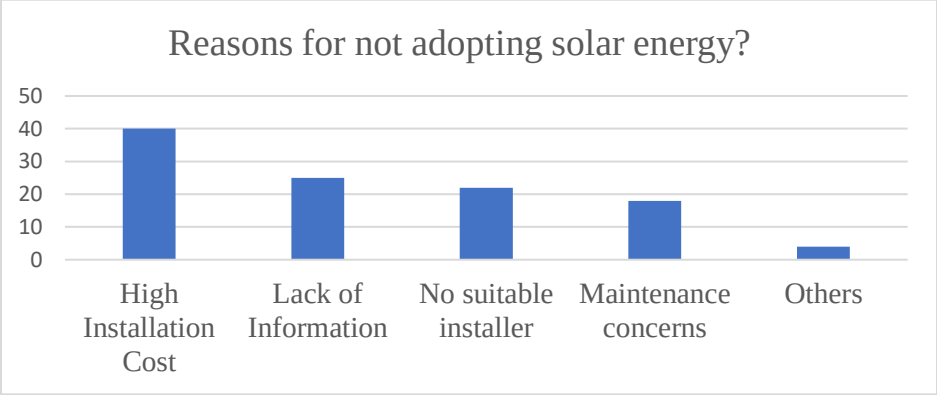
Average monthly electricity bill (INR)



Among the respondents, 44% (45 individuals) have an average monthly electricity bill between 3,000 and 5,000

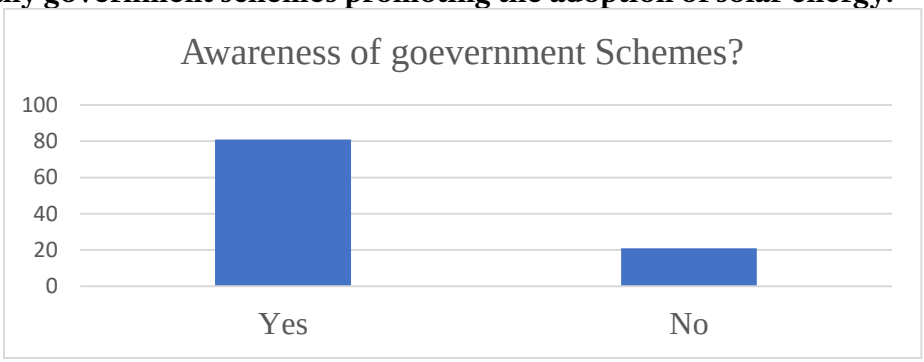
INR. Another 34% (35 individuals) report their bills range from 5,000 to 10,000 INR. Additionally, 12% (13 respondents) have bills between 10,000 and 15,000 INR, while 10% (9 respondents) have monthly bills exceeding 15,000 INR.

If no, what are the reasons for not adopting solar energy?



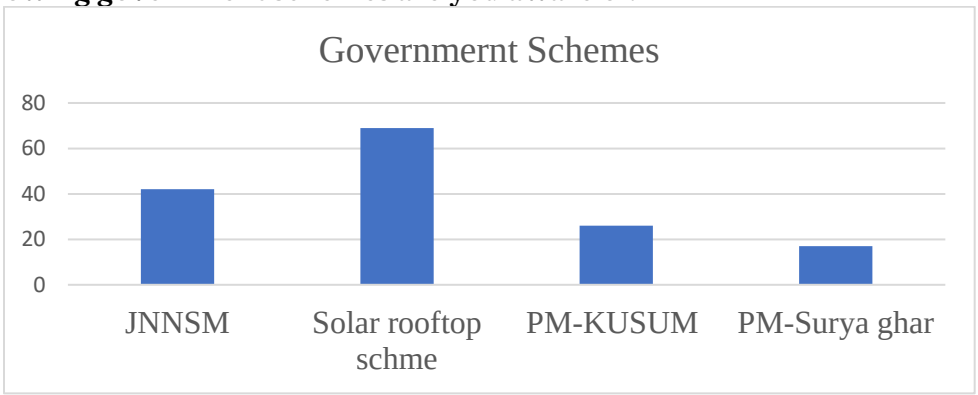
Among the respondents, 40 attributed their decision not to adopt solar energy to the high installation costs. A lack of information was cited by 25 respondents as a significant barrier, while 22 noted the absence of a suitable installer as a key issue. Maintenance concerns were mentioned by 18 respondents, and 4 listed various other reasons for not adopting solar energy.

Are you aware of any government schemes promoting the adoption of solar energy?



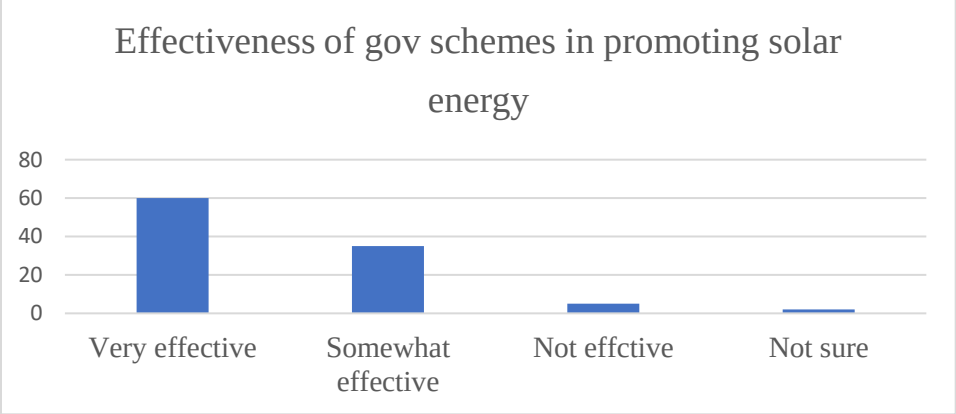
Out of the 102 respondents who took part in the survey, 81 (79%) are aware of government initiatives supporting the adoption of solar energy, whereas 21 respondents (21%) are not informed about these schemes. This suggests that most respondents are familiar with the government's efforts to promote solar energy, while a smaller percentage lack this awareness.

Which of the following government schemes are you aware of?



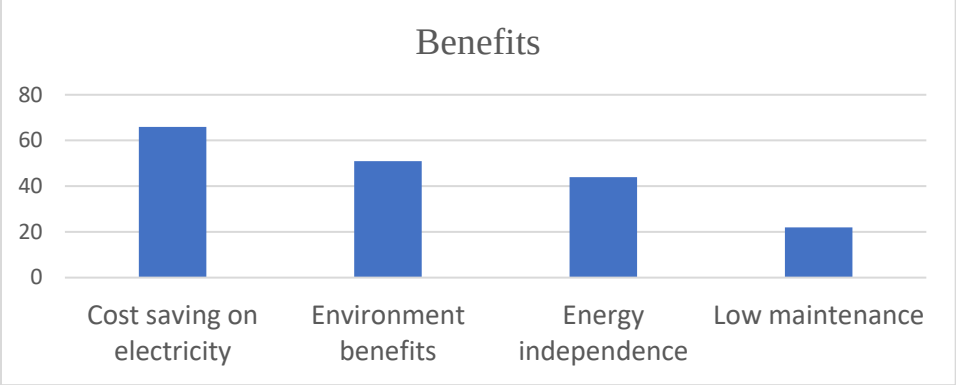
Among the respondents, 42 are familiar with the Jawaharlal Nehru National Solar Mission (JNNSM). The Solar Rooftop Scheme stands out as the most well-known, with 69 people aware of it. Meanwhile, 26 respondents are knowledgeable about the PM-KUSUM scheme, and 17 are informed about the PM-Surya Ghar scheme. The PM-Surya Ghar scheme is the least recognized among the schemes mentioned.

How effective do you think these government schemes are in promoting solar energy adoption?



Among 102 participants, 58% regard government schemes as highly effective in encouraging solar energy adoption, and 34% find them somewhat effective. Just 5% consider the schemes ineffective, while 2% remain undecided. Overall, 92% have a favourable view of these schemes.

What do you think are the main benefits of adopting solar energy?



Cost savings are the most noted benefit of solar energy, highlighted by 66 respondents, followed by its environmental impact, recognized by 51. Energy independence is appreciated by 44 participants, while 22 point to low maintenance. Overall, financial and environmental benefits lead, with energy independence and low maintenance mentioned less frequently.

FINDINGS

Solar energy **adoption** is on the rise in both residential and commercial sectors. Homeowners are increasingly recognizing the financial and environmental advantages, while businesses are motivated by potential long-term savings and sustainability objectives. Solar energy helps **reduce electricity bills** and carbon footprints, benefiting both homeowners and businesses. It also promotes energy independence by decreasing reliance on the power grid. High upfront **costs** remain a significant obstacle, especially for homeowners. There is also a need for greater awareness and education about solar energy's benefits. Residential installations may be limited by roof space, whereas commercial installations face challenges with integrating systems into existing infrastructures. **Government incentives** and subsidies are vital in promoting solar energy adoption, making the initial investment more feasible. **Supportive policies** and streamlined permitting processes can further boost adoption rates. **Demand** for solar energy systems is growing in both residential and commercial sectors due to rising energy costs and increasing environmental awareness. The integration of solar installations with smart home systems and energy management solutions is also becoming more common.

CONCLUSION

The rise in solar energy adoption across residential and commercial sectors is driven by its cost savings, environmental benefits, and energy independence. While obstacles such as high upfront costs and limited awareness persist, government incentives and technological progress are improving its accessibility. Homeowners

appreciate the long-term financial and ecological advantages, while businesses prioritize savings and sustainability. Supportive government policies address financial challenges, and technological improvements boost system efficiency. Market trends indicate growing demand, amplified by the integration of solar with smart technologies and energy management systems.

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