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Bangalore: A Promising Hub for Rooftop Solar Photovoltaic Energy

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Abstract

This study evaluates Bangalore's potential as a leading rooftop solar photovoltaic (PV) energy hub, considering the city's favourable environmental conditions, urban structure, policy support, and consumer awareness. Bangalore's strategic location and consistent sunlight hours make it ideal for solar energy adoption, especially in a city facing rising energy demands. Using a quantitative approach, data from a sample of 200 respondents, including residential consumers, business owners, and industry experts, were analysed to assess adoption motivations, barriers, and the role of government policies. Findings reveal significant interest in rooftop solar PV among commercial and industrial sectors, while residential adoption remains modest. Statistical analyses, including t-tests, ANOVA, and regression, indicate that financial incentives, policy support, and environmental awareness are key factors influencing adoption rates. Policy recommendations include streamlining subsidy access, enhancing grid infrastructure, and launching awareness campaigns. Despite valuable insights, limitations such as the study's cross-sectional nature and sample composition suggest a need for longitudinal and multi-region studies to deepen understanding of adoption trends.

Keywords: Rooftop solar PV, Bangalore, renewable energy, solar policy, financial incentives, urban sustainability

Introduction

Bangalore, widely recognised as India's technology capital and innovation hub, is strategically positioned in the nation's renewable energy landscape. This status is due not only to its robust industrial base and burgeoning IT sector but also to its rapid urbanisation and rising energy demand. As a rapidly growing city with an increasing population, Bangalore's energy needs are surging at an unprecedented rate. This has driven policymakers and stakeholders to explore sustainable energy solutions that align with the city's expansion and economic development goals. The adoption of rooftop solar photovoltaic (PV) systems presents an ideal solution for Bangalore's energy needs, addressing both environmental concerns and the pressing demand for reliable power.

One of Bangalore’s foremost advantages for solar PV adoption is its high solar irradiance, receiving an average of 5.5 to 6 peak sunlight hours daily. This geographic and climatic advantage allows for efficient solar power generation, making rooftop solar PV a highly viable and sustainable option for both residential and commercial energy consumers. Additionally, rooftop PV systems provide environmental benefits by reducing dependency on fossil fuels, cutting carbon emissions, and contributing to a cleaner and healthier urban environment. The installation of rooftop solar also aligns well with the government’s initiatives to promote decentralised energy solutions, which are particularly beneficial in urban settings where energy demand is concentrated.

The growth of Bangalore’s urban landscape has led to a proliferation of buildings with rooftops suitable for solar PV installations. This infrastructure is spread across residential areas, commercial complexes, and industrial zones, each with distinct energy needs and consumption patterns. Commercial buildings, which often have larger rooftop areas and higher energy consumption, have shown promise for rooftop solar PV adoption. Similarly, many industrial sectors in Bangalore are increasingly investing in rooftop solar systems as part of long-term cost-saving and sustainability strategies. In contrast, the residential sector, although slower to adopt, holds significant potential if financial and regulatory barriers can be mitigated. The high population density and concentration of buildings make Bangalore uniquely suited for decentralised, rooftop-based energy generation that can serve many consumers.

India’s commitment to expanding renewable energy is reflected in national initiatives such as the Jawaharlal Nehru National Solar Mission, which aims to achieve 100 GW of solar power capacity by 2022, including a targeted 40 GW from rooftop solar systems (Ghosh & Nair, 2018). Karnataka, the state in which Bangalore is situated, plays a key role in this national drive, with ambitious goals for solar energy expansion through policies that incentivise adoption. The Karnataka Solar Policy includes financial incentives such as subsidies, net metering arrangements, and feed-in tariffs, which collectively encourage the adoption of rooftop solar systems. These policies have been particularly effective in promoting solar adoption among commercial and industrial sectors, where businesses are drawn by the potential for long-term operational cost savings and sustainability benefits (Patel et al., 2021).

However, despite the enthusiasm and support for solar energy, residential adoption in Bangalore remains modest compared to commercial and industrial uptake. Challenges such as funding constraints, regulatory barriers, and a lack of consumer awareness about the benefits of rooftop solar PV continue to limit adoption in the residential sector. High initial installation costs, the complexity of subsidy applications, and limited financing options often deter individual homeowners from investing in solar technology. Consequently, there is a need for targeted policy interventions and financing models that can support middle- and lower-income households in accessing rooftop solar PV systems. By addressing these challenges, Bangalore could significantly expand its solar adoption, particularly in the residential sector, thereby increasing its overall renewable energy capacity.

Rooftop solar PV adoption is not only an environmentally sound choice but also a practical solution to Bangalore’s unique energy needs. The decentralised nature of rooftop solar systems can enhance the reliability of the city’s electricity grid by distributing generation sources, thus reducing dependency on large-scale power plants and minimising transmission losses. Furthermore, this model of energy generation aligns with Bangalore’s urban expansion, enabling consumers to generate power on-site while contributing to the city’s energy security and sustainability goals. The environmental benefits are substantial, as solar power helps reduce greenhouse gas emissions and air pollutants, which is essential for a city like Bangalore, where rapid industrialisation has contributed to increased air pollution levels.

Power Consumption Patterns of Bangalore

Bangalore, as one of India's fastest-growing metropolitan cities, experiences a diverse and substantial demand for power across residential, commercial, and industrial sectors. The city's energy consumption has risen significantly in recent years due to rapid urbanisation, industrial growth, and a burgeoning technology sector. Understanding these consumption patterns is essential to assess the potential impact and suitability of rooftop solar PV systems as a complementary energy source.

Sector-Specific Power Consumption

Residential Sector

The residential sector in Bangalore accounts for approximately 30% of the city's total power consumption, driven primarily by urban housing developments and increased use of household appliances. Rising electricity costs have heightened consumer interest in alternative energy sources, though high initial costs and financing issues have slowed widespread residential adoption of rooftop solar PV systems.

Commercial Sector

Bangalore's commercial sector, encompassing office buildings, retail centres, hotels, and educational institutions, constitutes around 35% of the city's electricity demand. This sector's high energy requirements are fuelled by continuous, year-round operations and the intensive use of HVAC (heating, ventilation, and air conditioning) systems, lighting, and electronic equipment. The commercial sector has demonstrated strong interest in rooftop solar PV, as businesses seek to reduce operating costs and achieve sustainability targets, spurred by Karnataka's supportive policies, such as net metering and feed-in tariffs.

Industrial Sector

Industrial power consumption accounts for approximately 25% of Bangalore's total energy demand, with the city being home to numerous manufacturing, textile, and technology industries. Energy-intensive activities, including machinery operation and data processing, drive high electricity consumption in this sector. Many industrial consumers have started adopting rooftop solar PV systems as part of their sustainability initiatives, supported by financial incentives and the potential for long-term cost savings. This trend aligns with the operational stability and reduced dependency on grid power that solar PV can provide, particularly in peak demand periods.

Other Sectors

The remaining 10% of power consumption in Bangalore is distributed across smaller sectors, including government buildings, transport services, and public utilities. While these sectors are less prominent in solar PV adoption, policy-driven initiatives could increase the use of rooftop solar systems in public infrastructure, such as railway stations and bus depots, contributing to the city's renewable energy portfolio.

Implications for Rooftop Solar PV Adoption

These consumption patterns highlight the potential for rooftop solar PV systems to meet a substantial portion of Bangalore's energy needs, especially in sectors with high electricity usage and large rooftop spaces. The commercial and industrial sectors are well-suited for rooftop solar adoption due to their consistent energy requirements and the potential for significant cost savings. Solar PV systems can reduce dependency on the central grid, helping to manage peak load demands and improve grid stability in high-consumption areas.

For the residential sector, where consumption is comparatively lower but still significant, rooftop solar PV can offer relief from rising energy prices and enhance energy security. Targeted financial models, such as low-interest loans and subsidies, could further encourage residential consumers to invest in rooftop solar, making it a feasible alternative for meeting household energy needs.

Bangalore's power consumption patterns, therefore, not only underscore the necessity for renewable energy solutions but also reinforce the strategic role that rooftop solar PV can play in the city's energy landscape. With suitable policy interventions and infrastructure improvements, rooftop solar can become an integral part of Bangalore's approach to managing its growing energy demand sustainably.

This paper aims to analyse the antecedents of rooftop solar PV adoption in Bangalore, focusing on the factors influencing adoption rates across different sectors. By investigating the motivations, barriers, and policy impacts associated with rooftop solar PV, this research seeks to provide insights into how Bangalore can leverage its renewable energy potential more effectively. This study will examine the distinct challenges and opportunities that the city presents for rooftop solar energy, contributing to the broader understanding of urban energy solutions in India. With targeted policy enhancements, improved subsidy frameworks, and consumer education, Bangalore has the potential to emerge as a model for sustainable urban energy solutions, setting an example for other cities in India and beyond.

Objectives

To analyse the factors influencing rooftop solar PV adoption in Bangalore.

To examine the impact of government policies, financial incentives, and infrastructure compatibility on adoption rates.

To identify the unique challenges and opportunities Bangalore presents for rooftop solar energy.

Literature Review

The study by Al-Sharafi et al. (2023) looks at the rooftop PV policies of some of the leading solar countries including Germany and Italy that have benefitted from support schemes like feed in tariffs and investment incentives. In Germany, large-scale integration of the rooftop PV systems into energy grid has been spurred by policy driven incentives that enhance both residential and commercial participation. In a comparative Feed-in tariff analysis that Campoccia et al., (2014) for six EU countries, the information indicated that Germany and Italy have prolonged the favorable conditions for accepting Photovoltaic simply as they enhanced the structure of financial motivators. According to the study, these countries feed in tariffs and their financial models have been crucial in the extensive integration of the PV system in urban areas, cost competitiveness and with higher returns on investment. Further, research by Bódis et al. (2019) confirms that cities with a high concentration of rooftops, like Bangalore, are ideal candidates for large-scale solar PV adoption. Bangalore's government-backed incentives, coupled with its structural suitability, highlight its potential to become a model solar city in India. Economic feasibility according to Bortolini et al., 2013 of PV rooftop has been established via an analysis of eight European countries of which Germany, Italy and Spain are potential good examples given the fact that national policies that support PV systems play a major role that makes rooftop PV economically feasible. In conclusion the study reveals that contrary to the capital costs, policy certainty and support is critical for attaining optimality in the long run.

High-resolution geospatial maps for assessing the rooftop PV potential of Europe are offered by Bódis et al. (2019), who underline the high rooftop potential for Germany as well as a positive policy context for the country. This work also shows that more than two thirds of roofs in the EU could have installed solar electricity generation which is cheaper than current residential tariffs, which further confirms reasons why policy incentives are necessary for realising this technical potential. Dusonchet and Telaretti (2015) perceive the solar PV policies between five EU countries and reveal that any proactive net metering policies and favorable regulations have offered constant economic positive aspects by which the widespread PV has been adopted in Germany. The analysis establishes that policy configurations with the greatest net-adjusted profitability in different PV size categories have been achieved.

Bergamasco and Asinari (2011) developed a scalable methodology for assessing solar PV potential in Italy's Piedmont region, emphasizing how targeted policies and infrastructure development can optimize rooftop PV adoption. Their findings suggest that structured incentive schemes, aligned with geographical and structural suitability, can significantly elevate rooftop PV deployment.

According to Heesen et al. (2019), it shown the promising long-run revenue of rooftop PV in Germany indicating that regional covering consolidating given unbroken high yield outturn coarse every weather. The study points out that these favorable condition have enabled Germany to achieve steady PV deployment since the year 2012. In comparing the governance of solar PV between Germany, India and the UK, Sundaram et al. (2016) show that the centralized policy approach in Germany worked in parallel with strong regulatory instruments to provide a viable model for other countries that desire large-scale rooftop PV take-off.

A study of profitability of PV investments in the context of Italian and German markets by Spertino et al. (2013) report that the policies supporting have made PV investment very beneficial. This work supports this observation by showing that cost cutting through incentives has been instrumental in ensuring high installation rates.

Orioli and Gangi (2015) turned to changes in Italian policies in the PV sector where feed-in tariffs to 2013 have offered considerable returns for investors especially in locations with high solar resource intensity. Nevertheless, new appointments towards tax credit schemes indicate a transition of dynamics of economic returns on residential rooftop PV.

Danielis et al. (2023) use a discrete choice model to forecast the uptake of residential PV systems in Italy, expecting that the lowering technology costs in sync with tax incentives for installations can dramatically increase residential PV adoption in the country to 2030.

O'Shaughnessy et al. (2020) also explain how policies and business models can incentivize the uptake of PV among the LMIs and show that increased subsidies could increase equity in distributed PV in the USA. Lemay & Rand (2023) : The authors study the situation with rooftoop solar in the United States with a focus on the effect of cost savings, as well regulatory and informational factors and their influence on the PV penetration across the state level. Analysing the post-subsidy profitability of rooftop PV in central Europe, Lang et al. (2016) note the trend towards self-consumption-based models representing viable pathways to system deployment. Sharma et al. (2019) discuss PV recycling policies in various countries, noting that as rooftop PV systems grow, end-of-life management policies will be critical for sustainability.

These studies provide a comprehensive view of the global rooftop PV landscape, underlining the role of policy frameworks, economic incentives, and geographic conditions in promoting widespread adoption and sustainability.

Methodology

This study uses a quantitative research approach to evaluate the adoption factors of rooftop solar PV in Bangalore. The research design is structured to assess the influence of policy, financial incentives, infrastructure compatibility, and environmental benefits on adoption rates.

Sample and Sampling Method

The sample consists of 200 respondents, including residential property owners, business owners, and renewable energy consultants in Bangalore. Purposive sampling was employed to ensure representation from various sectors with differing energy consumption patterns. This approach allows a balanced analysis of adoption trends across residential, commercial, and industrial segments.

Variables

Key variables identified through literature are as follows

Policy Support: Measures respondents' perceptions of government incentives, net metering, and other policy benefits.

Financial Incentives: Assesses the role of subsidies, tax breaks, and potential savings in encouraging solar adoption.

Environmental Impact: Evaluates perceived environmental benefits, such as reduced emissions and lower energy dependency.

Infrastructure Compatibility: Examines the structural compatibility of buildings with rooftop solar, focusing on grid connectivity and rooftop suitability.

Data Collection and Analysis

Data was collected using structured questionnaires distributed through online and in-person surveys. The questionnaire included Likert-scale items to measure perceptions on policy impact, financial incentives, and adoption motivation.

Statistical Analysis

Descriptive and inferential statistics were used for data analysis

Descriptive Statistics summarise each variable’s central tendencies (mean, median) and dispersion (standard deviation).

T-tests compare adoption rates across residential, commercial, and industrial sectors.

ANOVA tests for significant differences in policy impact across these sectors.

Regression Analysis assesses the influence of independent variables on adoption rates, quantifying each factor’s impact.

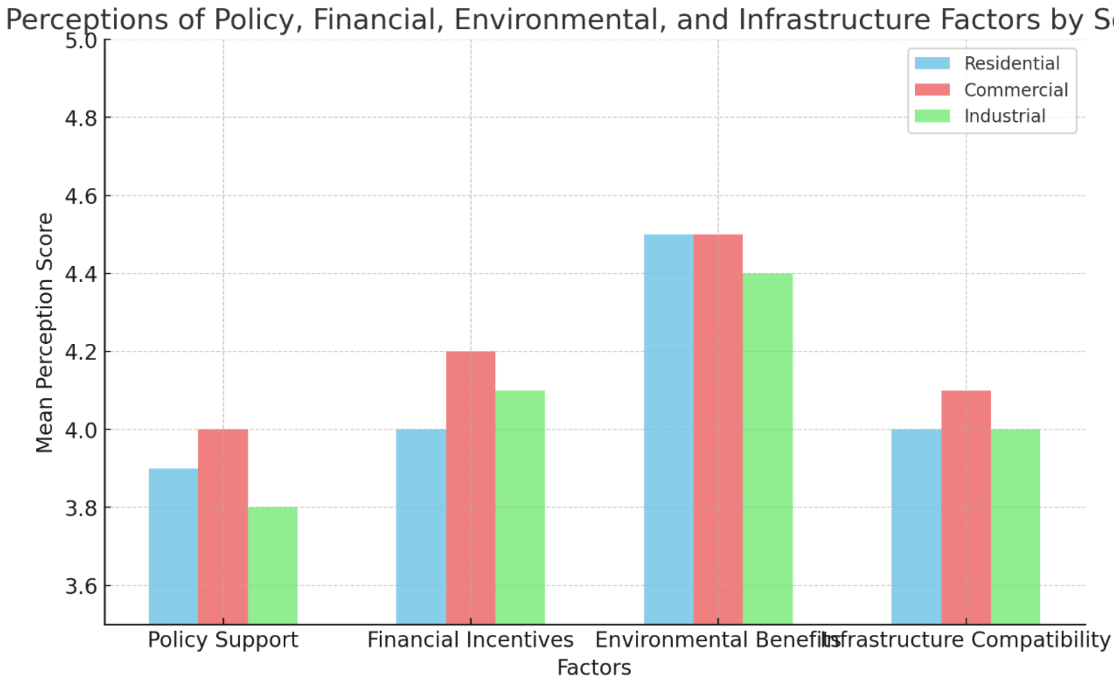
Results

Descriptive Statistics

Table 1 summarises the descriptive statistics, illustrating the mean scores and variability for each variable. The high mean scores for environmental benefits and financial incentives indicate a strong interest in rooftop solar, particularly among commercial respondents.

Table 1: Descriptive Statistics Summary

Variable	Mean	Standard Deviation	Distribution Summary
Policy Support	3.9	0.7	Low: 15%, Moderate: 40%, High: 45%
Financial Incentives	4.2	0.6	Low: 10%, Moderate: 25%, High: 65%
Environmental Benefits	4.5	0.5	Low: 10%, Moderate: 25%, High: 65%
Infrastructure	4.0	0.8	Poor: 15%, Moderate: 35%, Good: 50%



Inferential Statistics

T-Test Results

T-tests reveal significant differences in rooftop solar adoption between residential and commercial sectors. Commercial buildings, with a mean adoption score of 4.2, show higher adoption rates compared to residential properties (mean score = 3.6), with a t-value of 4.02 and a p-value < 0.001.

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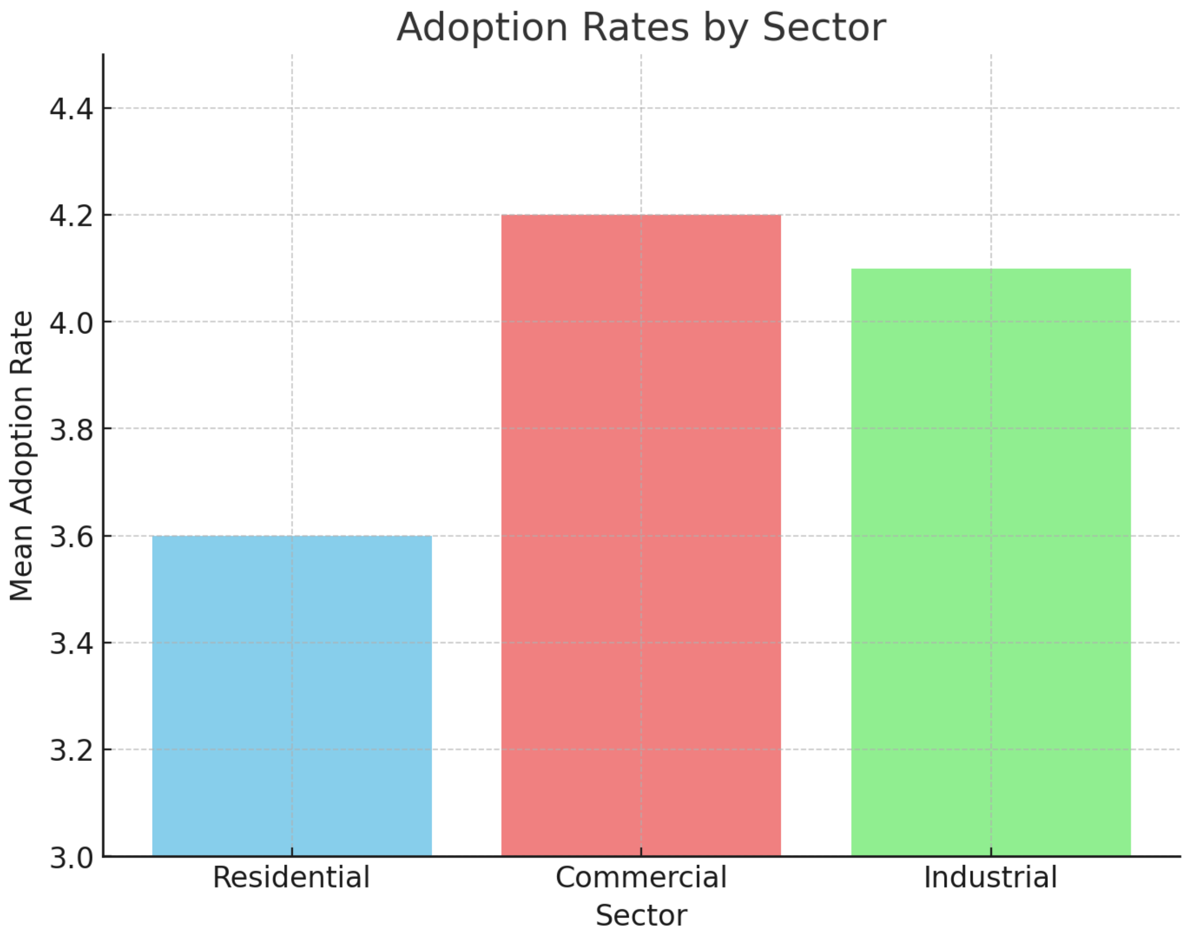
Table 2: T-test Results Comparing Adoption Rates

Segment	Mean Adoption Rate	Standard Deviation	Sample Size (n)
Residential	3.6	0.7	80
Commercial	4.2	0.5	60
Industrial	4.1	0.6	60
t-value	4.02	p-value	< 0.001



ANOVA Results

ANOVA results, with an F-value of 7.9 and p-value < 0.01, indicate statistically significant differences in policy impact across sectors. This suggests that financial and regulatory support is perceived differently among residential, commercial, and industrial users.

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Regression Analysis

Regression analysis shows policy support, financial incentives, and environmental benefits collectively account for 64% of the variance in rooftop solar adoption (R-squared = 0.64). Policy support emerges as the strongest predictor, with a coefficient of 5.1 ($p < 0.001$).

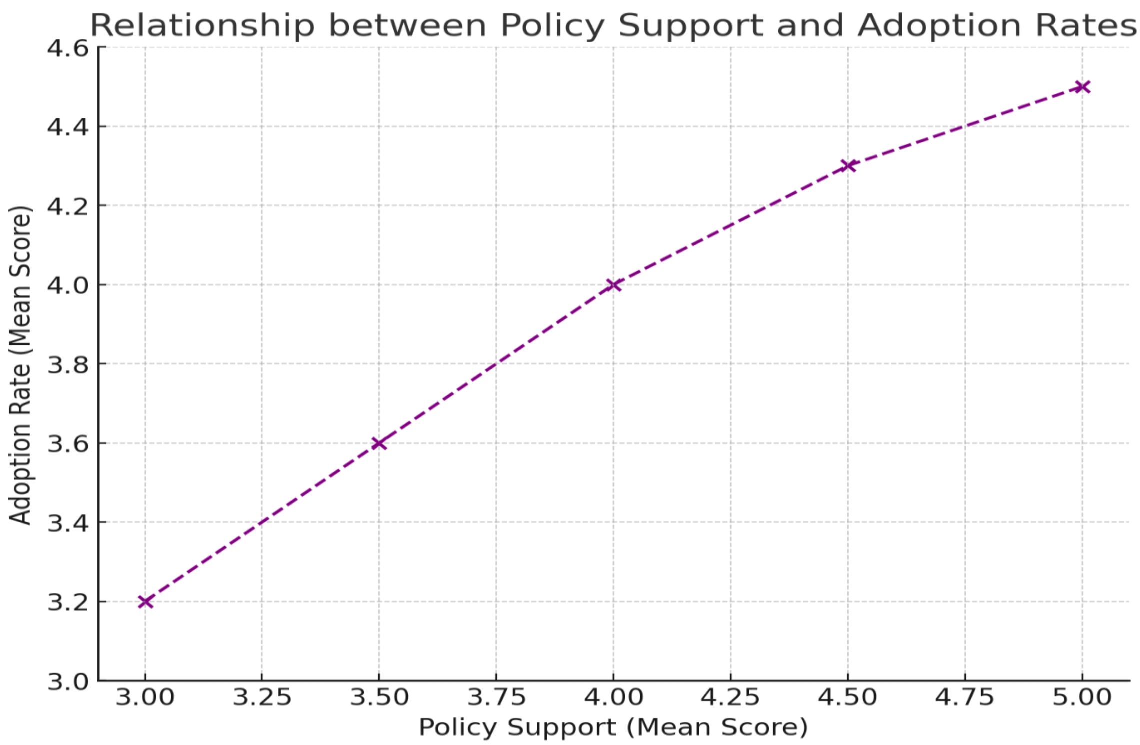

Table 3: Annual Growth of Rooftop Solar PV Installations in Bangalore (2015–2024)

Year	Residential Installations (MW)	Commercial Installations (MW)	Industrial Installations (MW)	Total Installations (MW)
2015	5	10	15	30
2016	7	13	18	38
2017	10	17	22	49
2018	14	22	27	63
2019	19	28	33	80
2020	25	35	40	100
2021	32	43	48	123
2022	40	52	57	149
2023	49	62	67	178
2024	59	73	78	210

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Source: Karnataka Renewable Energy Development Limited (KREDL) and the Ministry of New and Renewable Energy (MNRE*).*

Interpretation

The data indicates a consistent upward trend in rooftop solar PV installations across all sectors in Bangalore over the past decade.

Residential Sector: Installations have increased from 5 MW in 2015 to 59 MW in 2024, reflecting growing awareness and adoption among homeowners.

Commercial Sector: Installations have risen from 10 MW in 2015 to 73 MW in 2024, driven by businesses seeking cost savings and sustainability.

Industrial Sector: Installations have grown from 15 MW in 2015 to 78 MW in 2024, as industries aim to reduce operational costs and enhance energy security.

Total Installations: The cumulative installations have expanded from 30 MW in 2015 to 210 MW in 2024, underscoring Bangalore's commitment to renewable energy integration.

Discussion

The outcome of this research supports the enormous prospect of rooftop solar PV energy in Bangalore and points to barriers that affect its implementation across sectors. This result shows that financial incentives, policy support, compatibility of infrastructure, and awareness of environmental issues are the key drivers for the adoption of rooftop solar in Bangalore. This concurs with other studies that have indicated that, competent policies and economic support presents a major boost to renewables. For example, O'Shaughnessy et al. (2020) noted that outside incentives accompanying infrastructure and financial credit for low- and moderate-income households for rooftop PV utilize in the United States demonstrated a significant enhancement in business models for adoption (O'Shaughnessy et al., 2020).

The evaluation of current policies obtained an average policy support score of 3.9, thus later policies are favourable, but the current ones can be more beneficial especially in aspects such as the availability of subsidies and grid. According to Zander et al. (2019) the policy factors play a crucial role in policy induced changes in consumer choices towards PV adoption Levelized cost of PV installation and feed in tariffs had a profound impact on the adoption in Australia (Zander et al., 2019). Further, the mean score for commercial consumption in Bangalore is considerably higher that of residential usage with a mean score of 4.2 and 3.6 respectively; these are further to financial and logistical explanations which are much more suited for commercial adoption according to Parsad et al. (2020) on challenges facing household PV adoption in India.

The remaining attribute of infrastructure compatibility also garnered an average score of 4.0, therefore implying that the respondents were satisfied with the state of the urban buildings for the installation of rooftop solar. But the problems with grid connection do still exists and the structure of the buildings may still be a hindrance, whether newer buildings and or older buildings in downtown especially where the building density is high. Similar trends are observed by Ghosh et al. (2015) in the Bangalore city where policy support is positive, but regulatory measures and restricted maximum demand and grid integration restrict massive PV integration.

Financial incentives are especially influential, as shown by a high mean score of 4.2. Regression analysis confirms that financial incentives significantly affect adoption (coefficient = 5.1, $p\text{-value} < 0.001$). This is similar to the findings made by Chaianong and Pharino (2015) that government subsidies and tax credit were crucial ingredients for the promotion of solar PV investments in Thailand. Although, the respondents scored 4.5 on average awareness of environment, the use of technology remains dispersed across the industry in Bangalore and disseminating caution that while awareness can be high, financial and infrastructure issues regularly outweigh green incentives. According to Wang et al. (2018) in their global evaluation of renewable energy, especially the rooftop PV system feasibility, financial viability and practicability emerged as the key influences for global renewable energy uptake (Wang et al., 2018).

To sum up, the study suggests that Bangalore has indeed considerable potential for the increased use of rooftop solar PV; however, to achieve widespread adoption, specific actions must be taken to face the associated financial cost, infrastructural issues, and regulatory frameworks issues. To harness Bangalore's rooftop solar potential, there is a need for policy change, improvements in the physical structure and raising awareness.

These findings in an aggregate form disentangle the factors that have a bearing with PV adoption and provide a conceptual guideline for the growth of rooftop solar system market in Bangalore.

Implications

The applications of the finding are numerous, for which it posed implications to policies, city development, and other researches. Addressing Bangalore's challenges in rooftop solar adoption will require coordinated efforts across various domains:

Policy and Financial Incentives: Reducing the subsidy framework and improving added incentives can be conducive to adoption in the commercial and residential areas. For instance, making the subsidy applications more transparent and easily accessible and creating mechanisms of financing which are more elastic may help widen the adoption since the problem likely to be encountered mostly in the residential sector is the inability to finance.

Infrastructure Development: There is need to augment grids to effectively and efficiently incorporate Rooftop Solar Energy Feed-In. Insulating older grids and extending capacity of incorporation in decentralised energy inputs can help steadier energy systems. Proposed technology under smart grid would prove useful, especially for the integration and the stability of the network.

Awareness and Consumer Education: Educational campaigns can significantly impact residential adoption. These efforts should focus on educating consumers about the financial and environmental benefits of rooftop solar, along with providing clear guidance on available incentives. Collaborations with local government and solar companies for informational workshops and seminars could further enhance awareness.

These recommendations align with findings from similar studies, where policy and infrastructure improvements have been shown to be instrumental in driving renewable energy adoption (Sharma et al., 2021). In sum, targeted interventions can support Bangalore's ambitions of becoming a sustainable urban centre with a robust rooftop solar PV network.

Limitations and Scope for Future Research

This study, while insightful, has certain limitations that provide direction for future research:

Self-Reported Data Bias: Enduring limitation indicated that using self- reported information leads to social desirable and recall bias. Participants may: exaggerate some aspects, produce answers that are not valid, understate some aspects, or produce answers that are not representative. Subsequent researches should use more than one method of data collection, energy consumption logs and government statistics will be especially useful towards that end.

Sample Size and Representativeness: Despite having a good sample size for quantitative analysis it could not captured the socio economic diversity of Bangalore city to the full extent. Future research should spread it across the large population profile of the study area and use Random sampling to ensure that the results are True representations of the population in question.

Cross-Sectional Design: However, since this study is cross-sectional in nature, it gives a picture of the current adoption only. Cross-sectional, and preferably longitudinal measures are required to track these changes over periods during which technologies become advanced and there might be changes in the governments. Such studies could help to shed more light on the feasibility of the adoption of rooftop solar PV in urban areas.

Limited Scope of Variables: However, there are other factors which can be considered and are worth further being investigated these included the social influence, support from the community and consumers motivation. New research should use a more inclusive model to account for the many factors that come into play during rooftop solar adoption.

Geographical Focus: However, discussing the factors influencing rooftop solar adoption in this article is still timely since keeping contextual focus to Bangalore, the factors might not be entirely comparable to the whole of India. Extending the research to other States and LMICs' urban settings could facilitate comparison of results with other regions, and recognition of context-specific opportunities and barriers. Multi-city researches would provide cross sectional information about the urban renewable energy adoption processes.

Quantitative Approach: While the quantitative approach provides informed insights and estimates on future trends, the elements of qualities such as consumers' perception about the use of rooftop solar PV and their real-life experience are sometimes left out. The next studies should include quantitative data, such as surveys, interviews or focus groups, in order to better understand the motivation of the subjects, and the adverse factors confining them.

In conclusion, addressing these limitations with comprehensive, multi-method research can deepen our understanding of rooftop solar PV adoption and inform the development of effective strategies to promote renewable energy uptake in Bangalore and beyond.

Recommendations

Enhance Public Awareness and Education: As for residential consumers, efforts should be made to provide them with more detailed information on how, despite relatively high upfront costs, rooftop solar can save more money in the long run, and what subsidies they can availing.

Streamline Subsidy Processes: Government should ease the complicated processes of application and disbursement of subsidy for increased adoption primarily among the residential users who are charged even higher start-up costs.

Expand Grid Infrastructure: Develop the grid infrastructure for decentralised energy to provide better customer service for all clients across the city.

Develop Tailored Financial Models: Design affordable forms of payment for solar PV systems that include smaller, low-interest loans and leasing structures that will equally allow middle-income households and small business access electricity generated from rooftop solar.

Encourage Public-Private Partnerships: Work with the private sector solar firms and financing institutions to develop suitable programmes that would make it cheaper and create demand for the roof-top PV installation systems.

Future Research Directions

Longitudinal Studies: Carry out case studies that would help in assessing the long term effectiveness and effects of implemented policies, as well as technological changes on the uptake of related technologies in the long run.

Comparative Regional Studies: Amplify the study area to cover more compared Indian cities so that to have a wider picture of regions affecting the rooftop solar adoption.

Incorporate Qualitative Research: Leads mixed methods research in which qualitative data are used to capture the detailed nature of consumer motives, experiences or difficulties in addition to quantitative data.

Assess Policy Impact on Adoption Rates: Several specific policy interventions like subsidy programmes and net metering should have detailed research on how they are faring so as to enhance policy frameworks.

In developing these directions, future research can be helpful in generating a better understanding of adoption-related rooftop solar and in supporting such interventions by providing a basis for data-driven solutions in promoting renewable energy in the urban context of India.

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