

Assessing the Economic Feasibility of Solar Power Adoption at the Household Level: A Case Study

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Abstract: The shift towards renewable energy sources is crucial for India's sustainable development, with solar power standing out as a practical alternative to traditional electricity. This analysis assesses the economic viability of adopting rooftop solar systems in Indian households using a survey-based approach. A total of 200 survey responses were gathered to evaluate energy consumption patterns, awareness of governmental policies, and the financial readiness to invest in solar energy. The results indicate that 74 participants demonstrated a significant interest in the adoption of solar energy, whereas 158 individuals acknowledged the presence of current government initiatives aimed at encouraging solar adoption. Financial limitations and insufficient technical expertise were identified as significant obstacles, whereas long-term savings and environmental advantages emerged as the main driving forces. The findings emphasise the necessity for enhanced financial incentives, awareness initiatives, and better access to solar technology to promote faster adoption. Government-supported net metering policies, subsidies, and tax incentives are essential in ensuring that solar energy is financially feasible for households. The results show that using solar energy in homes can be good for the environment and your wallet, as long as the right support systems are in place. This will lead to a big drop in the use of nonrenewable energy sources.

Keywords: Focus of residential solar, importance of battery storage, economic analysis, Policy implications.

1. INTRODUCTION

Being a developing nation, India finds considerable difficulty satisfying its rising energy consumption. Rising electricity costs, swings in fuel prices, and the depletion of fossil fuel reserves highlight how urgently alternate energy sources are needed. (Kamalapur & Udaykumar, 2011). Moreover, environmental issues such as air pollution and climate change underline the need for switching to greener, more sustainable solutions. Among the several renewable energy sources accessible, solar power is a very intriguing one with financial as well as environmental advantages. Solar energy is considered one of the most plentiful and easily available renewable energy sources (Kapoor & Dwivedi, 2019). Particularly in nations like India that get enough sunlight all year round, solar power has a significantly higher potential for general acceptance than wind energy (Kapoor & Dwivedi, 2019). Understanding the possibilities of solar energy, the Indian government has developed several rules and offers subsidies to inspire the acceptance of solar photovoltaic systems. Manju & Sagar, 2016 The viability of using rooftop solar systems in households and the degree to which solar electricity may satisfy household energy needs is investigated in this work. The studies show that combining solar panels with a battery storage system improves energy coverage and raises the general use value of solar power. This study also assesses government incentives, possible savings on electricity expenses, solar panel installation costs, and return on investment. It investigates how solar energy acceptance is influenced by subsidies, prices, and weather patterns (Rathore et al., 2017). Manju & Sagar, 2016.

2. REVIEW OF THE LITERATURE

With the industry seeing a substantial drop in commercial pricing, greater efficiency, and enhanced deployment and consumption conveniences, existing data indicates that solar energy has shown enormous promise worldwide. Still, the acceptance of rooftop solar in India has lagged behind the 40 GW (Rathore et al., 2017) goal set by the National Solar Mission. Much research has concentrated on elements influencing household-level solar energy uptake. While Kwan [showed the good benefits of the cost of power and financial incentives in the US], Zhang et al. (Kapoor & Dwivedi, 2019) demonstrated positive effects of regional government policy, housing investment, and environmental consciousness on deployment in Japan. According to the body of current research, the acceptance of solar energy at the household level can be influenced by a mix of elements, including social, policy, and economic ones.

Financial Examination

This study's economic research evaluates the important financial aspects affecting Indian home solar power acceptance. Many homeowners still feel discouraged by the large initial outlay needed to build a household solar system, which involves panels, inverters, batteries, and labour costs. But as the government increasingly emphasises renewable energy, several financial instruments capital subsidies, concessional loans, and tax credits under Section 80-IA of the Income Tax Act have been added to lower costs. The study emphasises that the long-term instruments –ains including notable savings in electricity bills, equal the initial expenses. Solar energy is becoming more financially feasible because of government initiatives, including net metering systems letting surplus energy be sold back to the grid and the Rooftop Solar Program Phase II, which offers subsidies of up to 40% for residential installations. Further lowering the goods and services tax (GST) on solar components and state-wise incentives helps increase affordability. We predict that these economic benefits and increased public awareness will accelerate the adoption of rooftop solar systems in India, thereby promoting sustainability and energy security. The Indian government has launched many programs meant to promote household solar acceptance. Subsidies for capital help to lower the initial outlay of solar panel installations. By letting homes sell extra energy back to the grid, net metering rules help to mitigate electricity bills. Tax benefits offer financial relief to households investing in solar energy. Regulatory agencies also control quality criteria to guarantee dependable and effective installations. Although these legislative actions have helped to raise adoption rates, further work is required to guarantee financial affordability and accessibility.

Policies of India to Encourage Home Solar Energy

Different measures adopted by the Indian government aim to inspire household acceptance of solar energy. These include:

1. The government offers capital subsidies to help pay for some of the initial solar panel installation cost.
2. Homes with rooftop solar systems can offset their electricity costs by selling extra power back to the grid.
3. Households may claim tax deductions for the expenses connected with solar power systems.
4. The government established regulatory agencies to guarantee the quality of solar installations and equipment.
5. The rise in rooftop solar installations recently indicates that these regulatory actions have helped household solar power to flourish in India (Matisoff & Johnson, 2017).

Participation of Private Enterprises in Advocating Sustainable Energy

Accelerating the home-level adoption of solar power in India is mostly dependent on private enterprises, including solar energy firms, financial institutions, and technological providers. Many private companies have developed creative financing options, including solar leasing, zero-down-payment loans, and power purchase agreements (PPAs), thereby allowing homeowners to install solar systems free from bearing the whole upfront cost. To provide tailored loans with flexible payback terms, banks and non-banking financial institutions (NBFCs) have also teamed with solar companies, so increasing the availability of solar electricity to medium- and lower-income consumers. Reducing the complexity of adoption, several private solar companies offer complete solutions encompassing system design, installation, and long-term maintenance, therefore addressing system design. High-quality, reasonably priced solar solutions have been much sought after in the home market, thanks in great part to companies such as Tata Power Solar, Adani Solar, and Vikram Solar. Furthermore, gaining popularity are energy-as-a-service models, whereby private companies charge consumers depending on use while installing and maintaining solar systems. This method guarantees economy and effectiveness. Through training courses, community outreach, and educational programs, private projects working with government agencies and NGOs have also

helped raise awareness about solar energy. Along with raising customer trust, these alliances have helped the renewable energy industry build skills and generate jobs. Private companies remain essential enablers in India's shift towards a distributed and sustainable energy ecosystem with constant innovation and strategic investment.

3. METHODOLOGY

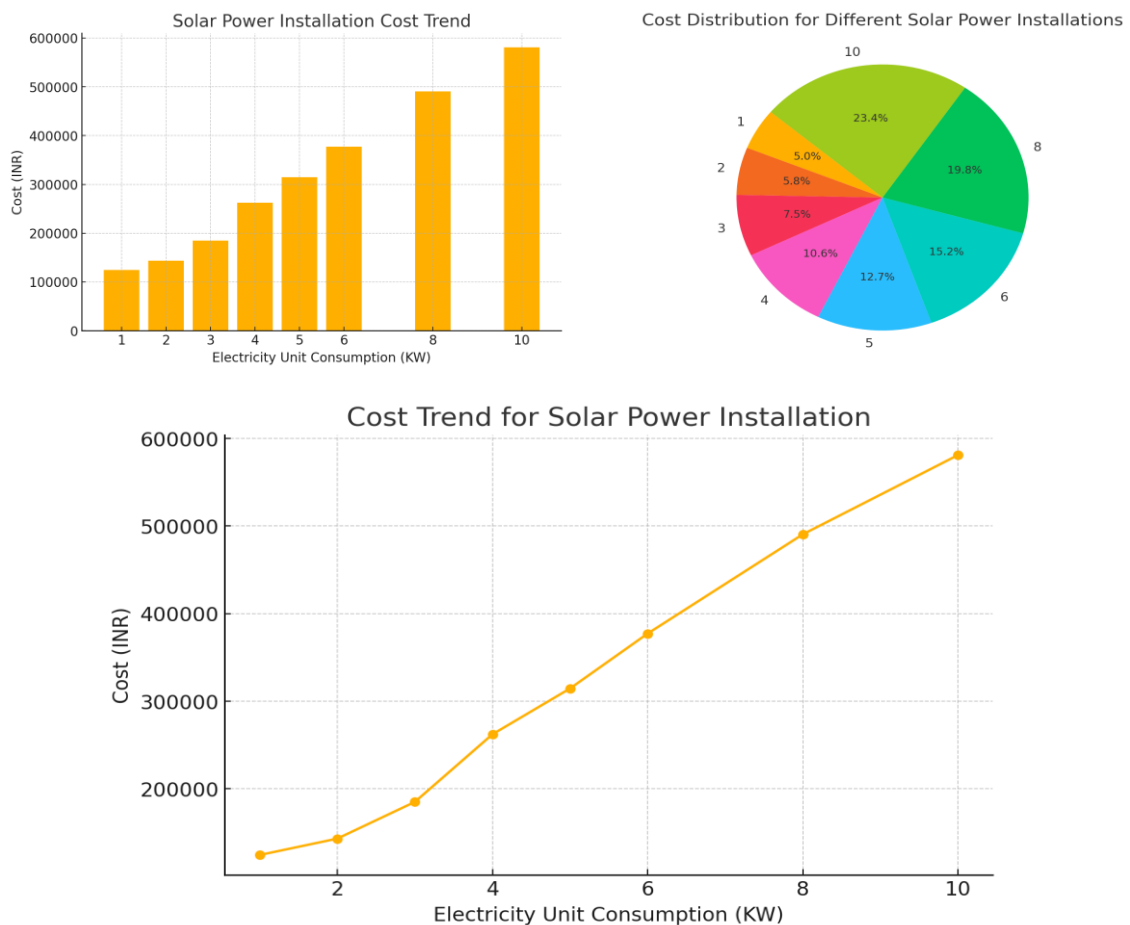
The feasibility of solar power acceptance in Indian households is assessed in this paper using a survey-based methodology. Structured questionnaires sent to several demographic groups helped gather data. The poll asked about energy use, knowledge of government programs, financial readiness, apparent advantages, and adoption challenges. With consideration for installation expenses, return on investment, and government incentives, a quantitative study was done to ascertain the financial feasibility of solar systems.

Survey Data

Two hundred people from metropolitan, semi-urban, and rural areas answered the poll. Key results demonstrate that, although 158 respondents knew of government programs favouring solar installations, 74 expressed great enthusiasm for using solar electricity. The main obstacle was financial worries; many respondents mentioned substantial initial investment expenses even though they acknowledged long-term financial gains. Participants also voiced worries about availability to trustworthy installation providers and maintenance needs. People emphasised the crucial role of net metering rules and government subsidies in shaping adoption decisions.

4. OUTCOMES AND ANALYSIS

The study shows that regulatory support and financial incentives greatly affect the economic viability of solar power acceptance. Higher potential savings in households using more electricity made them more ready to spend on solar panels. Government policies were critical; 158 of the respondents said that financial incentives affected their decisions. Reported as main obstacles were financial limitations and a lack of technical understanding, which emphasises the need for focused awareness campaigns and financial choices, including low-interest loans and solar leasing.



Advantages of using solar energy

Using solar energy has several advantages for the environment and money-wise. Particularly with net metering systems allowing extra energy to be sold back to the grid, households can drastically cut their power expenses (Manju & Sagar, 2016). Being a renewable resource, solar energy helps to minimise carbon emissions by thus reducing reliance on fossil fuels, so improving environmental quality (Kapoor & Dwivedi, 2019). Tax credits and subsidies provided by governments help solar electricity to be more easily available, therefore guaranteeing affordability for homes (Shrimali et al., 2020). Furthermore, low-maintenance solar panel systems provide long-term financial sustainability, as they last 25 years or more (Seel et al., 2014). By lowering reliance on traditional power networks and thereby limiting the dangers of electricity shortages, the switch to solar power also improves energy security (Zhang et al., 2019). Raising awareness of sustainable energy as India keeps pushing it would help home solar adoption by means of technology developments.

5. CONCLUSION

The study comes to the conclusion that, with the correct policy and financial backing, home-level adoption of solar power is economically possible. Although long-term savings and environmental benefits make solar energy an appealing substitute for conventional power, upfront investment prices still present a difficulty. Accelerating acceptance rates can be greatly aided by government incentives, publicity campaigns, and financial aid programmes. Solar power may become a common energy source for Indian homes by removing financial and informational obstacles and therefore helping to create a more sustainable energy future.

Author Contributions

Sakunthala Chinnasamy designed the study; Dr Hemachandran Ravikumar provided ideas on the final design and selection of assessment tools. Both authors were involved in data collection, summarising, statistical analysis, and finalising the report. Sakunthala Chinnasamy has made the rough draft of the research paper; Dr Hemachandran Ravikumar provided the initial draft of the manuscript, and the final version is made available by considerations of all.

Declarations of conflicts of interest

The authors declare that they have no potential conflicts of interest regarding the study design, research analysis, or publication of this article.

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Ethical Approval

The study was approved by the Review Committee of the UNS Research Council.

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