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THE VARANASI SOLAR STORY

A SOCIO-ECONOMIC ANALYSIS OF PM-SURYA GHAR: MUFT BIJLI YOJANA

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Disclaimer

This report is based on surveys conducted in person by a survey agency over a two-month period. While every effort has been made to ensure the accuracy of the data, neither UPNEDA nor Vasudha Foundation guarantees its accuracy or accepts responsibility for any consequences arising from its use.

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Contents

List of Figures

List of Tables

1

Executive Summary

Executive Summary

The **PM - Surya Ghar: Muft Bijli Yojana (PMSGY)**, launched on February 13, 2024 by the Honourable Prime Minister of India, Shri Narendra Modi, is a transformative initiative aimed at accelerating the adoption of residential solar rooftop systems across India. With an ambitious budget allocation of ₹75,021 crore, the program targets the installation of solar rooftop systems in 1 crore residential households by FY 2026-27, contributing significantly to India's clean energy transition and fulfilling its Nationally Determined Contributions (NDCs). This scheme, focused on delivering affordable and sustainable energy, has already demonstrated remarkable socio-economic and environmental impacts, particularly in Varanasi.

This report captures the summary of the responses of around 1,013 beneficiaries of PMSGY in Varanasi over a few months. The findings reveal that the majority of households installing solar rooftop systems have a connected electricity load of 4 kW, accounting for 35 percent of respondents. This is followed by 3 kW, representing 24 percent, and 2 kW, at 13 percent. Together, these three load categories comprise 72 percent of the total respondents, reflecting that the scheme primarily caters to low to medium-load residential consumers.

Key Outcomes in Varanasi

Financial Benefits

1. Cost Savings

- Beneficiaries have installed an average of 4 kWp solar rooftop system with an average cost of ₹59,604 per kW. They received an average subsidy of ₹1,06,043 per household, which includes the central subsidy from PMSGY and the state subsidy provided under the UP Solar Policy 2022. The average landed cost of the solar PV system (4 kWp) for the consumer comes out to be ₹1,32,373. The financial support reduces the initial cost of the system and makes solar energy more accessible and affordable.
- For a 4 kWp system, subsidies cover around 43 percent of the total system cost, leaving consumers to bear only 57 percent. In contrast, for households installing a 2 kW system, subsidies account for

approximately 73 percent of the cost. This higher subsidy percentage helps lower-income households more easily adopt solar rooftop systems, aligning with the scheme's objectives.

- Households save an average of ₹2,972 monthly, amounting to annual savings of ₹35,664 and lifetime savings of ₹8,91,600.
- The system's average payback period is an impressively short 3.8 years.

2. Utilisation of Savings

- 68.9 percent of savings are used for household expenses, while 23.6 percent are allocated to future savings, indicating improved financial planning.

Socio-Economic Impact

1. Enhanced Quality of Life

- 77.4 percent of beneficiaries reported an improvement in their quality of life, attributed to reduced energy expenses and greater energy reliability.

2. Employment Generation

- The scheme has created over 4,500 jobs in Varanasi, including skilled roles like project managers to semi-skilled jobs such as installers and customer support staff.

3. Educational and Behavioural Changes

- 60.4 percent of households observed increased interest among children in renewable energy and environmental issues.
- Adoption of solar rooftop systems fostered energy-conscious behaviours in nearly 60 percent of households.

Environmental Contributions

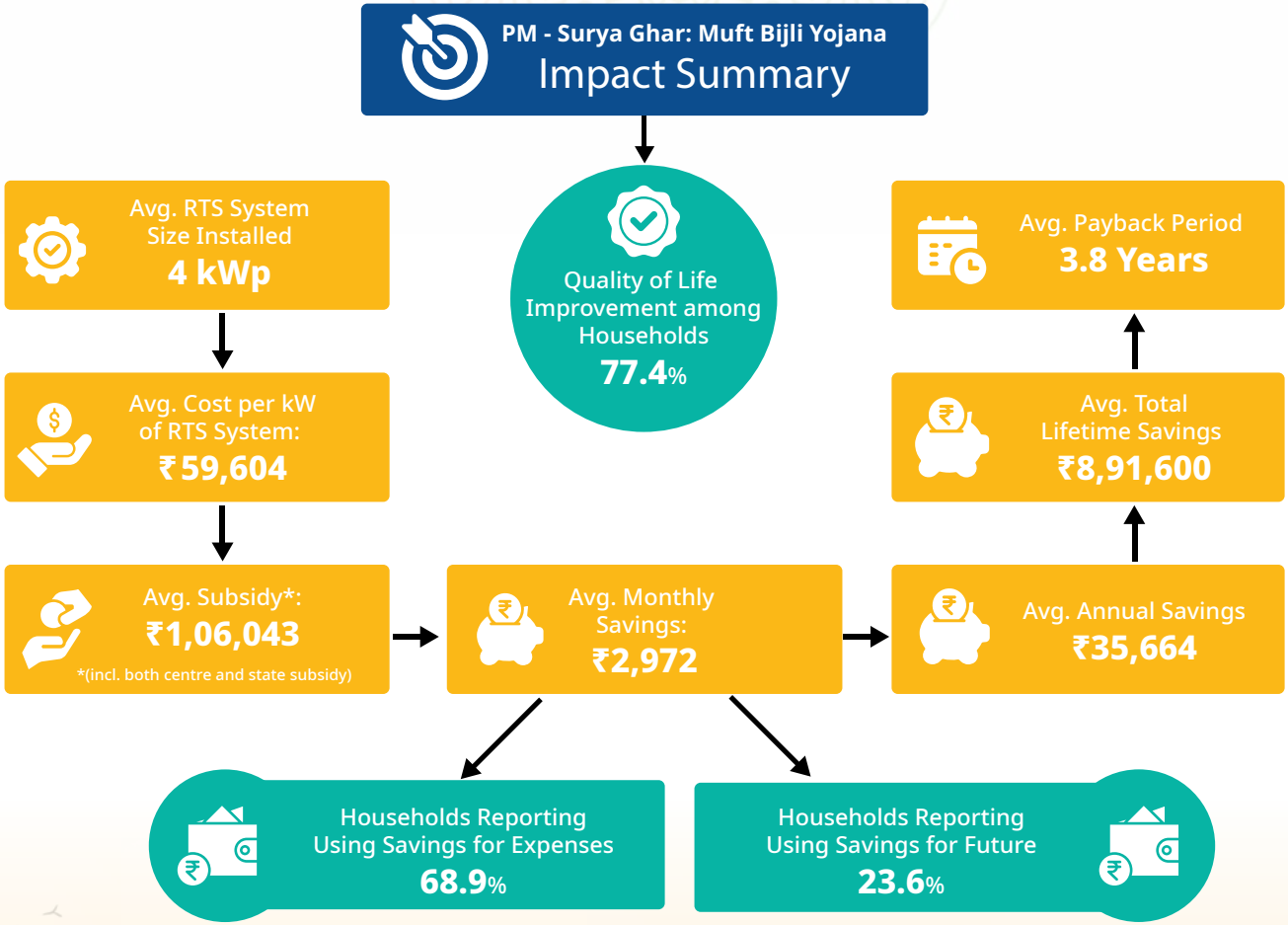
1. Energy and Emissions

- The initiative contributes to producing clean energy, significantly reducing dependence on conventional energy sources.

2. Catalysing Sustainability

- Beneficiaries adopted additional conservation practices, such as energy-efficient appliances and water conservation, amplifying the environmental benefits.

The **PMSGY** exemplifies how targeted renewable energy initiatives can deliver economic, social, and environmental dividends. By empowering households with affordable, clean energy, the Honourable Prime Minister has laid the foundation for a sustainable energy future while improving the financial well-being of communities.



2

Introduction

Introduction

India has demonstrated remarkable leadership in addressing climate change, securing a spot among the top 10 high-performing countries in the Climate Change Performance Index (CCPI) 2025 for the sixth consecutive year[1]. This accomplishment underscores India's expanding role in renewable energy (RE) and its progress in enhancing energy efficiency.

As of 30th April, 2025, RE contributes to 223.4 GW or 47.01 percent[2] of the total installed power capacity in India. This marks a 175 percent increase in RE capacity since 2014-15[3]. Solar energy, with a total installed capacity of 107.95 GW, has emerged as a cornerstone of this transition. It currently contributes 48.3 percent to India's installed RE capacity, a significant rise from 4.8 percent in 2014-15[3]. Figure 1 provides the breakdown of solar energy on the basis of types of installation, with ground-mounted solar being the most prominent, followed by solar rooftop.

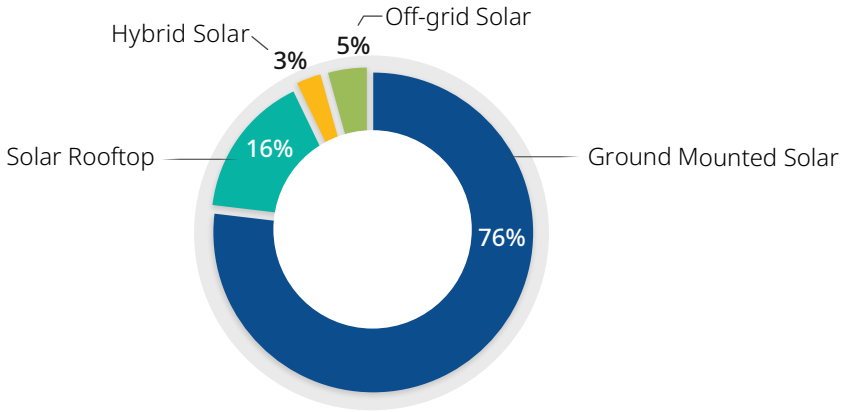


Figure 1: Breakdown of Solar Capacity by Type of Installation in India[3]

1 https://ccpi.org/

2 https://mnre.gov.in/en/physical-progress/

3 https://iced.niti.gov.in/

Upon deeper analysis of the data, we observe a significant increase in solar rooftop capacity deployment compared to the previous year, as illustrated in Figure 2. This remarkable growth is largely attributed to the announcement of the PMSGY.

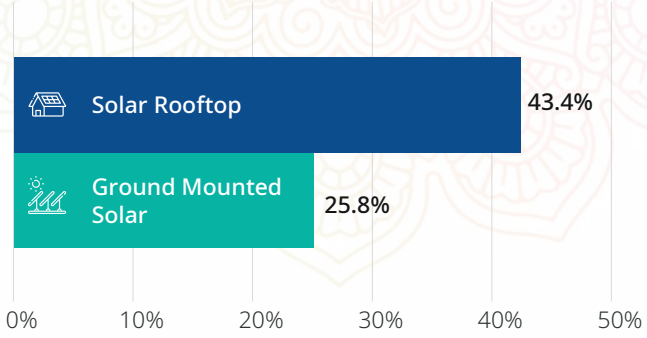


Figure 2: Percentage Growth in Solar Capacity Deployment for Different Typologies (FY 2024 v/s FY 2025)

PMSGY: A Brief Overview

Aim and Objectives

The **PMSGY**, launched by the Honourable Prime Minister of India, Shri Narendra Modi, on February 13, 2024, is a transformative initiative aimed at accelerating solar rooftop system adoption in the residential sector in India. With an ambitious outlay of ₹75,021 crore, it targets the installation of solar rooftop system in 1 crore residential households by FY 2026-27. The primary objectives of the scheme include:

1. Energy Generation and Environmental Impact:

- Facilitate the production of 1,000 billion units of renewable electricity during the lifetime of installed systems.
- Achieve a reduction of 720 million tons of CO_2 equivalent emissions over 25 years.

2. Economic and Employment Boost:

- Enhance local manufacturing, supply chains, and operational ecosystems.
- Generate local employment opportunities and strengthen energy security.

3. Support for Residential Energy Needs:

- Provide free or low-cost electricity up to 300 units per month for participating households through solar rooftop systems.

4. Green Commitments:

- Support India's Nationally Determined Contributions (NDCs) by installing 30 GW of solar rooftop system capacity by FY 2026-27.

Salient Features of the Scheme

Financial Assistance

- Central Financial Assistance (CFA) covers 60 percent of benchmark costs for the first 2 kWp of solar rooftop system capacity, and 40 percent for an additional kWp up to 3 kWp. No additional CFA for solar rooftop system capacity beyond 3 kWp.
- For Group Housing Societies/Residential Welfare Associations (GHS/RWA), the CFA is 40 percent of the benchmark cost for common facilities, including EV charging, up to 500 kWp, with a limit of 3 kWp per house.
- The benchmark cost is fixed at ₹50,000/kW for the first 2 kW and ₹45,000 for the additional kW. For special category states, the benchmark cost is ₹55,000 for the first 2 kW and ₹49,500 for the additional kW. The effective CFA is ₹30,000/kWp for the first 2 kWp and ₹18,000/kWp for the additional 1 kWp for general states and ₹33,000/kWp and ₹19,800/kWp respectively for special category states.

Eligibility and Scope

- Exclusive to residential sectors, with installations needing to meet specific technical standards and domestic content requirements.

- Aimed at boosting solar rooftop system installations on rooftops, terraces, and balconies, including innovative setups like Building Integrated Solar Rooftop Systems.

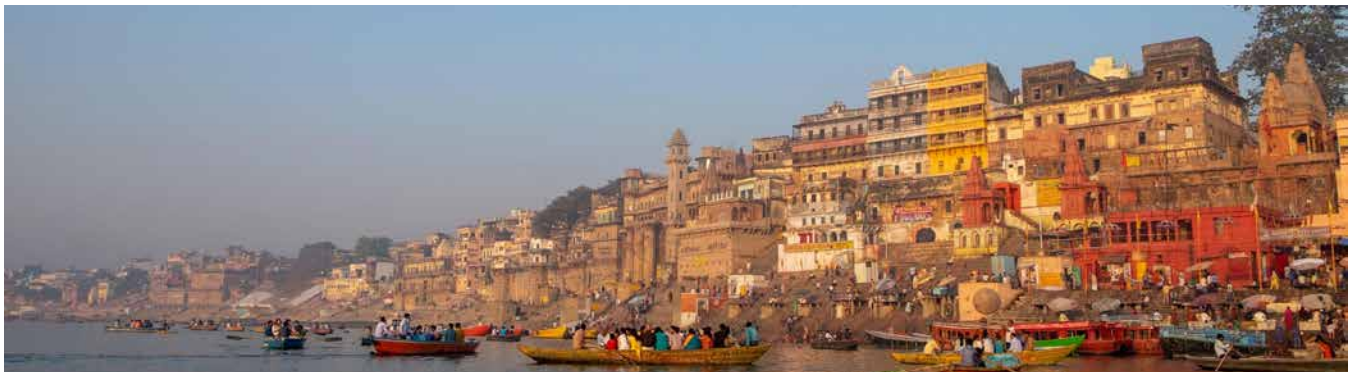
Status of Implementation of the Scheme (as of 10th March 2025)[4]

- Over 47.3 lakh applications have been recorded nationally.
- Completed installations stand at 10 lakh+ solar rooftop systems.

Status in Varanasi

City Profile

Varanasi, also known as Banaras or Kashi, is located at 25.3176° N, 82.9739° E in the eastern part of Uttar Pradesh. One of the oldest living cities in the world, Varanasi holds significant cultural and religious importance in Hindu mythology. The city spans 1,535 square kilometeres and is home to a population of 3,676,841[5]. Table 1 provides a brief overview of Varanasi's solar and climate parameters. With its high average day length and temperature, Varanasi offers ideal conditions for solar energy generation. The city receives a global horizontal radiation of 1,551.6 kWh/m^2/year[6].



4 https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=2111106#:~:text=Muft%20Bijli%20Yojana%20Crosses%20Milestone%20of%2010%20Lakh%20Installations&text=PM%20Surya%20Ghar:%20Muft%20Bijli,as%20of%2010th%20March%202025

5 https://varanasi.nic.in/demography/

6 Meteonorm data, PVSyst

Table 1: Solar and Climate Parameters for Varanasi[7]

Indicator	Value
Longitude /Latitude	82.9739 / 25.3176
Day Length (Min / Max)	10.42 / 13.58 hours
Avg. Temp. (Min / Max)	19 °C / 31 °C
Global Horizontal	1551.6(kWh/m^2/year)
Average Wind Velocity	1.7 (m/s)

Enhanced Solar Subsidy in Uttar Pradesh

The Uttar Pradesh Government has introduced an additional subsidy of ₹15,000 per kW, capped at a 2 kW system, in addition to the existing subsidy provided under the PMSGY. This initiative, first announced in the UP Solar Policy 2022[8] and sustained since, has made solar rooftop systems even more appealing to the public, significantly increasing interest in their adoption.

PMSGY Status

As of April 2025, a total of 57,802 applications have been submitted under the PMSGY in Varanasi. A total of 12,086 solar rooftop installations have been implemented, up from 8,394 in January 2025. The city's total installed solar rooftop capacity has grown from 32,304.93 kW in January to 43,678 kW in April 2025, reflecting a 35% increase over the three-month period. Figure 3 illustrates this comparative progress in solar rooftop deployment in Varanasi between January and April 2025.

7 https://vedas.sac.gov.in/solar-calculator/

8 https://upneda.org.in/MediaGallery/Uttar_Pradesh_Solar_Energy_Policy2022_English_.pdf

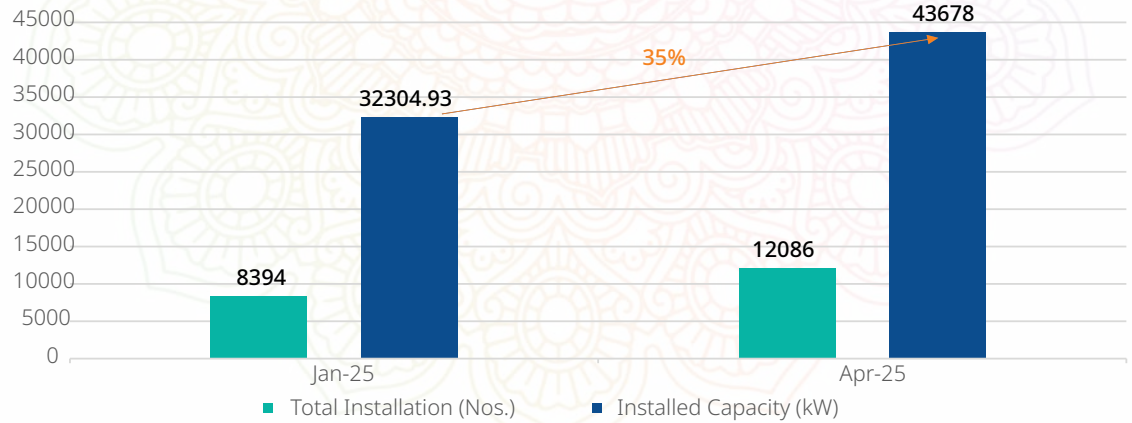


Figure 3: Status of Solar Rooftop Installations and Capacity in Varanasi: January to April 2025

The announcement of the PMSGY in February 2024 had a notable impact on solar rooftop deployment in Varanasi. Following the announcement, installed capacity surged from just 3421.4 kW in February 2024 to 4536.7 kW in March 2024, and continued to grow steadily in the subsequent months. Throughout 2024, the city added over 30,000 kW of solar rooftop capacity, with total capacity reaching 43,678 kW by April 2025. Figure 4 presents the month-on-month trend in solar rooftop capacity addition from January 2024 to January 2025, and also captures the cumulative installed capacity as of April 2025.

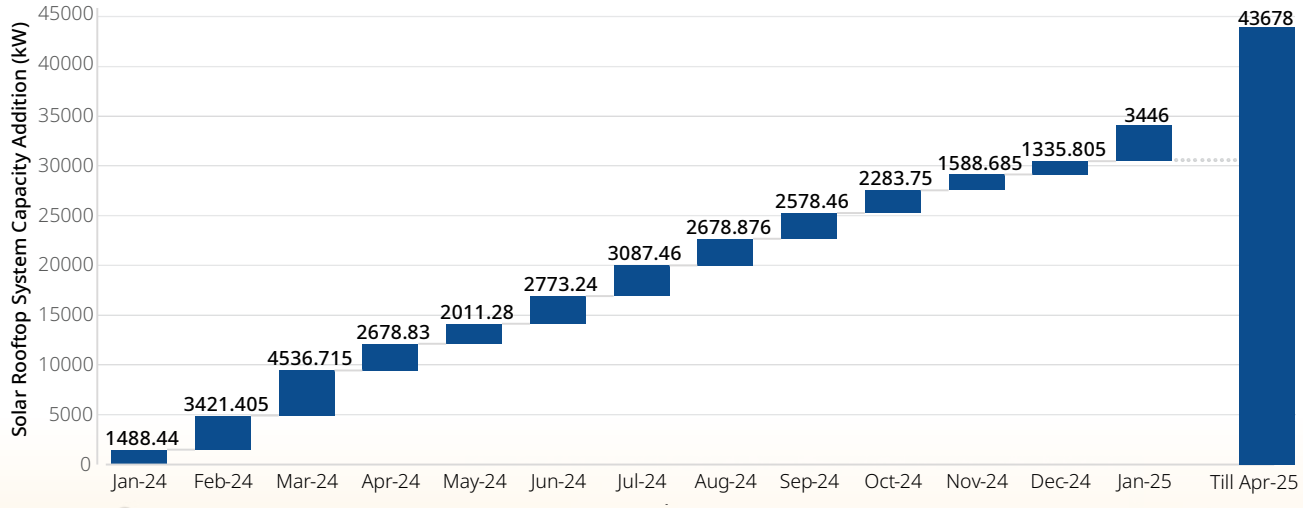


Figure 4: Month-on-Month Deployment of Residential Solar Rooftop in Varanasi b/w Jan 24'-25'

3

Objective of the Report

Objective of the Report

This report aims to evaluate the socio-economic, financial, and environmental impact of the PMSGY, a flagship initiative launched by the Honourable Prime Minister of India to promote residential solar rooftop systems. By analysing data from beneficiaries in Varanasi, the report aims to assess the scheme's effectiveness in delivering affordable, clean energy, reducing household energy costs, and fostering sustainable practices. It aims to highlight the program's role in improving quality of life, generating employment, and contributing to India's clean energy transition. Furthermore, the report captures key suggestions from the beneficiaries to enhance the programme's efficiency and scalability. By documenting the transformative outcomes of the PMSGY, the report aims to inspire broader adoption of renewable energy solutions and underscore their potential to achieve India's climate goals. The transformative outcomes also emphasise the need to keep full throttle until the overall objective of the scheme is achieved, as it is inspiring systemic change at the grassroots level across multiple tiers, ensuring India will reap its benefits for generations to come.

Survey Design and Methodology

Target Population

The target population for the survey comprised households in Varanasi that are beneficiaries of the PMSGY. These households were selected to represent a diverse demographic, ensuring insights into the socio-economic and behavioural impacts of the scheme across different income groups and regions within the city.

Sampling Method

A random sampling method was employed to ensure an unbiased selection of participants and a representative sample of the beneficiary population. The survey captured responses from 1,013 households, providing a statistically significant dataset for assessing the programme's impact.

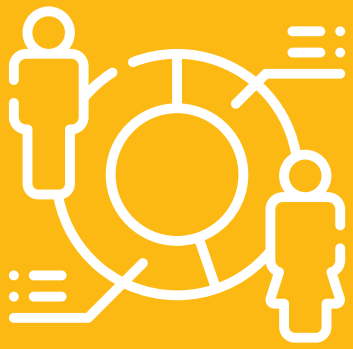
Data Collection Tools and Techniques

The survey utilised structured questionnaires to gather both quantitative and qualitative data. The questionnaires included a mix of multiple-choice questions, Likert scales, and open-ended questions, focusing on economic impacts, quality of life changes, community influence, and environmental awareness. Data collection was conducted through in-person interviews, ensuring clarity in responses and capturing nuanced insights that might be missed in remote surveys. For detailed questionnaire and masked dataset, please contact Vasudha Foundation.

Limitations of the Survey

- Self-reported Data: Findings are based on respondents' self-reported information, which may include recall bias or subjective interpretations.
- Time Constraints: The survey was conducted over a limited period, restricting the scope for longitudinal assessment of long-term impacts.

Despite these limitations, the survey provides valuable insights into the socio-economic impact on PMSGY beneficiaries.



4

Demographic and Socio-Economic Profile of Respondents

Demographic and Socio-Economic Profile of Respondents

Household Characteristics

The survey covered households across various colonies in Varanasi, representing a mix of family sizes and compositions. A majority of the households reported a family size ranging from three to four members, as shown in Figure 5, reflecting the scheme's adoption by nuclear family households.

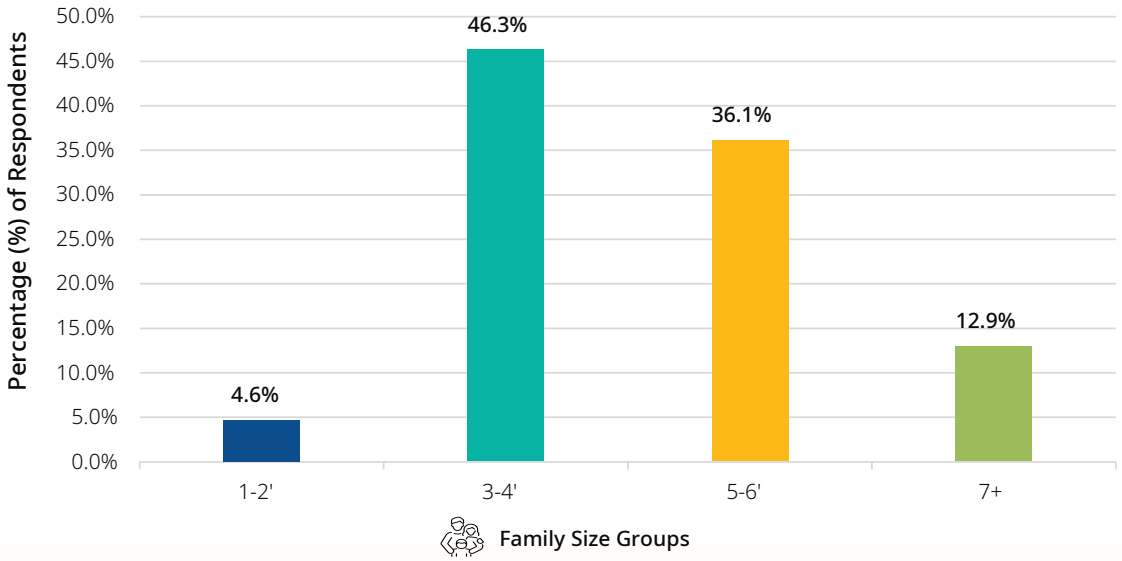


Figure 5: Distribution of Household Family Size

Income and Occupation

The analysis of respondent's occupation types shows a diverse distribution of occupations among respondents, with significant representation from private sector employees, government workers, and traders/business owners. They together form over 3/4th of the total respondents, as shown in Figure 6.

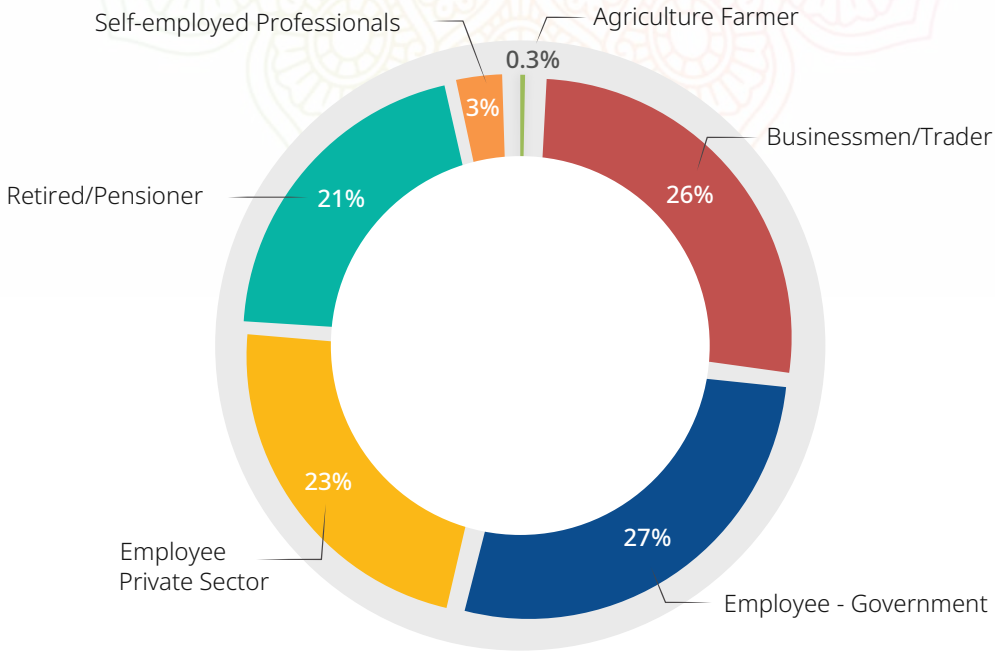


Figure 6: Occupation Type of Respondents

This reflects the scheme's broad appeal across middle-income households and entrepreneurial groups. The program effectively caters to varied demographics, driving solar adoption and energy savings.

The monthly household income predominantly fell within the range of ₹50,000 to ₹1,00,000, while a significant minority earned less than ₹50,000, as shown in Figure 7.

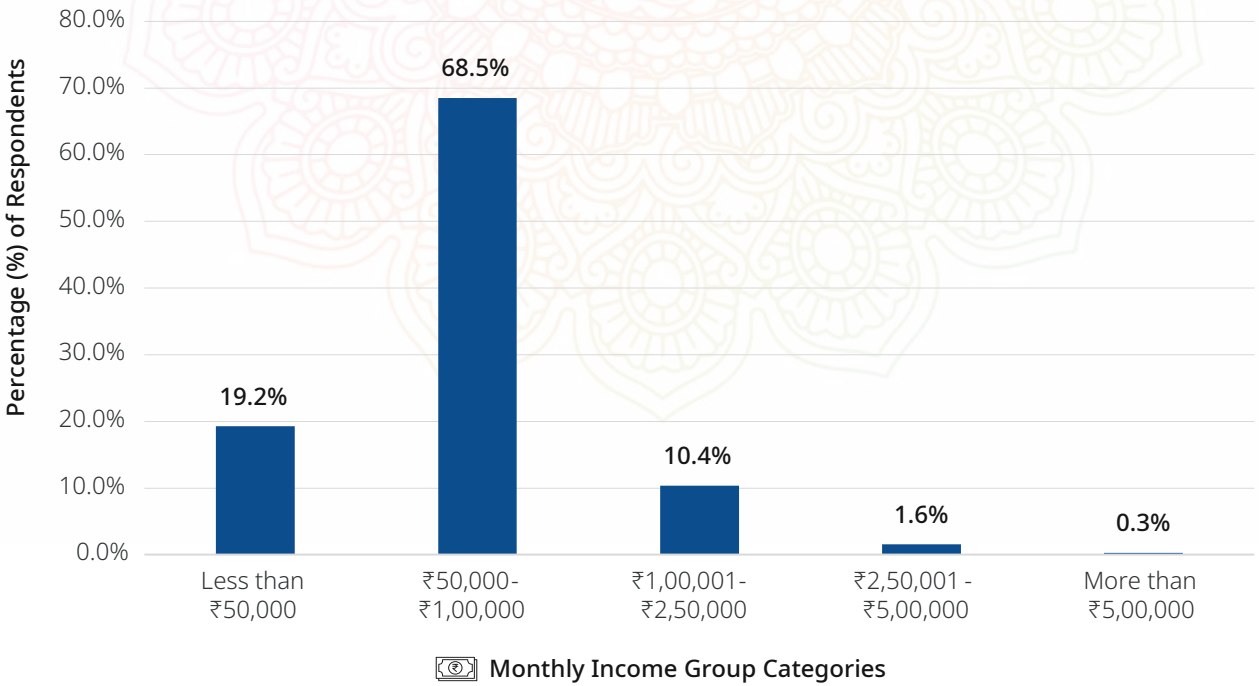


Figure 7: Distribution of Monthly Household Income among Respondents

This income distribution highlights the scheme's appeal across middle-income and lower-middle-income groups. **Property tax payments ranged from ₹500 to ₹2,000 annually for more than half of the respondents**, indicating modest residential setups.

Energy Consumption Pattern

Energy consumption patterns, represented in Figure 8, reveal that the majority of households installing solar rooftop systems have a connected electricity load of **4 kW**, accounting for **35.3 percent** of respondents, followed by **3 kW**, representing **24.3 percent**, and **2 kW**, at **13.3 percent**. Together, these three load categories comprise **72.9 percent** of the total respondents, reflecting that the scheme primarily caters to low to medium-load residential users.

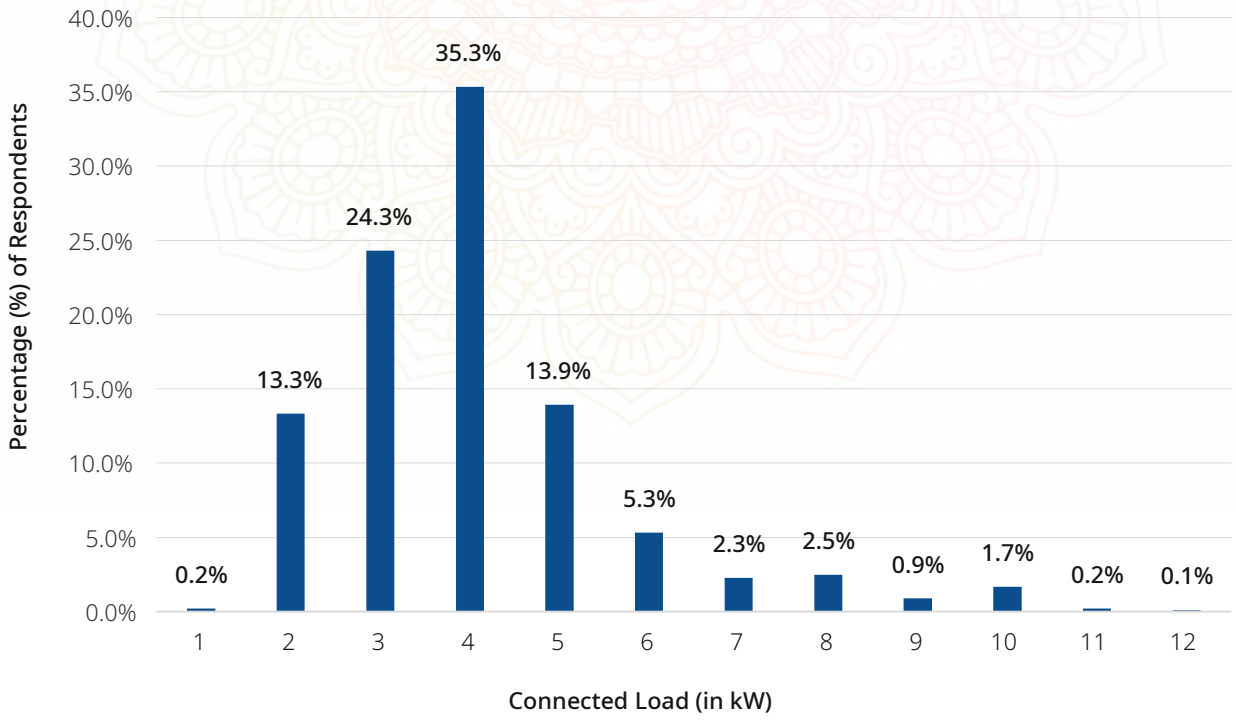


Figure 8: Connected Load of Households (in kW)

5

Solar System Installation and Energy Use

Solar System Installation and Energy Use

Motivation Factors

The primary driver for adopting solar rooftop systems among respondents is **cost savings**, as illustrated in Figure 9, with **83.1 percent** citing this as their main motivation. This overwhelming majority reflects the financial appeal of the PMSGY, where reduced electricity bills play a pivotal role in influencing decisions for low to medium income households.

Other reasons include **environmental benefits** (6.4%) and **energy independence** (5.3%), indicating a smaller but notable segment motivated by sustainability and self-reliance in energy consumption.

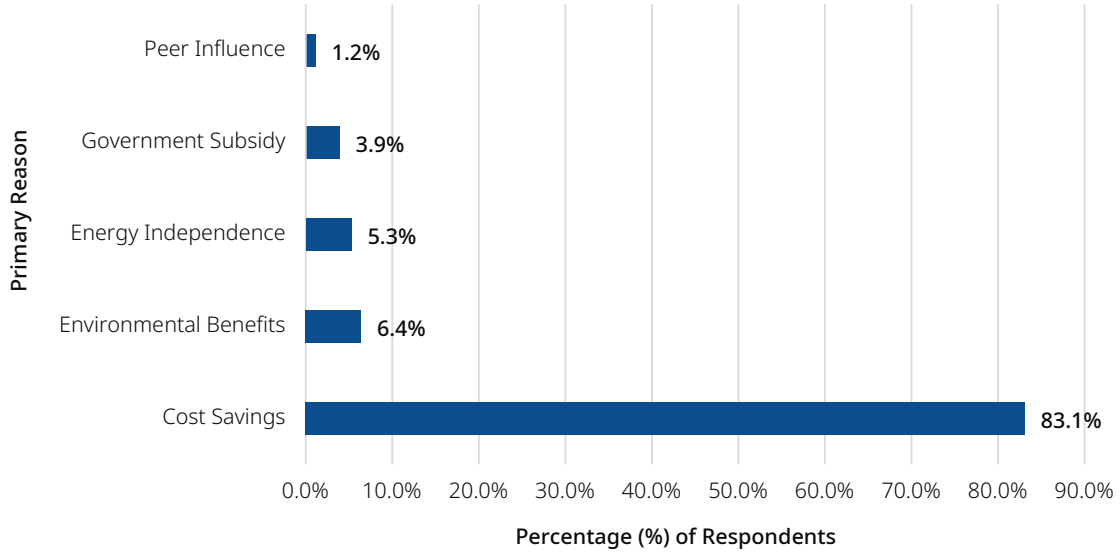


Figure 9: Primary Reason for Installing Solar Rooftop System

System Specifications

The distribution of solar rooftop system sizes among respondents reveals a clear preference for smaller system capacities, with 3 kW and 4 kW installations being the most prevalent, collectively accounting for over 66 percent of installations, as illustrated in Figure 10. This trend likely reflects the suitability of these capacities for average household energy consumption and financial affordability. Smaller systems, such as 2 kW, represent 10.9 percent of installations, further indicating a preference for cost-effective solutions or limited energy needs among certain respondents.

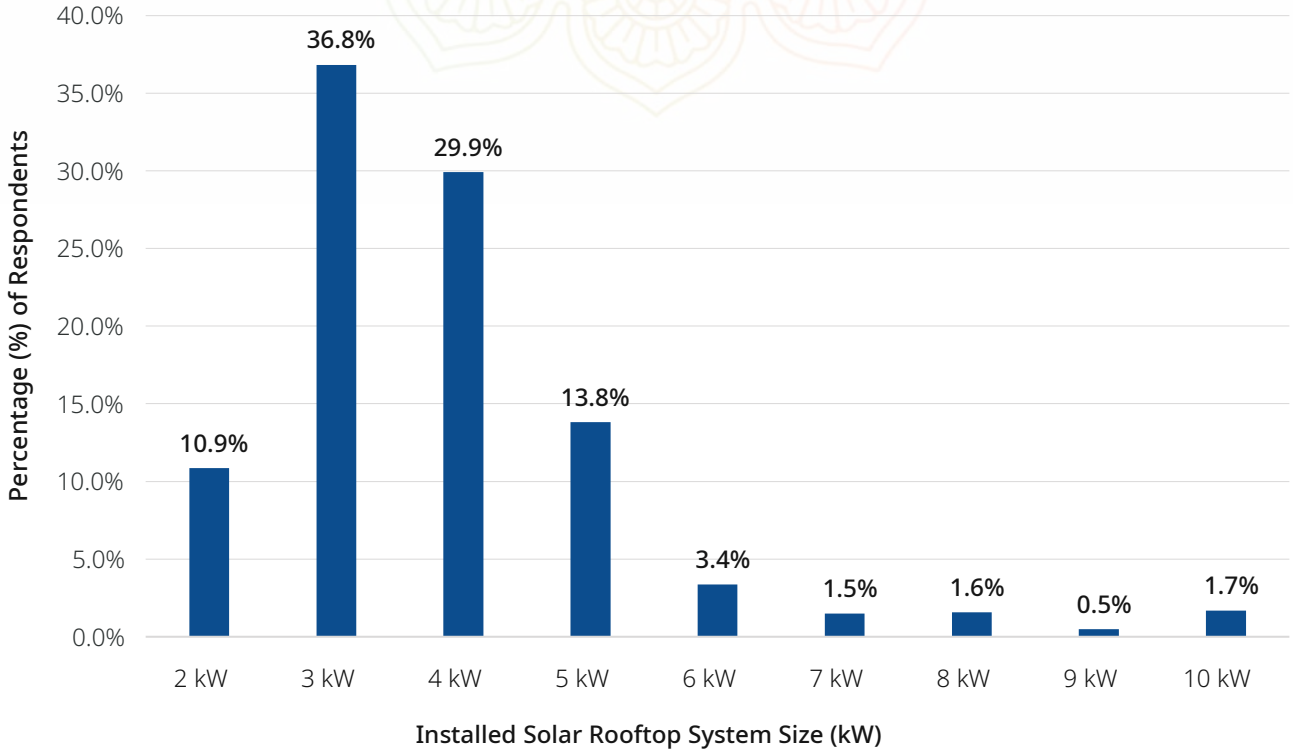


Figure 10: Size of Solar Rooftop System Installed

Energy Consumption Analysis

Pre-Installation Usage

Before the installation of the solar rooftop system, the average electricity consumption was **773.9 kWh per month**. This figure establishes the baseline for comparison.

Post-Installation Usage

Following the installation of the solar rooftop system, the average electricity consumption significantly decreased to **387.3 kWh per month**. This reduction demonstrates the contribution of solar energy in supplementing electricity needs and reducing dependence on conventional power sources.

Average Change in Consumption

The installation of the solar rooftop system resulted in an average reduction of **386 kWh** in electricity consumption per household per month. This substantial decrease underscores the effectiveness of solar rooftop systems in lowering energy costs and promoting sustainability.

Grid Export Analysis

On average, households exported **179 kWh to the grid** each month. A significant proportion (43.63%) of households exported between 101 and 200 kWh, as shown in Figure 11. This was followed by 25 percent of households exporting between 201 and 300 kWh, and 19 percent exporting between 0 and 100 kWh.

The data indicates an average reduction of 386 kWh in monthly electricity consumption per household, with an average of 179 kWh exported to the grid each month. This implies that approximately **189 kWh of solar energy**, on average, is directly utilised by households during solar generation hours each month.

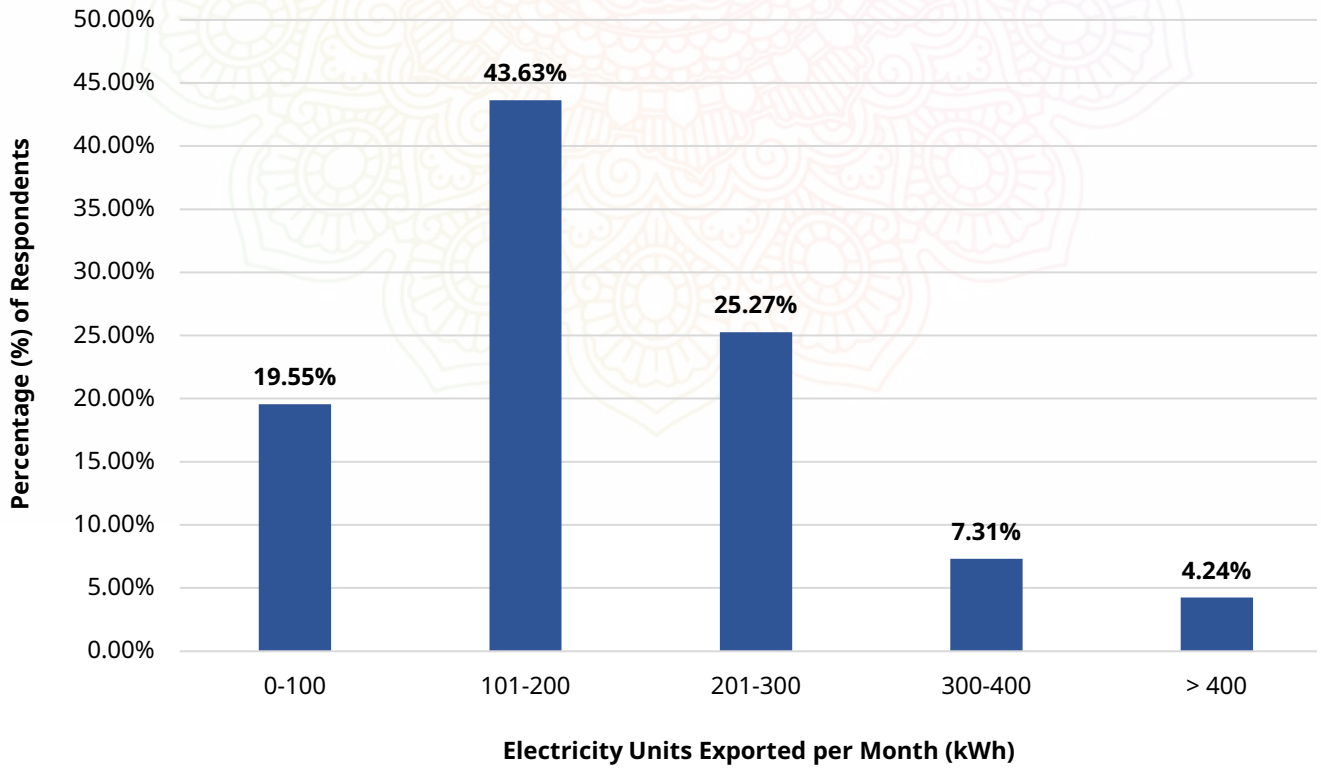


Figure 11: Electricity Units Exported to Grid after Solar Rooftop System Installation (in kWh)

6

Technical Performance and Maintenance

Technical Performance and Maintenance

System Performance Analysis

Figure 12 reveals that **81 percent** of respondents are satisfied with the performance of their solar systems, while **5 percent** are partially satisfied. The majority find the systems effective, with some scope to address concerns among the dissatisfied users.

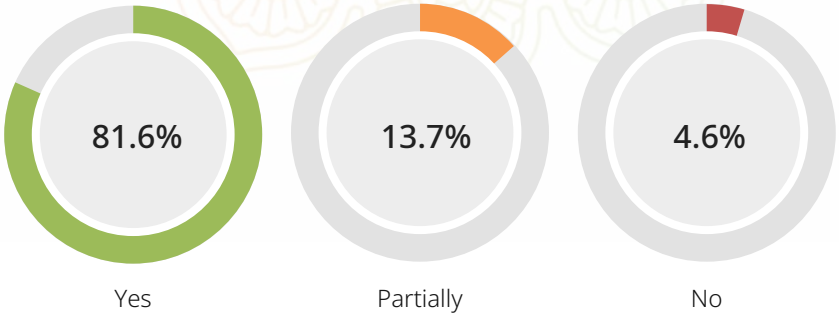


Figure 12: Respondent's Satisfaction with the Performance of Solar Rooftop System

The high satisfaction levels with solar rooftop systems are further reinforced by the fact that **99.5 percent** of respondents reported not having to replace any components since installation. This highlights the reliability and durability of the installed systems, contributing to a positive user experience.

Cleaning Practices

Regular cleaning of solar panels is crucial for maintaining their efficiency and ensuring optimal energy generation. The frequency of cleaning varies significantly among users, with ~77.5 percent of respondents cleaning their panels every 10 to 30 days, as indicated in Figure 13. This indicates a proactive approach toward maintenance, ensuring that dust and debris do not hinder performance. However, a few users reported cleaning intervals exceeding 30 days or infrequent practices, which could reduce the system's output over time.

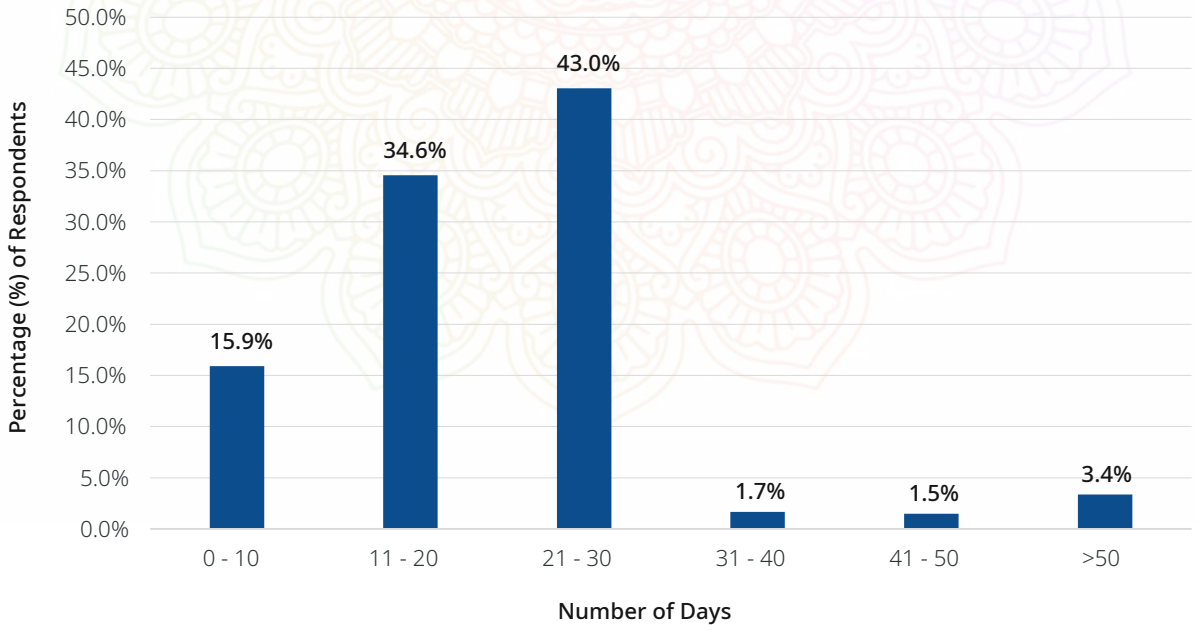


Figure 13: Frequency of Cleaning Solar Panels in Number of Days

Figure 14 indicates that vendors are the primary source of information for consumers regarding solar panel maintenance and cleaning, with 73.1 percent of respondents learning from them. This underscores the importance of vendor engagement and the need for vendors to proactively provide comprehensive guidance to consumers through both digital and in-person modes of engagement. Friends and family also emerged as a significant source of information, accounting for 30.7 percent of responses, highlighting the role of social networks in disseminating knowledge about solar rooftop systems. Additionally, 24.1 percent of respondents relied on online videos, reflecting the growing impact of digital platforms as an accessible and convenient medium for acquiring information. It is worth noting that the cumulative percentage exceeds 100 percent, indicating that the inputs were not mutually exclusive, as respondents may have accessed multiple sources of information.

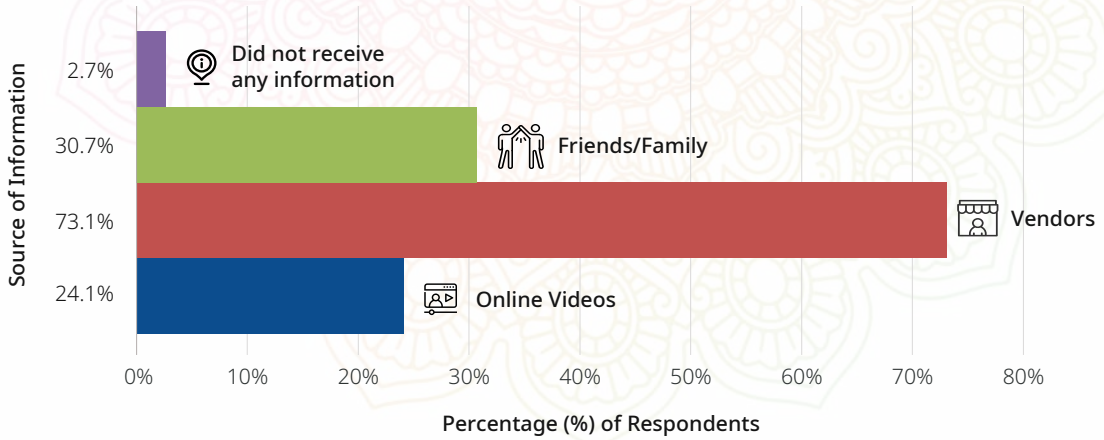


Figure 14: Awareness of Solar Panel Maintenance and Cleaning

Technical Challenges

When asked whether beneficiaries encountered difficulties in cleaning their solar panels, approximately 11 percent of respondents reported facing challenges. Among this group, 90 percent identified the height of the panels as the primary issue, as shown in Figure 15, making it a significant barrier to regular maintenance.

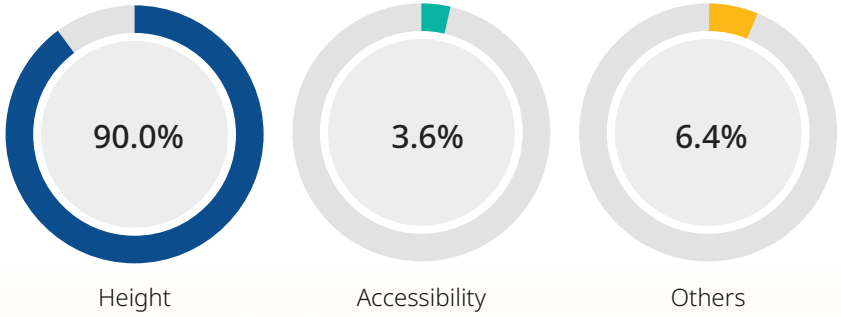


Figure 15: Issues faced by Consumers regarding cleaning of solar panels

Accessibility concerns, noted by 3.6 percent of respondents, underline the physical and logistical barriers associated with maintaining solar systems, particularly in areas with complex layouts or restricted access. Furthermore, it is crucial for vendors to prioritise optimised system deployment, considering all aspects, rather than solely focusing on ease of installation.

Vendor Service Analysis

Figure 16 illustrates respondents' ratings for vendor service during solar rooftop system installation through a box plot. The ratings range from 1 to 10, with most responses concentrated between 5 and 9, as indicated by the interquartile range. The median rating is 7, and the mean is slightly higher at 7.08, suggesting overall positive feedback with a slight right skew.

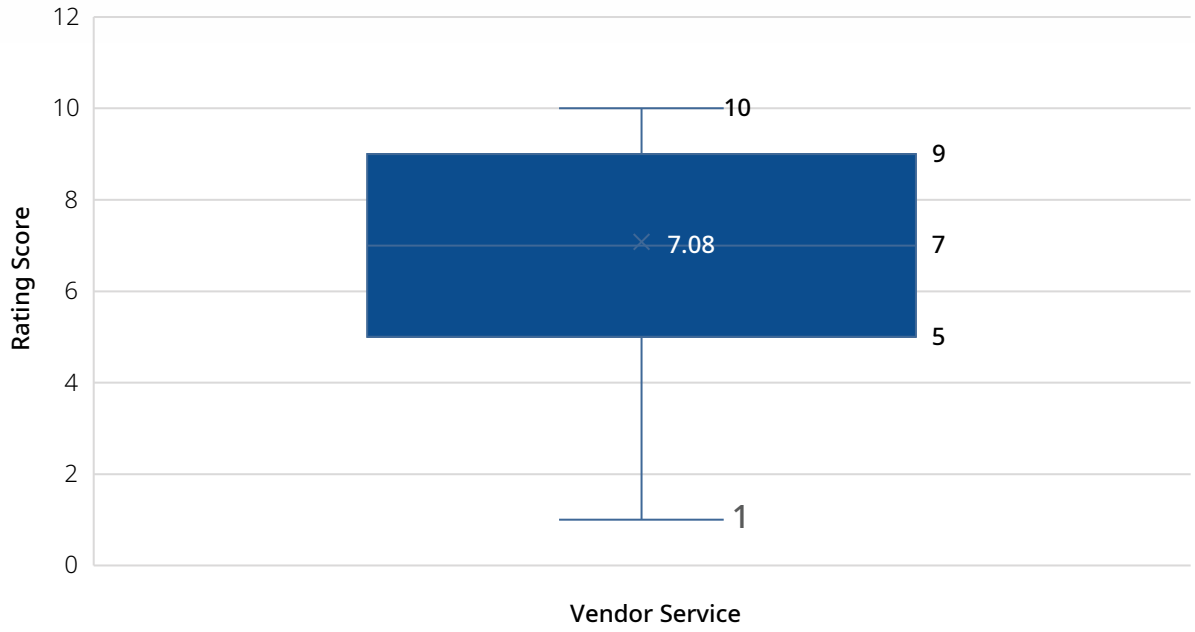


Figure 16: Box Plot Showcasing Vendor Service Rating

While the majority of respondents expressed satisfaction, the wide range highlights variability, indicating a mix of highly positive and a few low ratings.

The lowest quartile, represented by the range from 1 to 5, indicates the least favourable ratings given by respondents. This suggests that approximately 25 percent of respondents were dissatisfied or found the vendor service below expectations. Figure 17 lists the reasons for low score among the lowest quartile in percentage.

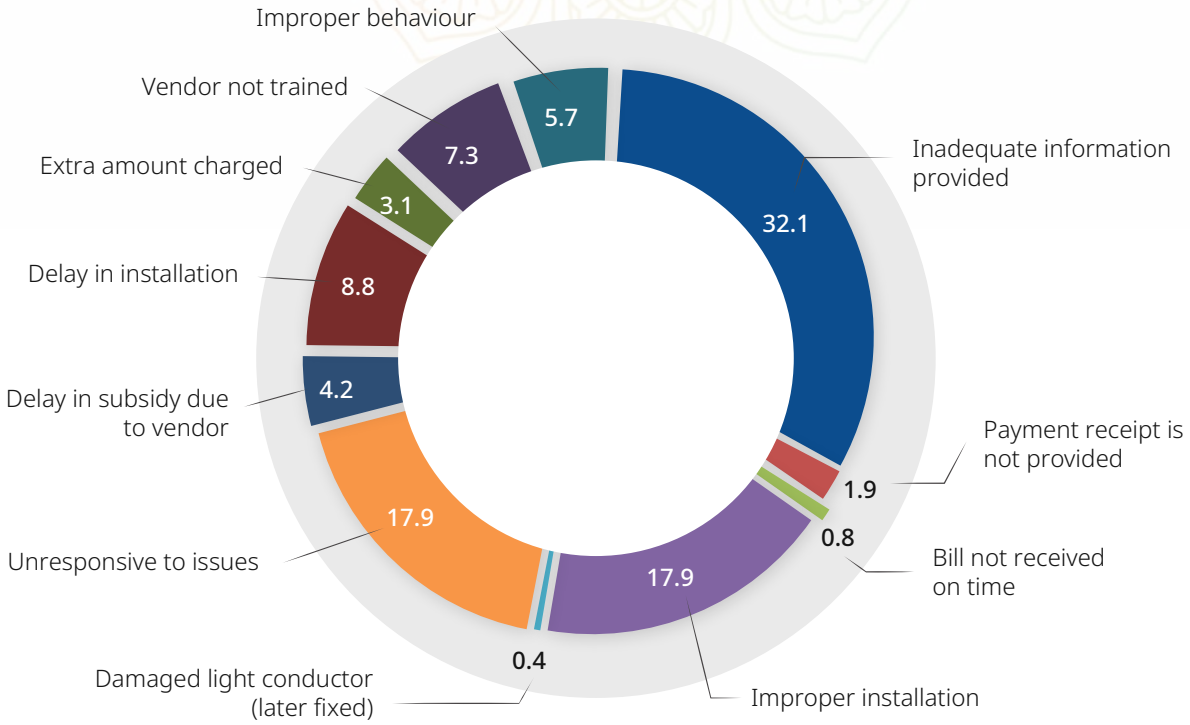


Figure 17: Percentage-wise List of Reasons for Poor (below '5') Vendor Service Rating

The low scores for vendor service can be attributed to several key issues identified by the respondents. Approximately 32.1 percent reported inadequate information being provided, followed by 17.9 percent citing improper installation and unresponsiveness to issues. Delays in installation accounted for 11 percent, while vendor training concerns and improper behaviour contributed 9 percent and 7 percent, respectively. Other factors, such as delays in subsidies (5%) and extra charges (4%), further highlight the areas requiring significant improvement in communication, professionalism, and service efficiency.

7

Impact Assessment

Impact Assessment

The Impact Assessment section examines the effects of solar energy adoption under the PMSGY. It explores adoption patterns, economic benefits such as electricity savings, social improvements such as enhanced quality of life, and environmental contributions through energy conservation and sustainability efforts.

Solar Energy Adoption

Awareness and Understanding of the PMSGY

Awareness is a critical factor in driving the adoption of the PMSGY, ensuring that potential beneficiaries are well-informed about its benefits and processes. The data reveals that media and advertisements have been the most significant sources of awareness, reaching **48.2 percent** of respondents. This underscores the effectiveness of mass media campaigns in disseminating information to a wide audience. Social networks, including friends, neighbours, and family, also play an important role, contributing to **25.8 percent** of awareness, reflecting the value of word-of-mouth communication in building trust and spreading knowledge.

While these mass media sources are essential, in-person booth camps have emerged as a highly effective and tangible outreach method, accounting for 12.1 percent of responses. The impact of booth camps cannot be overstated—they offer in-person, localised interventions that provide clear, actionable information, empowering potential beneficiaries to take the necessary steps toward installing solar systems. Beneficiaries have shared how helpful these camps are in addressing their questions and guiding them through the process. This feedback highlights the importance of booth camps as a crucial element of the outreach strategy, particularly for engaging local communities and offering personalised support.

Vendor outreach accounted for **10.1 percent of responses**, showcasing the role of industry stakeholders in promoting the scheme. These insights emphasise the need for a balanced approach that combines mass media campaigns with focused, local initiatives like booth camps to maximise awareness and program uptake.

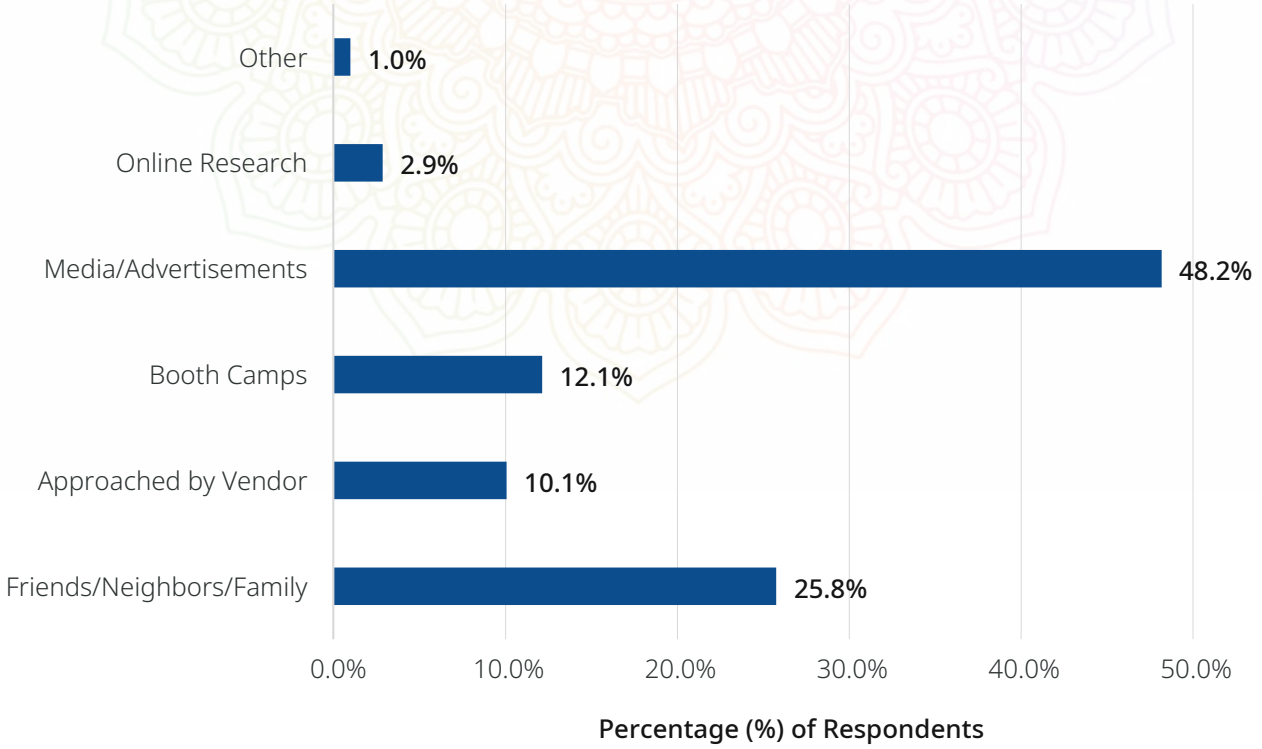


Figure 18: Percentage-wise Actual Mode of Communication for Awareness on PMSGY

Figure 19 reveals notable differences in how males and females learn about the PMSGY. While media and advertisements are the primary source of awareness for both genders, males rely on this channel significantly more (52.25%) than females (32.86%). On the other hand, females exhibit a stronger reliance on informal networks such as friends, neighbours, and family (34.74%) compared to males (23.38%). Booth camps are also a more effective outreach method for females (16.43%) than males (11.00%).

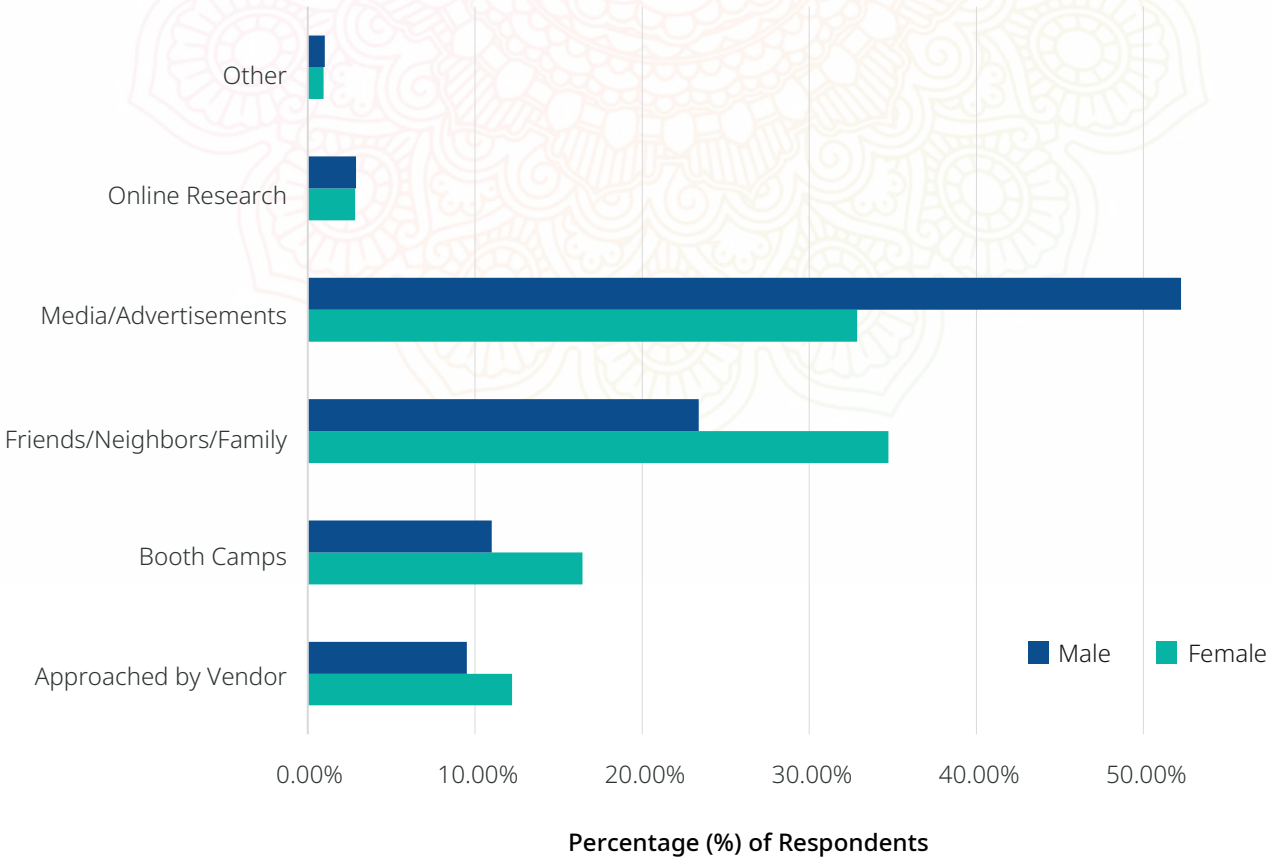


Figure 19: Variation in Mode of Communication for Awareness of PMSGY Scheme by Gender

Patterns in Adoption

This box and whisker plot, Figure 20, illustrates the distribution of installed solar rooftop system capacities across different household monthly income groups. The median capacity (represented by the line inside the box) and the interquartile range (IQR, represented by the box height) provide insights into variations within each income group.

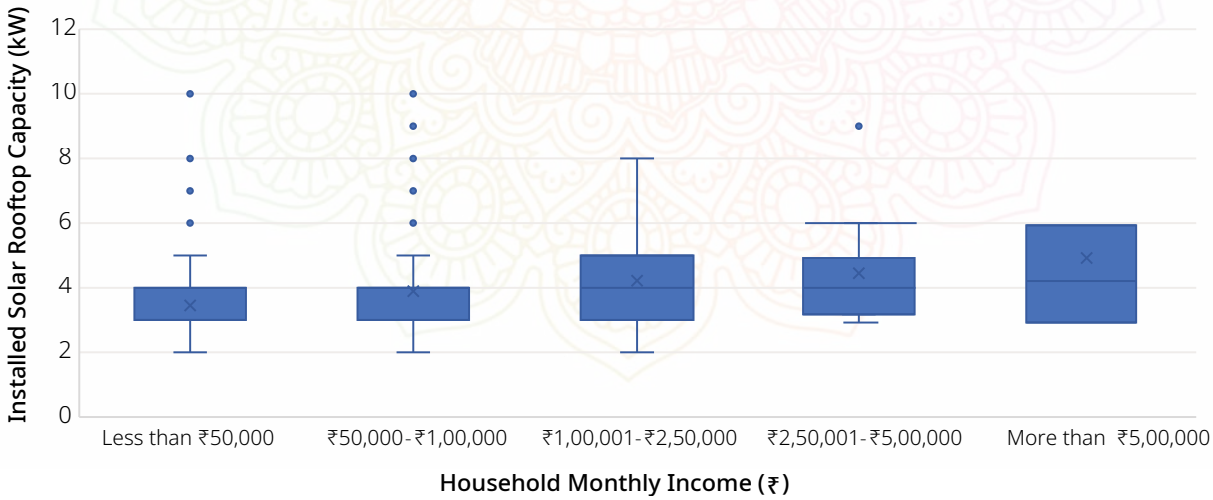


Figure 20: Variation of Household Monthly Income with Installed Solar Rooftop System Capacity

The plot displays a slight positive correlation between household monthly income and installed solar rooftop system capacity. The median capacity (represented by the horizontal line in each box) gradually increases with higher income levels. Households with income exceeding ₹5,00,000 have the highest median installed capacity.

In terms of spread and variability, all income groups exhibit considerable variation in installed capacity, as indicated by the box sizes and whiskers. There are several outliers (shown as dots) in the lower income groups, particularly households earning less than ₹50,000 and those in ₹50,000-1,00,000 range. These outliers suggest that some lower-income households have managed to install relatively high-capacity systems. This might be attributed to their better understanding of the financial benefits of the solar rooftop systems.

Additionally, the boxes (representing the middle 50% of data) become slightly larger as income increases, suggesting more variation in installation sizes among higher-income households. This highlights that the higher income households are also interested in deploying smaller rooftop systems for which the capital subsidy (including both PMSGY and state) is available. This is further supplanted by Figure 21.

It highlights that out of the 131 respondents with a connected load of 6 kW or more, **66.4 percent** (87 respondents) have installed solar rooftop systems of 6 kW or higher, while **33.6 percent** (44 respondents) have installed smaller systems. This behaviour highlights the importance of policies that promote larger installations for high-income households, ensuring greater adoption of renewable energy in line with their financial capacity.

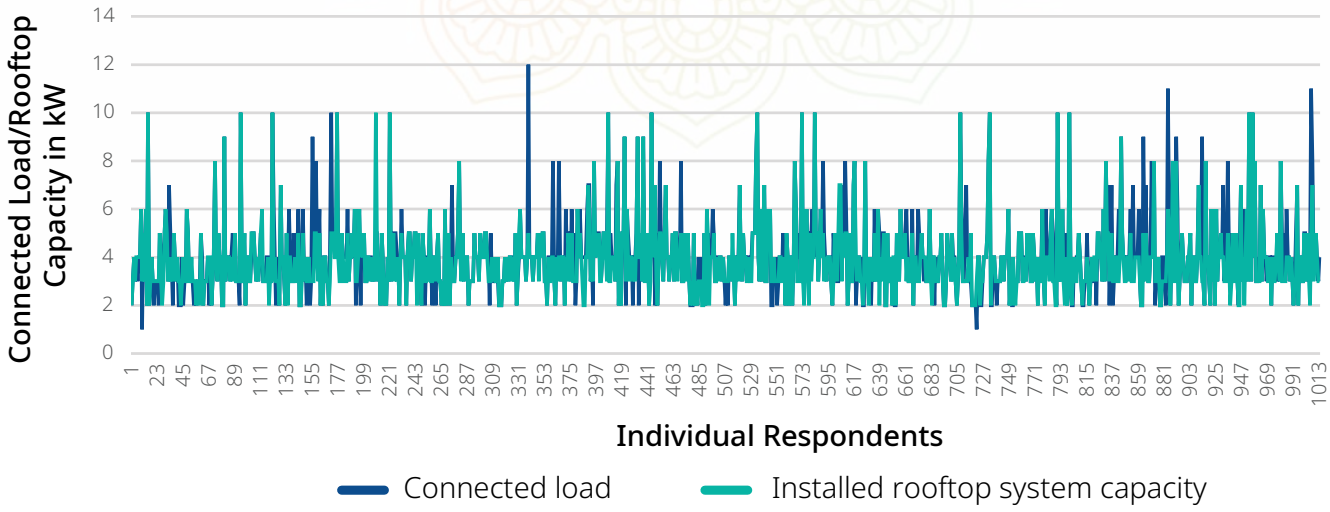


Figure 21: Connected Load vs Rooftop Capacity for Each Household

When analysing the patterns in adoption among gender groups, Figure 22 shows that cost savings are the most significant motivator for both males (82.88%) and females (84.04%), with only minor differences observed in other areas.

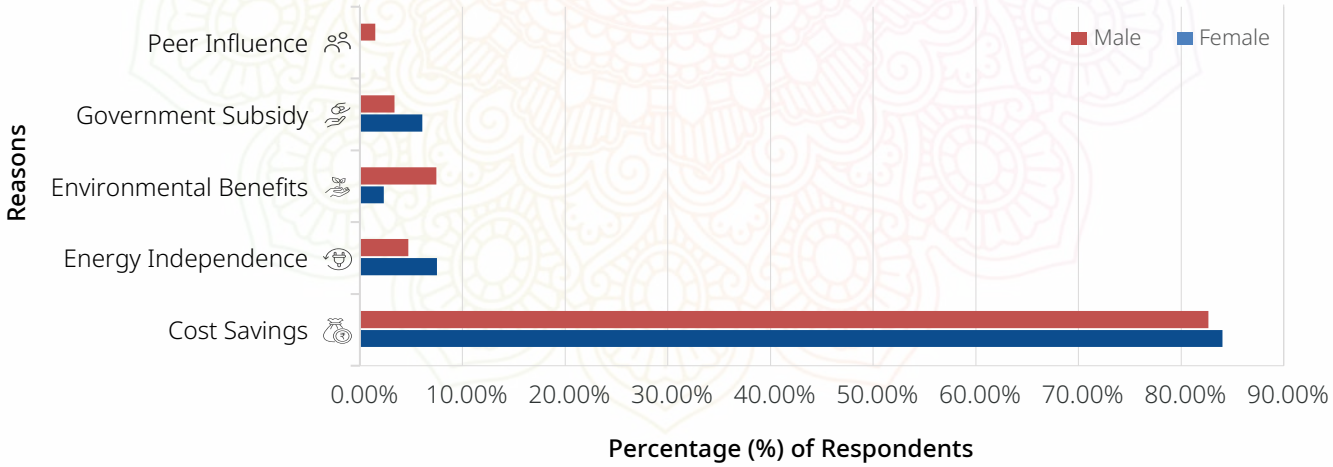


Figure 22: Reason for Solar Rooftop System Adoption Among Male and Female Respondents

Economic Impact

Savings on Electricity Bills

The adoption of solar rooftop systems has resulted in an average monthly electricity bill reduction of ₹2,972 representing a substantial 45 percent decrease. Before installation, households reported an average monthly electricity bill of ₹5,398, which dropped to ₹2,426 post-installation. This significant cost reduction highlights the scheme's effectiveness in alleviating the financial burden of electricity expenses for middle-income households, showcasing the direct economic benefits of solar energy adoption for cost-conscious consumers.

Figure 23 illustrates that 52.4 percent of respondents found the savings from the system to be in line with their expectations, indicating a majority are satisfied. However, 41.8 percent reported that the savings did not meet their expectations, and 5.8 percent experienced only partial alignment, suggesting a need to address gaps in system performance or the communication of expected savings.

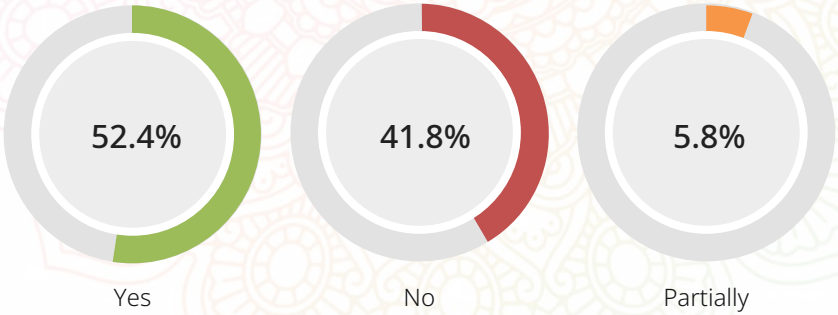


Figure 23: Satisfaction with Savings from Solar Rooftop System

Impact on Household Income

The utilisation of savings from solar systems, displayed in Figure 24, demonstrates a positive impact on household income. A majority (68.9%) of respondents used these savings to manage household expenses, indicating a direct enhancement in financial flexibility. Additionally, 23.6 percent of respondents saved for future needs, reflecting improved financial planning and security. A smaller proportion (4.8%) invested in new appliances, signifying an ability to allocate resources for enhancing quality of life. This highlights how reduced electricity costs contribute to better income management and improved living standards.

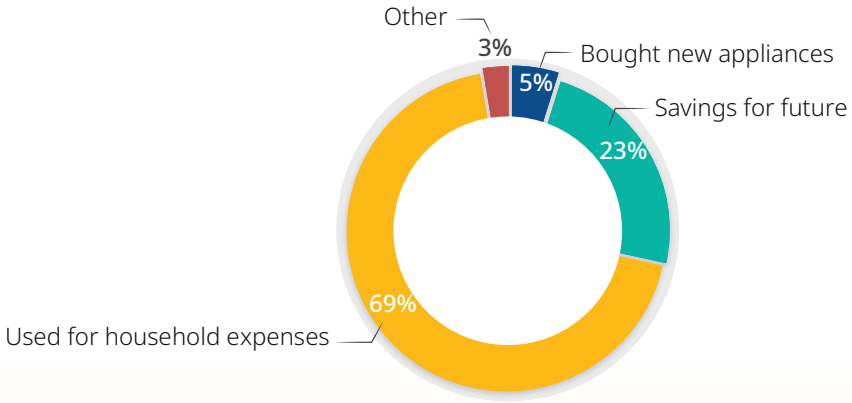


Figure 24: Percentage-wise Utilisation of Savings from Solar Rooftop System Installation

The impact of solar rooftop systems on household income extends beyond electricity bill savings. A significant 53.6 percent of respondents reported reduced home cooling expenses due to the temperature-moderating effect of rooftop panels, as illustrated in Figure 25, further alleviating financial burdens.

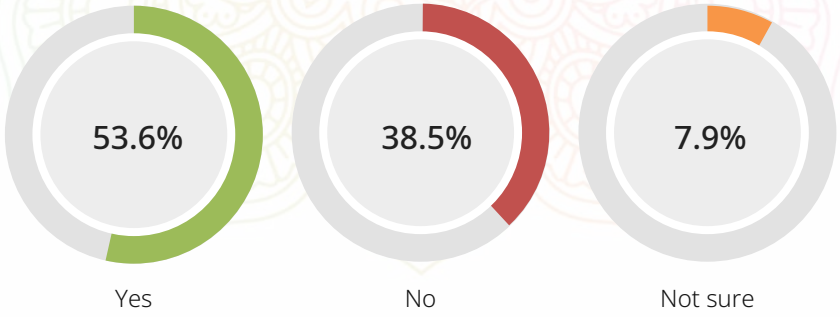


Figure 25: Impact of Solar Rooftop on Home Cooling Expenses

Together with direct electricity savings, this dual benefit enhances disposable income and supports financial stability for households. Meanwhile, 38.5 percent of respondents reported no change, and 7.9 percent were unsure, highlighting the need for more awareness of secondary economic benefits.

Employment Effects

The deployment of solar projects in Varanasi has significantly contributed to the local economy by generating substantial employment opportunities. Around **387 solar vendors** have implemented projects, leading to the creation of approximately **4,530 jobs**[9]. Of these roles, 55 percent were skilled roles, while 45 percent were semi-skilled, as shown in Figure 26, thereby providing livelihoods across diverse segments of the workforce.

9 The job creation assessment employed k-means clustering to group solar vendors in Varanasi into three distinct categories. To estimate total employment, the number of vendors in each cluster was multiplied by the cluster's average workforce size, specific to operations in Varanasi. This workforce figure included both skilled and unskilled roles and was derived from direct interviews and surveys with vendors. This approach provides a more accurate estimation of grassroots employment generated in the solar rooftop sector.

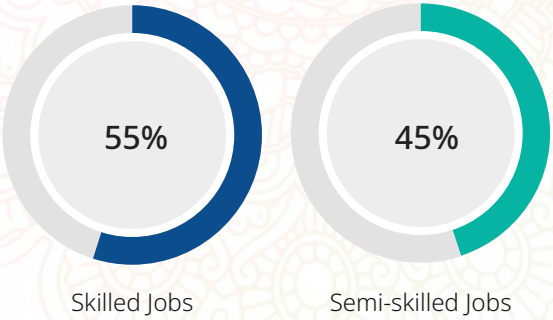


Figure 26: Division of Jobs Created in Varanasi through PMSGY

The diverse range of jobs created, as illustrated in Table 2, includes skilled roles such as project managers, solar rooftop system technicians, IT support specialists, and accountants, as well as semi-skilled roles like installers, customer support specialists, and sales marketing coordinators.

This data underscores the dual impact of solar rooftop installations: fostering economic growth through job creation and enabling skill development in the renewable energy sector. The inclusion of both skilled and semi-skilled roles highlights the accessibility of employment opportunities generated by the solar industry, further reinforcing its importance in driving economic development in the region.

Table 2: List of Jobs Created Through Solar Rooftop System Adoption

Skilled Roles	Semi-skilled Roles
Site In Charge/ Supervisor	Installers
Project Manager	Customer Support Specialist
Consultant	Social Media Handler
Business Development Manager	Sales Marketing Coordinator
HR	Peon
Sales Marketing Executive	
Data Analysts	
IT Support Specialist	
Supply Chain Manager/ Logistic Specialist	
Accountant	
Solar Rooftop System Technicians Specialist	
Solar Trainer	
CA	
Legal Advisor	
Electricians	
Service Engineers	

Cost-Benefit Analysis of Solar Rooftop Installations

Average System Size- 4 kWp

The adoption of solar rooftop systems under the PMSGY has proven to be a highly economical choice for households. With an average system size of 4 kWp, the investment metrics reflect a robust financial benefit for the beneficiaries. The average cost per kWp of ₹59,604, coupled with an average subsidy of ₹1,06,043 (includes both PMSGY and UP's state subsidy), has significantly reduced the initial financial burden on households.

This subsidy plays a crucial role, covering 46 percent of the total system cost and leaving households responsible for only 54 percent, as illustrated in Figure 27.

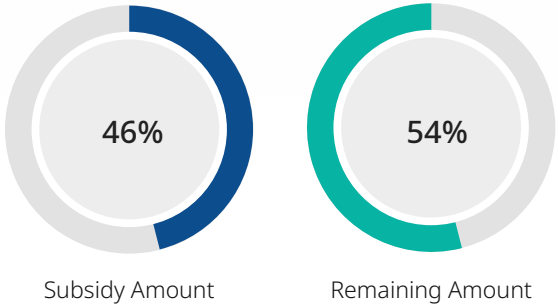


Figure 27: Contribution of Subsidy to Total Cost of Solar Rooftop System

Smaller System Size- 2 kWp

For households that installed solar rooftop systems of smaller size, on average 2 kW, the financial advantages show a marked improvement. With an average system cost of ₹1,22,898, beneficiaries received a subsidy of ₹90,000, covering **73 percent of the total cost**. This generous subsidy meant households installed the solar rooftop system at a net cost of ₹32,898 or 26 percent of the total cost. Post-installation, the average monthly electricity bill decreased from ₹2,650 to ₹1,295, resulting in a **~51 percent** reduction in energy expenses. This translates to annual savings of approximately ₹16,262, allowing beneficiaries to recover their investment in a shorter time frame while enjoying long-term economic benefits.

By substantially reducing the initial financial burden, the scheme has made solar rooftop system installations more accessible, enabling cost-conscious households to embrace clean energy solutions with greater ease.

One of the most compelling aspects of this initiative is the short average payback period of just **3.8 years**, highlighting the scheme's financial feasibility. The substantial savings on monthly electricity bills ensure a swift recovery of the investment. Additionally, the average lifetime savings for households is **₹8,91,600**, further emphasising the long-term economic benefits of adopting solar energy.

By addressing concerns about high initial costs and demonstrating clear economic benefits, the scheme has positioned itself as a financially viable and attractive option for households. This cost-benefit structure underscores its potential to accelerate the adoption of solar energy across diverse economic groups.

Social Impact

Improvement in Quality of Life

The installation of solar rooftop systems has positively impacted the overall quality of life for the majority of beneficiaries under the PMSGY. As illustrated in Figure 28, 77.4 percent of respondents reported an improvement in their quality of life, with 35 percent stating it has significantly improved and 42.4 percent noting a somewhat improved experience.

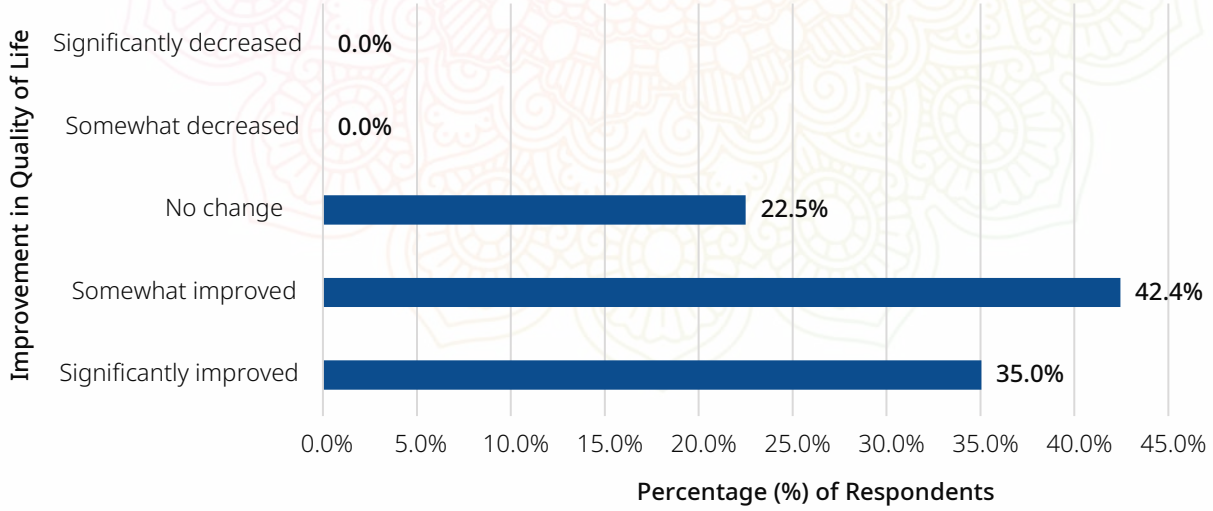


Figure 28: Improvement in Quality of Life after Installation of Solar Rooftop System

This enhanced quality of life can be attributed to financial savings on electricity bills, reduced reliance on grid electricity, and the long-term stability and sustainability provided by solar energy. Notably, no respondents reported any decrease in their quality of life, reflecting the scheme's success in fostering positive outcomes for households.

Additionally, **88.2 percent of respondents reported improved electricity availability** after installing the solar rooftop system, reflecting the scheme's positive impact on energy reliability. **While 30.2 percent of respondents experienced a reduction in voltage fluctuations**, the majority (63.9%) did not observe any change. The improvement in electricity availability and reduction in voltage fluctuations further underscore the benefits of solar rooftop installations on quality of life. Reliable access to electricity ensures the uninterrupted operation of essential household appliances, enhancing daily comfort and productivity. Additionally, reduced voltage fluctuations minimise the risk of appliance damage, lowering maintenance costs and extending the lifespan of household equipment. These advancements not only contribute to financial stability but also foster a sense of energy security, collectively enhancing the overall living standards of beneficiaries.

Figure 29 indicates a positive correlation between higher net bill savings and improved quality of life after solar rooftop system installation. Respondents reporting significant improvements experienced the highest average savings of ₹3,055.73, while those perceiving no change had lower savings hovering around ₹2,550.08. This suggests that financial benefits play a key role in shaping the perceived impact of the solar initiative on household well-being.

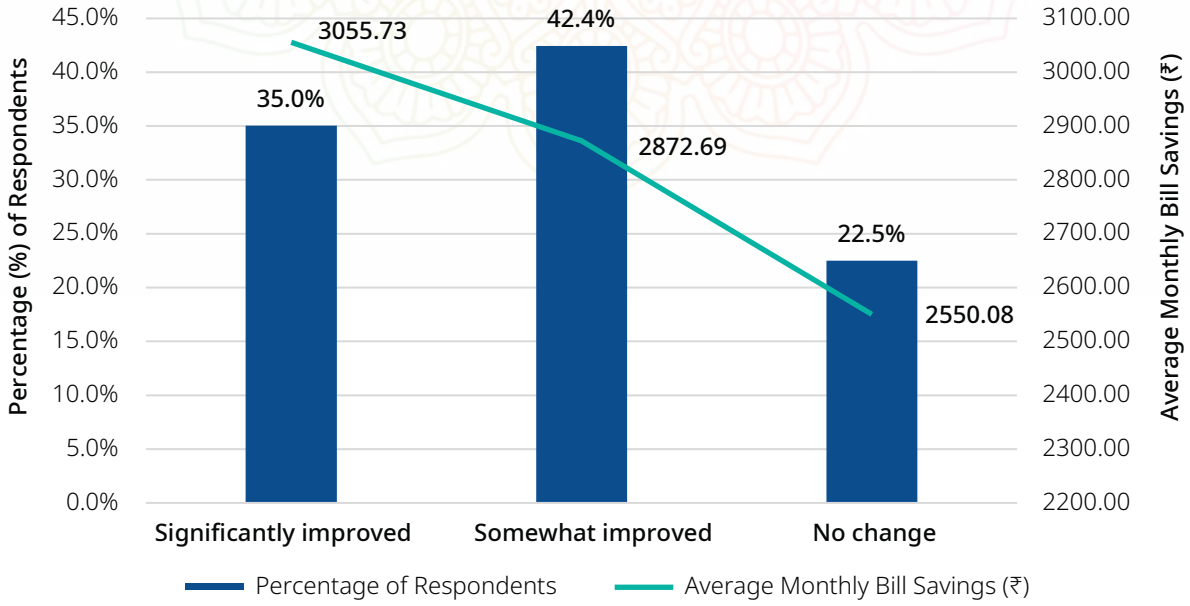


Figure 29: Perception of Change in Quality of Life Based on Varying Average Monthly Savings from Electricity Bill

Impact on Education and Health

The installation of solar rooftop systems under the PMSGY has had a multifaceted impact on households, particularly in the domains of education and health. A notable 62 percent of respondents, as illustrated in Figure 30, reported a positive influence on their household's ability to engage in educational or leisure activities, indicating that the financial savings and stable energy access have enabled families to allocate resources and time for personal and intellectual growth.

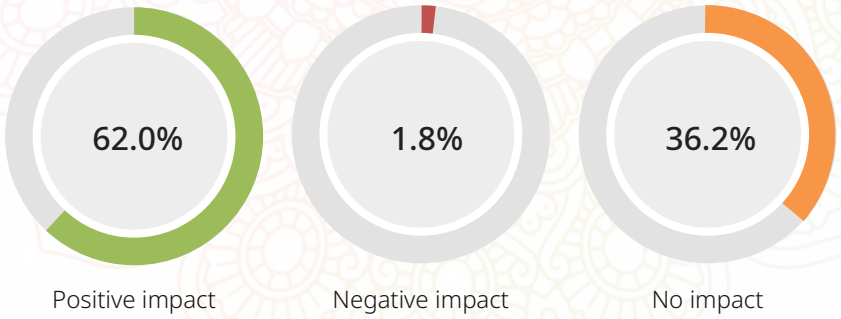


Figure 30: Impact of PMSGY on Household's Ability to Engage in Educational or Leisure Activities

Additionally, the scheme has contributed to fostering environmental awareness among younger generations. Approximately 60.4 percent of respondents observed an increase in their children's interest in renewable energy and environmental issues, with 34.8 percent reporting a significant increase, as illustrated in Figure 31. This reflects the scheme's potential in shaping long-term attitudes and behaviour towards sustainability within families.

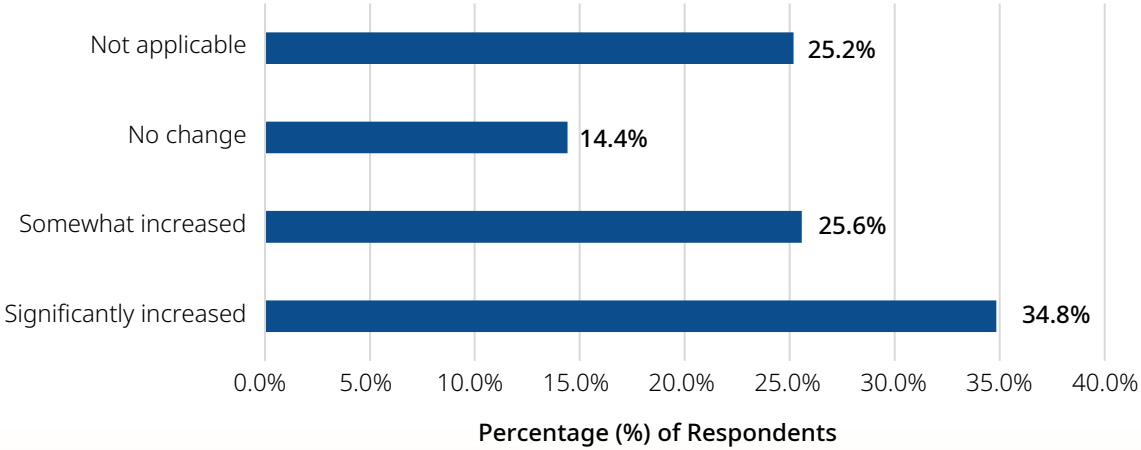


Figure 31: Impact of Solar Rooftop System on Children's Interest in Renewable Energy and Environmental Issues

The solar installations have also led to more conscious energy consumption habits, with nearly 60 percent of households becoming more mindful of their electricity use, as illustrated in Figure 32.

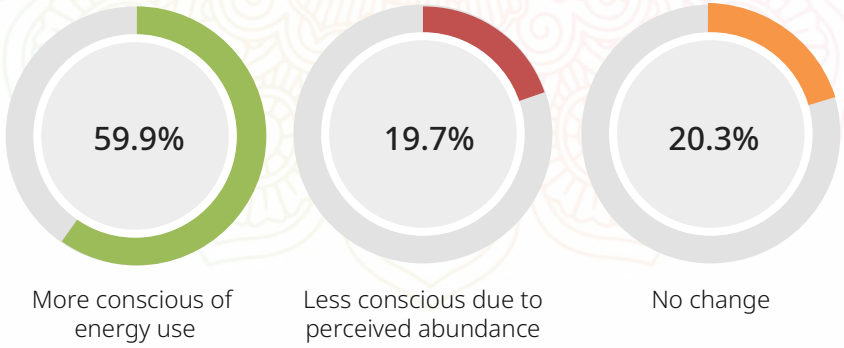


Figure 32: Impact of Solar Rooftop System on Household's Energy Consumption Habits

Almost all of the respondents stated that the space occupied by the solar rooftop system did not disrupt any regular household activities, ensuring that the installations integrate seamlessly into daily life.

These findings underscore the holistic benefits of solar rooftop systems, extending beyond economic and environmental advantages to drive positive social changes in education and health.

Community Perception and Social Acceptance

The adoption of solar rooftop systems under the PMSGY has significantly influenced community attitudes, fostering widespread acceptance and interest in renewable energy. A remarkable **89.8 percent of respondents stated they would recommend solar rooftop systems to others**, underscoring the program's success in building trust and satisfaction among users. Among these respondents, as displayed in Table 3, 45.3 percent identified electricity bill savings as the primary reason, while 23.1 percent highlighted the promotion of green energy, reflecting a growing alignment with environmental values. Furthermore, 14.9 percent pointed to the combined benefit of cost savings and government subsidies, emphasising the scheme's success in making clean energy financially accessible and delivering immediate financial benefits that extend over a 25-year period.

Table 3: Main Reasons Stated by Respondents for Recommending Solar Rooftop System

Main Reason for Recommending Solar Rooftop System	Percentage of Respondents
It helps in saving electricity bill	45.3%
It promotes Green Energy	23.1%
It saves money and subsidy is also being provided	14.9%
Maintenance cost is very low and is good for long term	6.0%
Saves money and safe for environment	4.8%
Good Scheme	3.0%
The government offers subsidies for solar panel installation.	1.8%
Community development takes place.	0.4%
Solar panels provide an independent power source that works even during grid failures or power cuts.	0.2%
It creates jobs	0.2%
Increase property value	0.2%

These responses emphasise the multifaceted benefits that have resonated with households, bolstering social acceptance of solar rooftop installations.

The influence of the scheme has extended beyond individual adopters to their communities. Notably, 74.5 percent of respondents, as illustrated in Figure 33, reported an increased interest in solar energy among their neighbours, indicating a ripple effect of awareness and curiosity. This highlights the role of early adopters in inspiring wider acceptance and encouraging discussions around renewable energy. While a minority (3.9%) expressed scepticism or criticism, such sentiments were minimal compared to the overwhelming positivity observed.

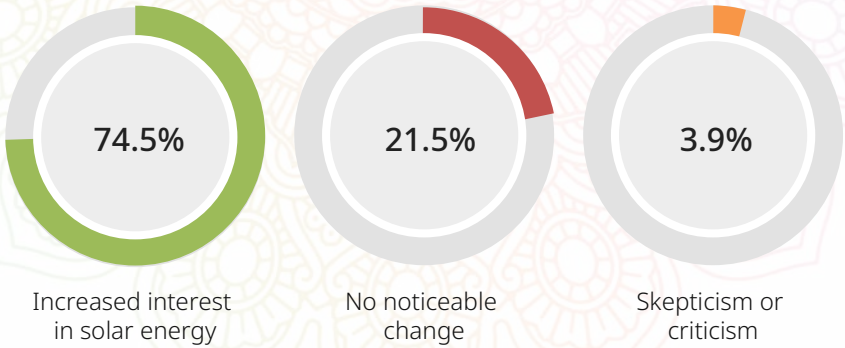


Figure 33: Observation of Behavioural Change in Neighbours Since Installation of Solar Rooftop System

This data illustrates the scheme's success in shaping community perceptions, normalising solar rooftop installations as a sustainable and economically viable energy solution. By addressing financial, environmental, and social priorities, the initiative has cultivated an environment where renewable energy is not only accepted but actively advocated by its beneficiaries.

Environmental Impact

The installation of solar rooftop systems under the PMSGY has contributed significantly to environmental sustainability through energy conservation, heightened environmental awareness, and the adoption of additional conservation measures.

Energy Conservation

One of the most notable impacts of solar rooftop installations has been the shift in household energy consumption patterns. As displayed in Figure 28, a majority (59.9%) of respondents reported becoming more conscious of their energy use after adopting these systems, indicating a behavioural change driven by the transition to renewable energy. This heightened mindfulness reduces overall energy wastage, amplifying the environmental benefits of the scheme.

Environmental Awareness

This initiative has also played a vital role in fostering environmental awareness among beneficiaries and their families. For instance, as showcased in Figure 27, the installation of solar systems has sparked interest in renewable energy and environmental issues among children, as evidenced by a significant increase in their awareness levels. The fact that 6.4 percent of respondents cited environmental benefits as a primary reason for installation, as illustrated in Figure 10, underscores a growing alignment with sustainability goals, even if cost savings remain the dominant motivator.

Additional Conservation Measures

The positive environmental impact of solar rooftop installations has extended beyond energy savings, inspiring households to adopt other eco-friendly practices—**energy-efficient appliances**, **waste reduction**, and **water conservation**. Among respondents who adopted additional environment conservation measures, **62 percent adopted all three measures**, indicating strong commitment to sustainability as seen in Figure 34.

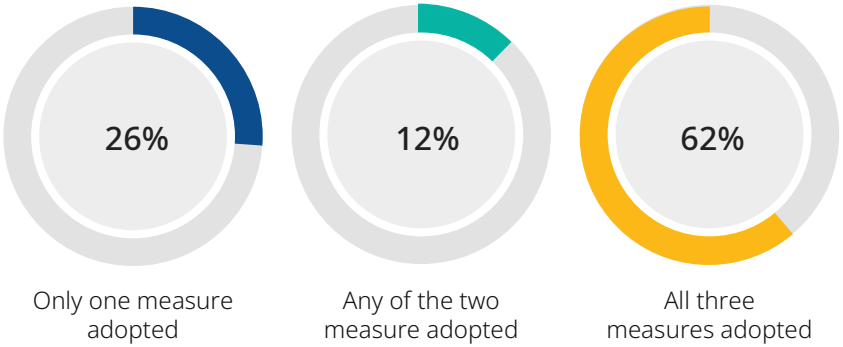


Figure 34: Number of Measures adopted among those who took up additional Environment Conservation Measures

These practices demonstrate how solar rooftop systems can serve as a catalyst for broader environmental stewardship.

8

Recommendations

Recommendations

Based on insights from the survey conducted as part of the PMSGY evaluation, the following recommendations aim to enhance the adoption and impact of solar rooftop systems:

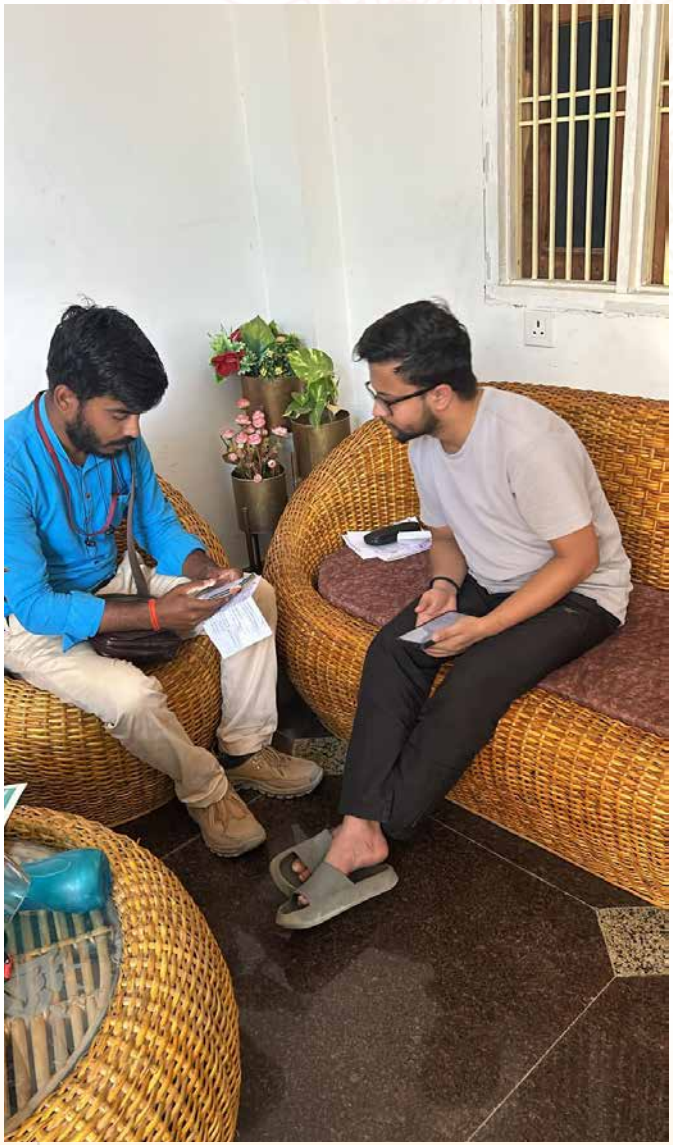
1. **Enhance Community Engagement Programs**: Booth camps have proven to be a highly effective and tangible outreach method, with their impact growing as more respondents recognise their value, with 14.4 percent citing them as the most effective method. These in-person, localised interventions provide clear, actionable information, enabling potential beneficiaries to take the necessary steps toward solar installation. Beneficiaries have shared how valuable these camps are in addressing their questions and guiding them through the process. Given this feedback, it is recommended to expand booth camps as a key part of the outreach strategy. Additionally, word-of-mouth campaigns should be encouraged by empowering satisfied customers to act as ambassadors within their communities, further amplifying the reach and impact of these community-focused initiatives
2. **Leverage Successful Implementations for Wider Adoption**: Positive outcomes from solar rooftop installations, such as enhanced energy consciousness (reported by 59.9% of respondents) and increased quality of life (significantly or somewhat improved for 77.4 percent of respondents), should be highlighted to drive adoption. Moreover, the survey revealed that 74.5 percent of respondents observed increased interest in solar energy among neighbours, indicating that showcasing successful implementations can have a ripple effect within communities. Demonstrating minimal disruption caused by installations, supported by the 99.9 percent of households reporting no disturbance to regular activities, can further alleviate hesitations.
3. **Promote Environmental Awareness**: While financial benefits are the leading motivator, 6.4 percent of respondents adopted solar rooftop systems due to environmental concerns. Campaigns should emphasise the role of solar energy in reducing carbon footprints and promoting sustainability. Furthermore, households reported additional conservation efforts, such as adopting energy-efficient appliances (86.2%) and water conservation practices (75.4%). Integrating these measures into broader awareness campaigns can encourage households to adopt a comprehensive approach to environmental responsibility.

4. **Vendors should provide basic cleaning and maintenance guidance to consumers:** The survey found that 49 percent of respondents clean their solar panels every 21 days or more. However, optimal system performance requires regular cleaning to remove dust and debris. Vendors should communicate the importance of consistent panel cleaning and provide training, such as video tutorials or live demonstrations, on proper cleaning techniques that do not damage the panels. This will ensure consumers have the necessary knowledge and tools to maintain their solar systems effectively.

Conclusion

The adoption of solar rooftop systems under the PMSGY has significantly reduced reliance on conventional energy sources while promoting a culture of sustainability and environmental responsibility. The Honourable Prime Minister of India has paved the way for the public to reduce financial burdens while empowering grassroots participation in the renewable energy movement and contributing to climate change mitigation. By encouraging both direct and supporting conservation efforts, the scheme has effectively aligned household priorities with the broader objectives and the Indian ethos of environmental conservation.

Field Photographs



NOTES

UPNEDA

In April 1983, the Uttar Pradesh Government established the Non-Conventional Energy Development Agency (NEDA) as an autonomous institution under the Department of Additional Energy Sources. Over time, the agency has been renamed as the Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA). Right from its inception, UPNEDA has been serving as the central authority responsible for executing a range of initiatives and policies pertaining to renewable energy within the state. These initiatives encompass diverse areas such as solar energy, biomass energy, pumped storage, and more.

VASUDHA FOUNDATION
Green ways for a good earth!

Vasudha Foundation is a non-profit organisation set up in 2010. We believe in the conservation of Vasudha, which in Sanskrit means the Earth, the giver of wealth, with the objective of promoting sustainable consumption of its bounties. Our mission is to promote environment-friendly, socially just and sustainable models of energy by focusing on renewable energy and energy-efficient technologies as well as sustainable lifestyle solutions. Through an innovative approach and data- driven analysis, creation of data repositories with cross-sectoral analysis, along with outreach to ensure resource conservation, we aim to help create a sustainable and inclusive future for India and Mother Earth.