

A REVIEW OF PRADHAN MANTRI SURYA GHAR MUFT BIJLI YOJANA SCHEME



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Deepmala Patel & Pranay Raj





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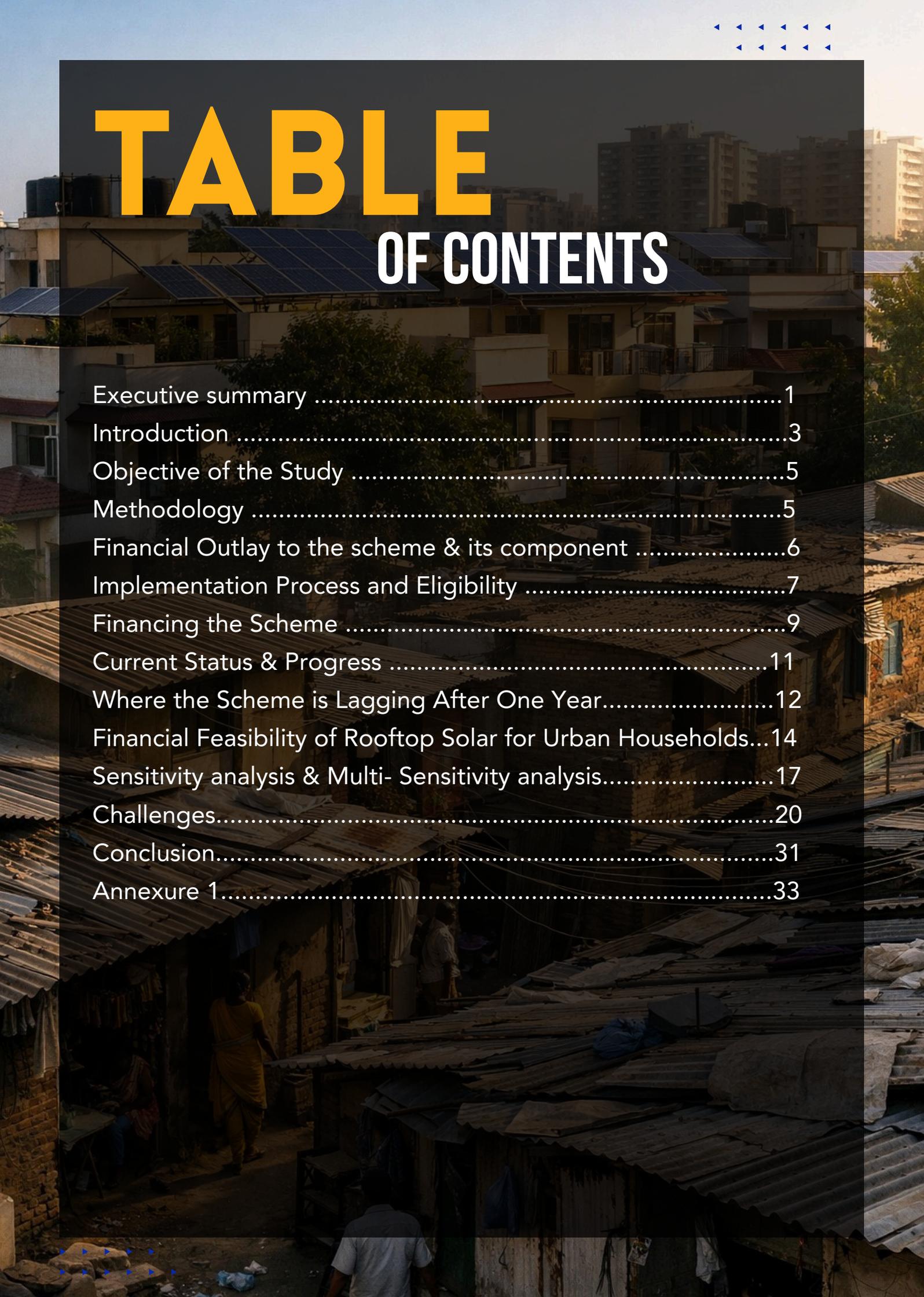
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EXECUTIVE SUMMARY

The Pradhan Mantri Surya Ghar - Muft Bijli Yojana (PM-SGMBY- Free Electricity Scheme) was launched with the stated objective of reducing electricity costs for domestic consumers by connecting them to solar energy, and was specifically claimed to benefit the poor and middle class. However, after one year of implementation, an examination of the scheme from the perspective of low-income families reveals a significant gap between its intended purpose and its actual impact on the ground.

The most important conclusion is that this scheme is structurally unsuitable for low-income families. The scheme's basic model is based on individual rooftop solar installations, while a large proportion of poor families live in rented houses, temporary shelters, slums, or multi-story shared housing, where they do not own the roof and the technical feasibility is lacking. Consequently, a significant portion of these families are excluded from the scheme from the outset.

The second major finding relates to the initial investment. Despite subsidies, the amount consumers have to pay themselves to install a solar system is beyond the financial means of low-income families. Bank loans, formal documentation, and guarantee requirements pose an additional obstacle for this group. Consequently, the actual benefits of the scheme remain limited to relatively affluent households.

The financial feasibility analysis further reinforces that the scheme disproportionately benefits households with moderate to high electricity consumption. Break-even (the number of years it takes for electricity bill savings to recover the money spent on installing solar panels) and Net Present Value (NPV) (total financial gain or loss a household makes over the solar system's lifetime, after accounting for all costs and savings) results show that very low-consumption household, typically low-income families, take more than 20 years to recover their upfront investment, and often experience negative NPVs over the project lifetime. In contrast, households with higher electricity usage recover their costs within 5–10 years and generate substantial long-term financial gains. This clearly indicates that rooftop solar under the current subsidy is economically viable primarily for those households with higher electricity demand.

Sensitivity Analysis (testing how the results are impacted if certain assumptions change, such as Interest rate on the loan, Electricity Consumption, Tariff rate variations) also highlights that electricity consumption, not the Interest rates or Tariff slabs, is the dominant driver of the financial feasibility of the system installation. Even when the Interest rate or tariff rates vary, very low and low consumption households remain financially unviable, while on the other hand moderate to high consumption households continue to perform well across all scenarios.

Overall, the analysis demonstrates that without significantly higher subsidies (that would reduce the upfront cost), alternative delivery models, or targeted support mechanisms, the scheme is unlikely to provide meaningful or sustainable economic relief to low-income households with low electricity consumption needs.

The concept of "free electricity" for low-income families is fraught with contradictions, the biggest of which lies in its very claim of being "free." In reality, the scheme does not provide completely free electricity, but rather offers subsidized relief up to a limited number of units. Fixed charges, net metering conditions, and maintenance costs add to the financial burden on low-income families. Since these families already have low electricity consumption, the savings from solar energy are also limited, reducing the economic attractiveness of the scheme. At the administrative and institutional levels, the processes of DISCOMs (electricity distribution companies) are particularly challenging for poor families. The complexities of net metering, inspections, and payment adjustments demand time, money, and patience—resources that low-income families have in limited supply. The reliance on digital portals, technical jargon, and private vendors makes the scheme even more inaccessible for this segment of the population.

Viewed within the broader context of energy poverty, the scheme does not directly address the fundamental problem faced by low-income households: affordable, reliable, and consistent electricity supply. Their priority is not technological investment, but rather secure and stable electricity at the lowest possible cost. In this sense, the scheme appears to promote market-based access to energy rather than energy justice.

In its current form, the scheme has emerged less as a solution for the poor and more as an opportunity for the relatively affluent. To truly make it pro-poor and inclusive, the policy needs to move beyond the individual rooftop model and prioritize community solar projects, tenant-friendly frameworks, complete or near-complete financial assistance, offline support mechanisms. Only then can this scheme become a genuine source of energy relief and social justice for low-income families.



File Photo: ITG | AajTak

INTRODUCTION

The Government of India approved the PM Surya Ghar : Muft Bijli Yojana (PM-SGMBY) on 29th February, 2024 to increase the share of solar rooftop capacity and empower residential households to generate their own electricity. The scheme has an outlay of Rs 75,0210 million and is to be implemented till FY 2026-27.¹ The scheme will be implemented by a National Programme Implementation Agency (NPIA) at the National level and by the State Implementation Agencies (SIAs) at the state level.

The PM-SGMBY was announced with the goal of providing rooftop solar panels to one crore households and up to 300 units of free electricity per month. The scheme emerged in the backdrop of India's rapidly growing energy demand, dependence on coal-based power, and rising household electricity costs. At the same time, India had made strong global commitments to expand renewable energy capacity to 500 GW by 2030 and achieve net zero emissions by 2070.² Rooftop solar was seen as a way to reduce pressure on the grid, empower households with energy self-reliance, cut subsidies on electricity, and promote a cleaner energy transition. Thus, the scheme was both a social welfare measure (lowering bills for households) and a strategic push to strengthen India's decentralized renewable energy landscape.

The Indian government launched two ambitious schemes after Prime Minister Modi announced that rooftop solar installations should be boosted in India.

Surya Ghar: Muft Bijli Yojana: This scheme targets low- and middle-income households, offering free electricity (up to 300 units/month) and increased subsidies for rooftop solar panel installation (up to Rs 78,000). It aims to incentivize wider adoption of solar power for home use.

Pradhanmantri Suryodaya Yojana: This scheme has a broader goal of 10 million rooftop solar installations. While no deadline is set, the government aims to achieve 40 GW of rooftop solar by 2026-27.

After unveiling the PM-SGMBY with a target of 10 million solar installations on January 22, 2024 Prime Minister Narendra Modi introduced the PM-SGMBY just three weeks later.

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¹ <https://www.india.gov.in/spotlight/pm-surya-ghar-muft-bijli-yojana>

² <https://www.pib.gov.in/PressReleaselframePage.aspx?PRID=1961797>

³ <https://hindi.economicstimes.com/wealth/yojana/difference-between-pm-suryoday-yojana-and-pm-surya-ghar-yojana-know-the-benefits/articleshow/107692127.cms>

This new scheme offers up to 300 units of free electricity per month to consumers who install rooftop solar systems.⁴ Under this initiative, households with solar installations up to 3 kW will receive a subsidy of up to Rs 78,000. This subsidy is provided as a lump sum amount after installation, an increase from the previous Rs 43,764. The scheme primarily targets low- and middle-income households. Overall, these new schemes show India's commitment to becoming a solar power leader. However, this path is strewn with numerous challenges and raising awareness about them will be crucial to achieving the ambitious goals. The government's goal behind launching the PM-SGMBY is to light up 10 million houses in the country by providing free electricity. The central government will invest more than Rs 75,000 crore in this project.⁵

This scheme will support the installation of grid-connected rooftop solar projects in the residential sector through Central Financial Assistance (CFA) from the central government. No CFA will be provided to consumers in the non-residential segment (which includes government, commercial, and industrial segments, etc.). This report covers only the residential sector, including both owner-occupied and rental housing.

The scheme focuses on the household segment with up to 3 kW system, which covers most of the residential consumers in India. The scheme provides for a subsidy of 60% of the solar unit cost for systems up to 2 kW capacity and 40 percent of additional system cost for systems between 2 to 3 kW capacity. The subsidy has been capped at 3 kW capacity. At current benchmark prices, this will mean Rs 30,000 subsidy for 1 kW system, Rs 60,000 for 2 kW systems and Rs 78,000 for 3 kW systems or higher. This subsidy is provided as a lump sum amount after installation to eligible households who install a system of 3 kW or more capacity.

In its first year, the scheme installed solar power in over 8.6 lakh homes. A total of 16.78 lakh no. of households have been benefitted with rooftop solar installations under the scheme as on 05.08.2025.⁷ The government has prepared a roadmap to achieve this ambitious goal, targeting 10 lakh homes by March 2025, 20 lakh by October 2025, 40 lakh by March 2026, and a full 10 million by March 2027.⁸

⁴ <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2010674>

⁵ <https://economictimes.indiatimes.com/industry/renewables/pm-surya-ghar-muft-bijli-yojana-over-1-crore-households-registered-for-centres-solar-rooftop-scheme/articleshow/108539426.cms?from=mdr>

⁶ <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2010674>

⁷ <https://www.outlookindia.com/business/1678-lakh-households-benefit-from-pm-surya-ghar-scheme?>

⁸ <https://egov.eletsonline.com/2025/02/budget-2025-boosts-pm-surya-ghar-scheme-with-80-percent-higher-allocation/#>

OBJECTIVE OF THE STUDY

The objective of this report is to review the PM-SGMBY on its completion in one year and to reflect on its targets, achievements and challenges.

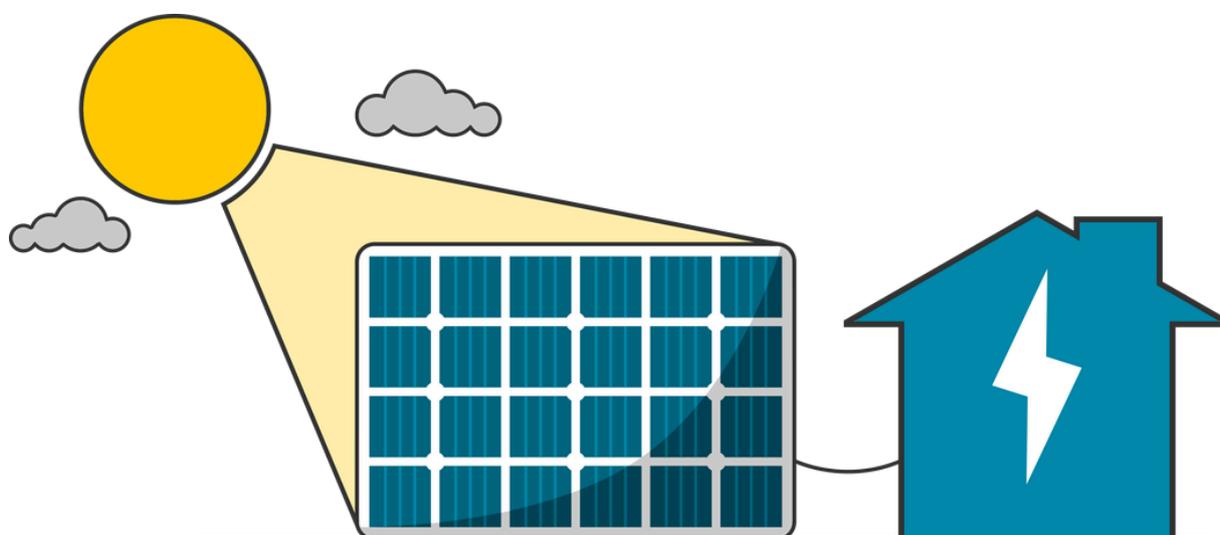
METHODOLOGY

The report is based on a study of primary and secondary data such as official government portals, MNRE, PM-SGMBY Dashboard, media reports, think-tank studies, combining household surveys, stakeholder interviews, and statistical and thematic analysis to present a picture of the scheme's performance in its first year.

This study offers reasonable speculative evaluation of the financial viability of rooftop solar adoption under the PM-SGMBY for urban households in Nagpur, Maharashtra, India. The analysis focuses on understanding how the scheme performs across different household electricity consumption levels and income groups, taking into account affordability, system costs, savings from solar generation, and loan repayment capacity.

The aim is to assess monthly savings, loan repayment feasibility, breakeven period (time it takes for a project to recover the money originally invested in it), and Net Present Value (NPV) (measure of whether a project makes or loses money after adjusting future earnings to today's value) for different household consumption and income groups over a 20 year project lifetime.

In Annexure 1 of this report we explain the financial model used for this report.



FINANCIAL OUTLAY TO THE SCHEME & ITS COMPONENT

The Financial Outlay of Rs 75,0210 million and is to be implemented till FY 2026-27 (2024-2027). The scheme includes the following components:-

PM-SGMBY Component & Outlay⁹

S. No.	Scheme Component	Outlay
1	CFA to Residential Consumers	₹ 65,7000 million
2	Incentives for Discoms	₹ 49500 million
3	Model Solar Villages in each district	₹ 8000 million
4	Incentives for Local Bodies	₹ 10000 million
5	Payment Security Mechanism	₹ 1000 million
6	Innovative Projects	₹ 5000 million
7	Capacity Building (1% of CFA)	₹ 6570 million
8	Awareness & Outreach (1% of CFA)	₹ 6570 million
9	Service Charge (1% of CFA)	₹ 6570 million
	Total	₹ 75,0210 million



⁹ <https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2024/07/202407021768035484.pdf>

IMPLEMENTATION PROCESS AND ELIGIBILITY

Consumer Registration Process

Step 01: Visit the website at <https://pmsuryaghar.gov.in/>

Step 02: Go to the consumer page and select “Apply Now” (or) Open the Login dropdown menu and select “Consumer Login”.

Step 03: Enter a valid Registered Consumer Mobile Number for Registration, enter a valid Captcha and select “Yes, I have read all the guidelines of PM-SGMBY.” Then, click on “Verify”

Step 04: Enter the valid Mobile OTP received through SMS and then click on “Login”.

Step 05: After successful Login, enter the profile details of the Registration Consumer by entering a valid Consumer Name, E-Mail, Address, State, District and PIN Code and then click on “Save”.

Step 06: Registered consumers can submit applications either through click on “Apply for Solar Rooftop” (or) through Vendor Selection. Consumers can apply for Solar Rooftop by selecting State, District and Electricity Distribution Company/ Utility and entering the Consumer account number, then click on “Fetch Details”. After loading the Consumer details, then click on “Next” to start filling for submission of application.

Criteria

- The consumer should be an Indian Citizen.
- The household must own a house with a roof that is suitable for installing solar panels.
- The beneficiary must have a valid electricity connection.
- The beneficiary should not have availed of any other subsidy for solar panels.
- An Aadhar card linked to the bank account is mandatory to facilitate direct subsidy transfers.¹⁰

¹⁰ <https://pmsuryaghar.gov.in/#/>

Subsidy Structure

- The PM-SGMBY provides subsidies to encourage residential households to adopt solar power. (PM-SGMBY offers a one-time, direct subsidy to households for installing rooftop solar.)
- Households using 0-150 units/month will get Rs 30,000 to Rs 60,000 for 1-2 kW systems.
- Those using 150-300 units/month will get Rs 60,000 to Rs 78,000 for 2-3 kW systems.
- Households consuming more than 300 units/month can install systems above 3 kW, with a maximum subsidy of Rs 78,000.
- For group housing societies or residents' welfare associations, the subsidy, which was earlier Rs 7,294 per kW for a maximum of 500 kW, now includes coverage for common areas and electric vehicle charging stations up to 500 kW at a rate of Rs 18,000 per kW. Additionally, the subsidy for households requiring more than 10 kW units, which was earlier fixed at Rs 94,822, has been revised to a maximum of Rs 78,000 for units above 3 kW."



¹¹ <https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2024/07/202407021768035484.pdf>

FINANCING THE SCHEME

The Union Budget 2025–26 significantly increased financial support for the PM-SGMBY, reflecting the government's commitment to expanding solar energy adoption across India. The budget has increased the allocation for the scheme by 80%, from ₹11,100 crore to ₹20,000 crore in 2024–25, with the aim of accelerating the installation of rooftop solar systems and meeting the country's renewable energy targets.¹²

Estimated fund issue from June 2024 till Now.¹³

Since the scheme's launch in February 2024, ₹4,770 crore had been disbursed by March 2025.¹⁴ Between March and August 2025, this figure increased to approximately ₹9,280.88 crore. This suggests that an additional ₹4,500–₹4,600 crore was disbursed between April and August 2025.¹⁵

Potential sources of funding:

Central Government Budget: The most likely source is a dedicated budget allocation for the scheme within the annual Union Budget. This could be a specific line item for PM-SGB or fall under a broader allocation for renewable energy initiatives.

Subsidy Sharing: This is a direct grant from the central government to help cover the initial cost of installing a rooftop solar system. The subsidy amount is determined based on the system's capacity and is transferred directly to the beneficiary's bank or loan account (through Direct Benefit Transfer) after successful installation and verification of the system.

The central government has already allocated funds and can share the financial burden with state governments. This could include a pre-determined percentage cost-sharing or a variable share based on the state's participation and performance in implementing the scheme. No separate budget has been announced for the PM-SGMBY 2025 for the state, but rather for the entire country. The Union Ministry of Finance has allocated 80% of the budget for this scheme, amounting to ₹20,000 crore, which will be used to install solar energy in homes across India.

Some state governments have announced their own expenditure for this scheme from their budgets.

¹² <https://apacnewsnetwork.com/2025/02/pm-surya-ghar-muft-bijli-yojana-hits-8-lakh-milestone-within-a-year/>

¹³ <https://www.outlookindia.com/business/1678-lakh-households-benefit-from-pm-surya-ghar-scheme?>

¹⁴ <https://ibef.org/news/pm-surya-ghar-india-s-solar-revolution?>

¹⁵ https://www.business-standard.com/economy/news/over-1-67-million-households-benefitted-under-solar-scheme-govt-to-rs-125081201588_1.html

For example, “the Delhi government has proposed a new scheme called 'Pradhan Mantri Surya Ghar: Free Electricity Scheme - State Top-up' in its State Budget 2025, for which a budget of ₹50 crore has been allocated. Under this scheme, 2.3 lakh residential rooftops will be equipped with solar energy over the next three years.”¹⁶

Collateral-free, low-interest bank loans: Households can avail standardized loan products from participating banks and financial institutions through the national portal.



¹⁶ <https://www.saurenergy.com/solar-energy-news/delhi-govt-allocates-rs-50cr-for-pm-surya-ghar-top-up>

CURRENT STATUS & PROGRESS

"Between 2014 and 2024, only 11 gigawatts of rooftop solar has been installed," as per Binit Das, deputy programme manager at the Centre for Science and Environment in Delhi.¹⁷"The number of households with solar power plants is less than 1 million. Despite the promise of free electricity, reaching 10 million households seems ambitious. It looks challenging to achieve this by 2026 or even in the next five years."

India ranks fifth globally in solar power installed capacity and aims to get 50% of its cumulative power capacity from non-fossil fuels by 2030. Currently, non-fossil fuels account for 42.2% of installed capacity, with solar contributing 17%. Despite this, India is far from its target of 100 GW of solar power by 2026, including 40 GW from rooftop solar, having installed only 11 GW of rooftop solar to date.

India is striving to become a global leader in solar power and has become part of initiatives such as the International Solar Alliance, which now has 94 member countries. The ISA is a collaborative initiative between India and France aimed at uniting efforts to combat climate change by implementing solar energy solutions. During India's G20 presidency last year, global leaders committed to triple their renewable energy capacity, a commitment that was reiterated at COP28. India has also committed to achieving carbon neutrality by 2070, with renewable energy playing a key role in this transition. Research shows that India has the potential to generate 637 GW of solar power if all suitable rooftops are covered with solar panels. However, due to factors such as demand, technological limitations, consumer willingness to pay, and a payback period of about five years, only 11 GW has been achieved so far.¹⁸The payback period of PM-SGMBY is around 2.5 to 3 years, which means the cost of installing solar panels can be recovered in approximately this period but it depends on the subsidy and electricity savings.

India has grown its clean power rapidly in recent years and has the fourth-most installed renewable power, trailing only China, the U.S., and Brazil. It had 180 gigawatts as of December, enough to power about 18 million homes, with nearly half from solar.

According to a report in the Economic Times "most of that solar power comes from numerous football-field-sized solar farms. Less than 15% comes from rooftop arrays, and India has so far managed to set up only 11 gigawatts of rooftop solar." That's far less than the 40 gigawatts set target.¹⁹ PM-SGMBY small household solar installations are significant within the rooftop solar category. But they are a piece in the overall energy production/consumption mix of the country.

¹⁷ <https://www.indiaspend.com/explainers/explained-the-fine-print-in-modi-govts-rooftop-solarfree-electricity-scheme-899893>

¹⁸ <https://www.ceew.in/press-releases/india-has-637-gw-residential-rooftop-solar-energy-potential-for-over-25-crore-households>

¹⁹ <https://energy.economicstimes.indiatimes.com/news/renewable/india-wants-to-hook-its-population-onto-clean-energy-by-boosting-rooftop-solar/107928372>

TARGET & ACHIEVEMENT

(STATE-WISE ACHIEVEMENT)

The details of the state-wise installations of PM-SGMBY are not publicly available, but the scheme aims to achieve the national target (across the country) of installing rooftop solar power in 10 million households by 2026-27.

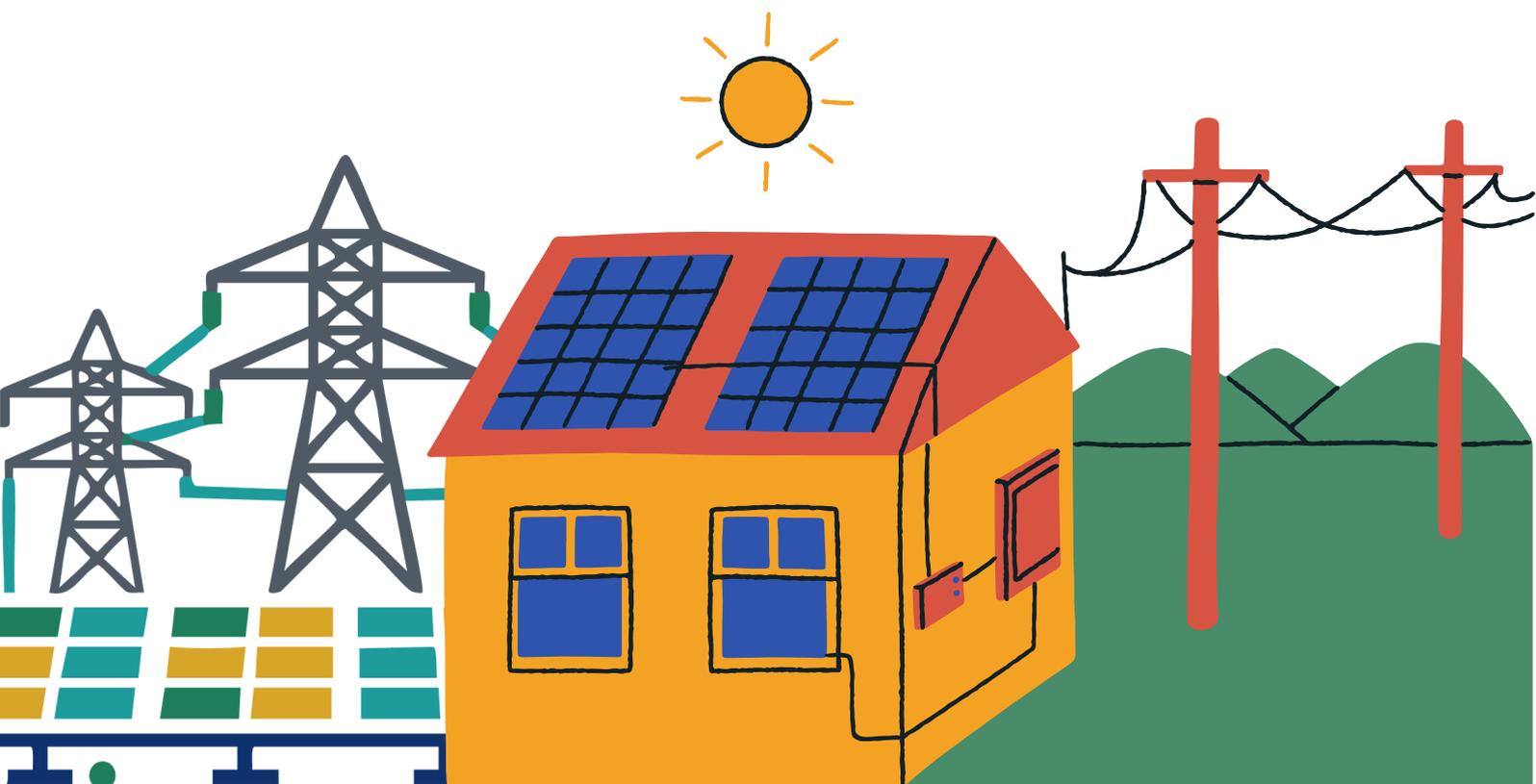
*Households benefited with rooftop solar installed at Residential Welfare Associations (RWA)²⁰

State	Installation (Residential Nos.)	Installation (RWA* Nos.) Residential Welfare Associations	Installation (Total Households Covered)
Andaman and Nicobar Island	1		1
Andhra Pradesh	6,878	672	7550
Asam	3328	64	3392
Bihar	2196	317	2513
Chandigarh	365	1	366
Chhattisgarh	853	5	858
Goa	359	-	359
Gujarat	2321917	70889	302806
Hariyana	9663	5175	14838
Himachal Pradesh	509	1	510
Jammu and Kashmir	398	1	399
Jharkhand	78	2	80
Karnataka	4743	813	5556
Kerala	51405	3956	55361
Ladakh	157	-	157
Lakshdweep	108	-	108
Madhya Pradesh	18837	689	19526
Maharashtra	91248	48489	139737
Manipur	72-	-	72

²⁰ https://sansad.in/getFile/annex/266/AU2541_ACnKTf.pdf?source=pqars

Meghalaya	14	-	14
Mizoram	57	1	58
Nagaland	6	-	6
NCT of Delhi	1131	711	1842
Odisha	1217	1	1218
Puducherry	465	-	465
Punjab	3739	3	3742
Rajasthan	19812	509	20321
Sikkim	1	-	1
Tamil nadu	18256	2919	21175
Telangana	5833	2926	8759
DNH & DD	33	-	33
Tripura	82	-	82
Uttar Pradesh	54135	2233	56368
Uttarakhand	10144	407	10551
West Bengal	280	-	280
Total	538320	140784	679204

Note- There is no state-wise targeting on any government website.



WHERE THE SCHEME IS LAGGING AFTER ONE YEAR

The PM-SGMBY, after a year of implementation, the scheme's progress remains significantly below expectations. Despite receiving 47.3 million applications,²¹ Only approximately 1.67 million households have installed solar plants as on 05.08.2025, representing a mere 16.7% of the total target.²² There is a significant backlog/inertia, with many applications remaining unconverted. Application processing, delays in subsidy disbursement, technical constraints, and inconsistent state-level policies are key reasons for this slow progress. To achieve scale, capacity additions must accelerate annually.

While the scheme has had a positive impact in some states, its benefits have been limited in low-income groups and remote areas. If improvements in administrative processes, access to financial support, and public awareness are not addressed urgently, the scheme risks deviating from its stated objectives—the goal of affordable, clean, and inclusive energy.

This scheme is structurally flawed for low-income families. The scheme's core model is based on individual rooftop solar installations, while a large proportion of poor families live in rented accommodations, temporary housing, slums, or multi-story shared buildings, where they do not own the roof and technical suitability is lacking. Consequently, a significant portion of these families are excluded from the scheme from the outset.

The financial and institutional bottlenecks are the biggest hurdles. Even low-income households, who do own their roofs and therefore the primary beneficiaries of the scheme, continue to struggle with high upfront costs, limited credit access, and slow bank loan processing. Additionally, lack of awareness, inconsistent vendor quality, and complex approval procedures have further reduced enthusiasm among potential adopters.

One year on, the PM-SGMBY stands as a well-intentioned but underperforming initiative, highlighting India's larger challenge of balancing ambitious renewable energy goals with on-ground execution realities. Unless financial mechanisms are simplified, state coordination improves, and household-level incentives are strengthened, the scheme risks missing its 2027 targets and losing public trust in the process

²¹ <https://ibef.org/news/pm-surya-ghar-india-s-solar-revolution?>

²² https://www.business-standard.com/economy/news/over-1-67-million-households-benefitted-under-solar-scheme-govt-to-rs-125081201588_1.html

This scheme is not as affordable for low-income families in India as it claims to be.

Challenges for the Lower Income Group in Nagpur, Maharashtra State (As an example, we assess the challenges faced by low-income families in Nagpur, Maharashtra.)

Based on available data, the following are estimated rooftop solar installation costs (1-3 kW) for low-income families²³ in Nagpur/Maharashtra under the PM-SGMBY. These are illustrative; actual costs may vary depending on vendor quotes, rooftop location, etc.

Estimated Cost Table - PM-SGMBY for Low-Income Families in Nagpur

System size	Approx. Installed Cost*	Central Financial Assistance (CFA) / Subsidy under PM Surya Ghar	Net Cost to Household after Subsidy*
1 kW	₹ 75,000 – ₹ 85,000 Synergy Solar ²⁴	₹ 30,000 ²⁵	₹ 45,000 – ₹ 55,000
2 kW	₹ 1,50,000 – ₹ 1,70,000 Solar Ace Energy	₹ 60,000	₹ 90,000 – ₹ 1,10,000
3 kW	₹ 1,89,000 – ₹ 2,15,000 Solar Ace Energy ²⁶	₹ 78,000	₹ 1,11,000 – ₹ 1,37,000

"Estimated installed cost" includes modules, inverters, mounting, wiring, etc. Net cost excludes subsidies and optional costs such as battery storage. These costs are based on current market estimates for Maharashtra.²⁷

- Over 21,027 households in Nagpur have benefited from the PM-SGMBY.²⁸
- Subsidy amount: ₹30,000 per kWh for up to 2 kWh, ₹18,000 per kWh for 2-3 kWh (i.e., maximum subsidy limited to ₹78,000 for systems up to ₹3 kWh).
- Net meters are provided free of charge under this scheme in Maharashtra, reducing the initial cost of the meter.

Central government subsidies are believed to significantly reduce the upfront burden. For example, for a 3 kW system, a subsidy of ₹78,000 reduces the amount a family pays by approximately 40-45% in many cases. However, with the subsidy and potential monthly electricity bill savings, many families can recover this cost within 2-3 years under favorable circumstances. If families can take out low-interest/long-term loans, or pay in installments, the burden is eased. Free net meters and simplified procedures help reduce hidden costs.

²³ <https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2024/07/202407021768035484.pdf>

²⁴ <https://synergysolar.in/know-more-about-solar-panel-system-price-and-subsidy-in-maharashtra-2025/>

²⁵ https://www.pmindia.gov.in/en/news_updates/cabinet-approves-pm-surya-ghar-muft-bijli-yojana-for-installing-rooftop-solar-in-one-crore-households/

²⁶ <https://solaraceenergy.com/solar-price-and-solar-subsidy-in-maharashtra/>

²⁷ <https://solaraceenergy.com/solar-price-and-solar-subsidy-in-maharashtra/>

²⁸ https://thelivenagpur.com/2025/02/27/pradhan-mantri-surya-ghar-muft-bijlee-yojana-100day-target-achieved-in-82-days100/#google_vignette

However, even after subsidies, the net cost (₹1.11-1.37 lakh for 3 kW) can be quite high for low-income households, especially if a full upfront payment is required. Households may have to rely on financing/loans/EMIs to spread the payment. Even after subsidies, the initial cost is high—around ₹80,000-₹1,12,000—which may be difficult for low-income households to afford.

Estimated burden/cost for low-income households in Nagpur-

System Size	Approx Total Installed Cost (Nagpur Estimate)	Subsidy Under PM Surya Ghar	Net Up-Front Cost to Household	Monthly Instalment (if financed)	Monthly Savings (electricity replaced)
2 kW	₹ 1,50,000 – ₹1,70,000 Solar Ace Energy	₹ 60,000	₹ 90,000 – ₹ 1,10,000	₹ 700-1,200 (depends on interest rate & loan period)	If ~200 units replaced, at ₹8-10/unit → ₹ 1,600-2,000
3kW	₹ 1,89,000 – ₹ 2,15,000 Solar Ace Energy ²⁹	₹ 78,000	₹ 1,11,000 – ₹ 1,37,000	₹ 1,000-1,800	If ~300 units replaced → ₹ 2,400-3,000

(These cost estimates are in line with local vendor cost limits and scheme subsidies in Nagpur.)

These are just examples. Savings of Rs 1600-2000 per month on 200 units and Rs 2400-3000 per month on 300 units seem insignificant. For a low-income household, the "burden" refers to the initial investment after the subsidy, financing/loan interest, and monthly installments if not paid in cash. Actual monthly cash flow will vary with usage, maintenance, delays in net-metering, interest rates, etc. In the current environment of rising debt and declining savings, the current financing model under the PM-SGMBY, despite the subsidy, does not sufficiently incentivize low-income households to adopt solar energy.

Now the question is, is this a significant risk/additional cost burden? Yes, because even after subsidies, the initial cost is high around ₹80,000-₹112,000, which can be difficult to afford for a low-income family. Delays in subsidy or bank loan disbursements can force families to seek financing or wait, increasing costs or wasting time to receive benefits. Quality issues (low-efficiency panels, inverter malfunctions) reduce production lower savings. Rooftop suitability/shade can reduce solar energy production less free electricity, leading to greater dependence on paid grid electricity. Maintenance costs (cleaning, periodic inspections, inverter replacement). Opportunity cost money spent on solar energy could have been used elsewhere (e.g., health, education)

²⁹ <https://solaraceenergy.com/solar-price-and-solar-subsidy-in-maharashtra/>

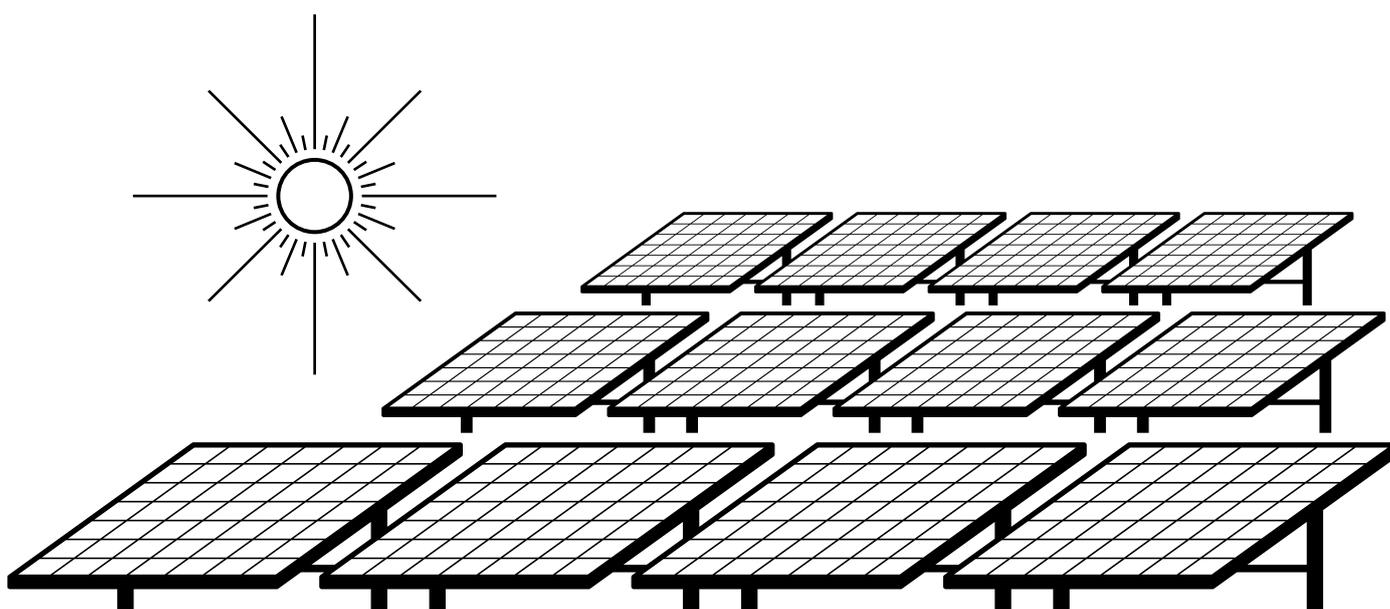
FINANCIAL FEASIBILITY OF ROOFTOP SOLAR FOR URBAN HOUSEHOLDS

Table 1: Household Category wise Financial Feasibility

Table 1 below shows how the financial viability of rooftop solar varies across household electricity consumption categories. The table reports net monthly cash flow, the breakeven year (the year in which cumulative electricity savings offset upfront and financing costs), and the Net Present Value (NPV) over a 20-year project life. Two binary indicators i.e household viability and project viability are used to summarise whether the investment is financially sustainable from the household’s perspective (positive monthly cash flow) and economically viable over the project lifetime (positive NPV)

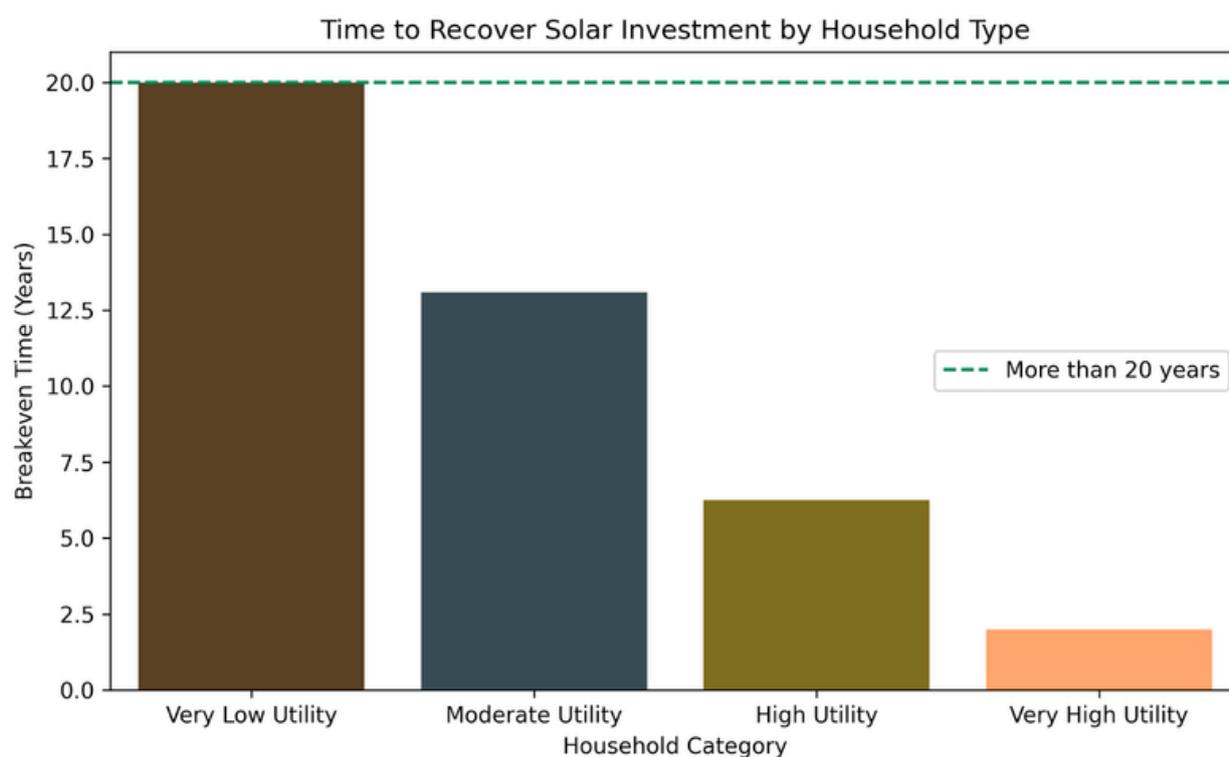
Household Category	Net Monthly Cash Flow (Rs)	Breakeven Year	NPV (Rs)	Household Viability	Project Viability
Very Low Utility	-74	>20	-52,124	No	No
Moderate Utility	638	13	-13,137	Yes	No
High Utility	1,627	6	99,578	Yes	No
Very High Utility	5,225	2	5,89,256	Yes	Yes

Note Figures are rounded to two decimal points*



BREAK-EVEN ANALYSIS

Chart 1: Time taken to recover Solar Investment by Household Category



The breakeven chart shows the time it takes for households to recover their upfront investment in solar systems through monthly electricity savings:

Very Low Utility households: The investment recovery takes the longest, exceeding 20 years. This is because their electricity consumption is low, so the monthly savings from solar generation are limited.

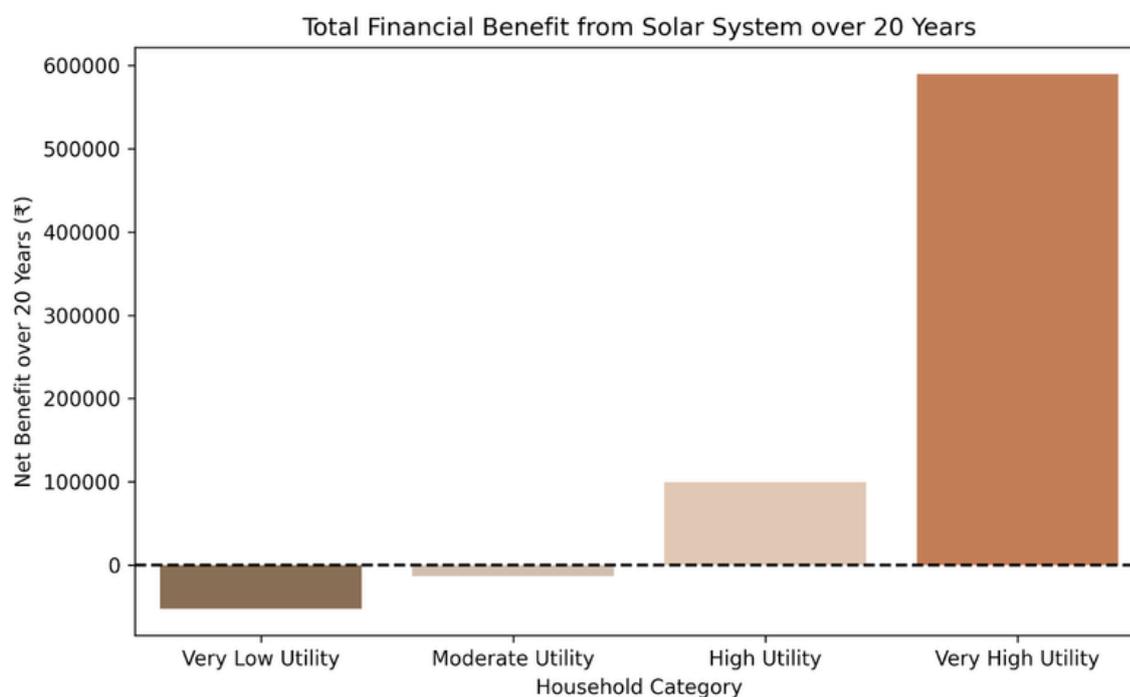
Moderate Utility households: These households recover their investment in approximately 10–15 years, depending on system size and electricity use.

High and Very High Utility households: These households achieve breakeven much faster, typically within 5–10 years, as higher electricity consumption leads to greater monthly electricity savings.

Households with higher consumption achieve immediate net monthly savings that exceed loan EMIs, indicating strong household-level viability, while low-usage households may require additional support. Overall, solar adoption is more financially attractive for moderate to high-usage households, highlighting where the scheme yields the greatest impact.

NPV ANALYSIS

Chart2: Total Financial Benefit from the Solar System over the Project life time



The above NPV chart represents the total financial benefit (in Rs) that households gain over the 20-year project lifetime after installing a solar panel, accounting for both loan payments and discounting future cash flows.

The Net Present Value (NPV) analysis shows that the financial viability of rooftop solar systems under the PM-SGMBY depends strongly on household consumption levels and the corresponding system size.

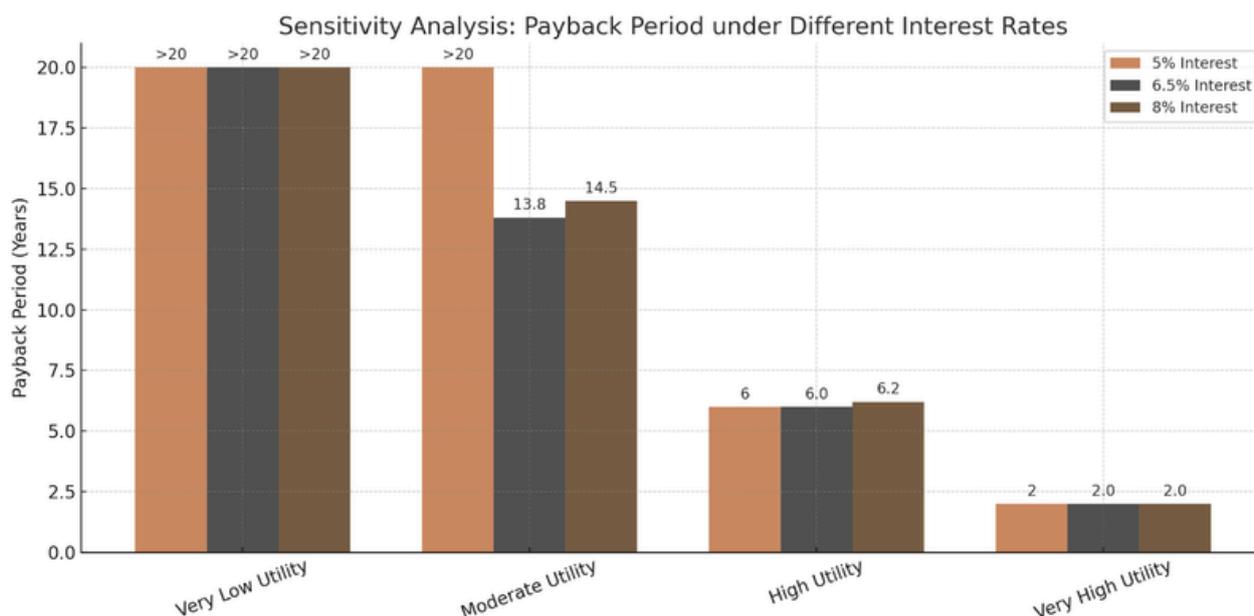
For very-low and moderate-consumption households (typically installing 1 kW systems), the NPV remains negative, indicating that the value of electricity bill savings over 20 years is insufficient to fully offset the total system cost and loan repayments that the household pays. These households effectively experience a net financial loss, even though their monthly electricity expenses have reduced.

In contrast, higher-consumption households (installing 2 kW and 3 kW systems) show a positive and progressively larger NPV, meaning they recover their investment and generate substantial long-term financial gains. The large positive NPV values for higher-consuming households reflect the strong relationship between system size and high monthly savings on electricity bills. Overall, the NPV results make it clear that rooftop solar is financially attractive primarily for medium- to high-consumption urban households, while it remains marginal or unviable for very low-consumption households under the current tariff and subsidy structure

SENSITIVITY ANALYSIS & MULTI- SENSITIVITY ANALYSIS

INTEREST RATE VARIATIONS

Chart 3: Household category wise Payback period under Different Interest rates



The interest rate sensitivity results clearly shows that changes in loan interest rates have very limited influence on the viability of rooftop solar systems. For the lowest-consumption households (Very Low Utility), the payback period remains above 20 years across all interest rate scenarios, indicating that such households simply do not generate enough monthly electricity savings to recover their investment through EMIs.

Moderate Utility households show only marginal variation in payback from about 13.8 years at the base rate (6.5%) to around 14.5 years at 8%; demonstrating that the loan interest rate does not materially shift the economics of solar adoption for this group.

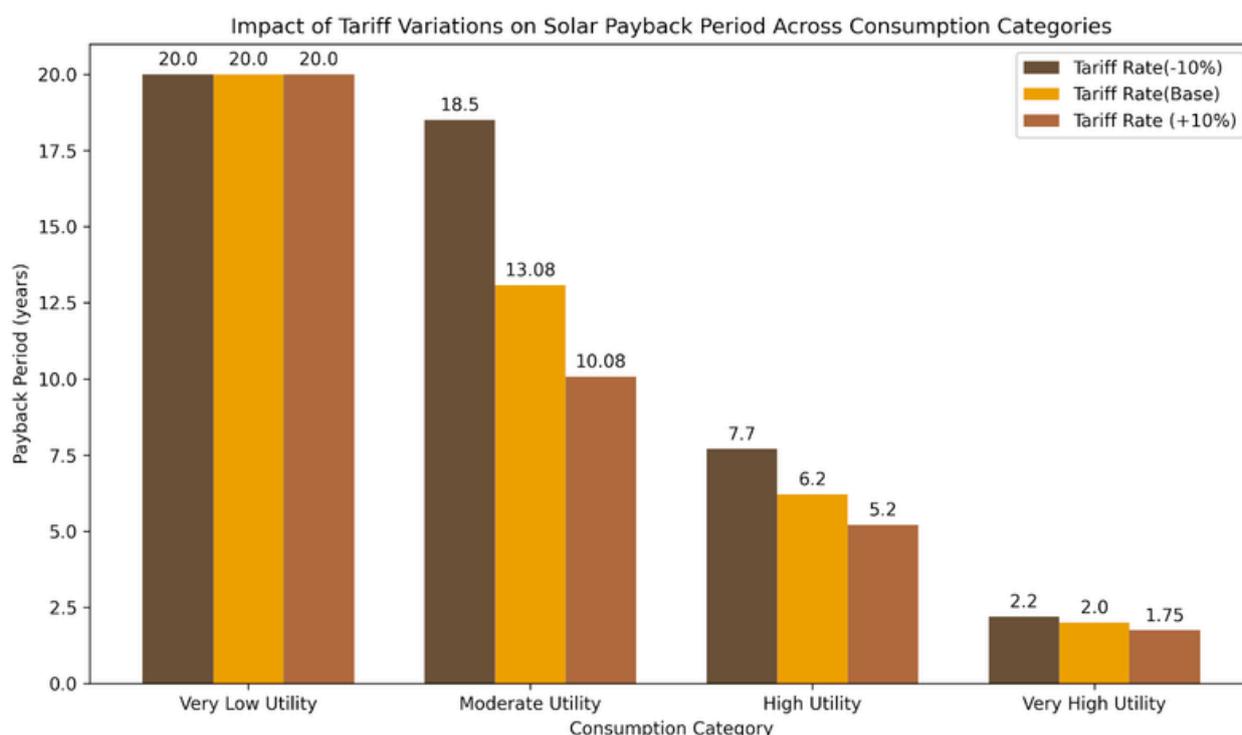
On the other hand, High Utility and Very High Utility households continue to exhibit strong economic viability regardless of interest rates, with payback periods remaining in the range of 2–6 years.

Overall, the analysis suggests that electricity consumption level (i.e., the amount of savings generated) is the dominant factor, while interest rate changes of $\pm 1.5\%$ do not significantly impact affordability or decision-making for most households.

TARIFF RATE VARIATION

The bar chart below compares how the solar system's payback period changes when electricity tariffs are reduced by 10%, stay at the base level, or increase by 10%

Chart 4: Household category-wise payback period under different tariff rates



Tariff variation has a clear and predictable effect on the payback period. For households with higher consumption, an increase in the electricity tariff significantly accelerates the payback period because savings from solar offset a larger electricity bill. For example, high-utility households reduce payback from 7.7 years under a -10% tariff to 5.2 years under +10% tariff, making solar highly attractive.

Moderate-utility homes also show meaningful improvements, tariff increases reduce payback from 18.5 years to 10.08 years, widening the economic benefit.

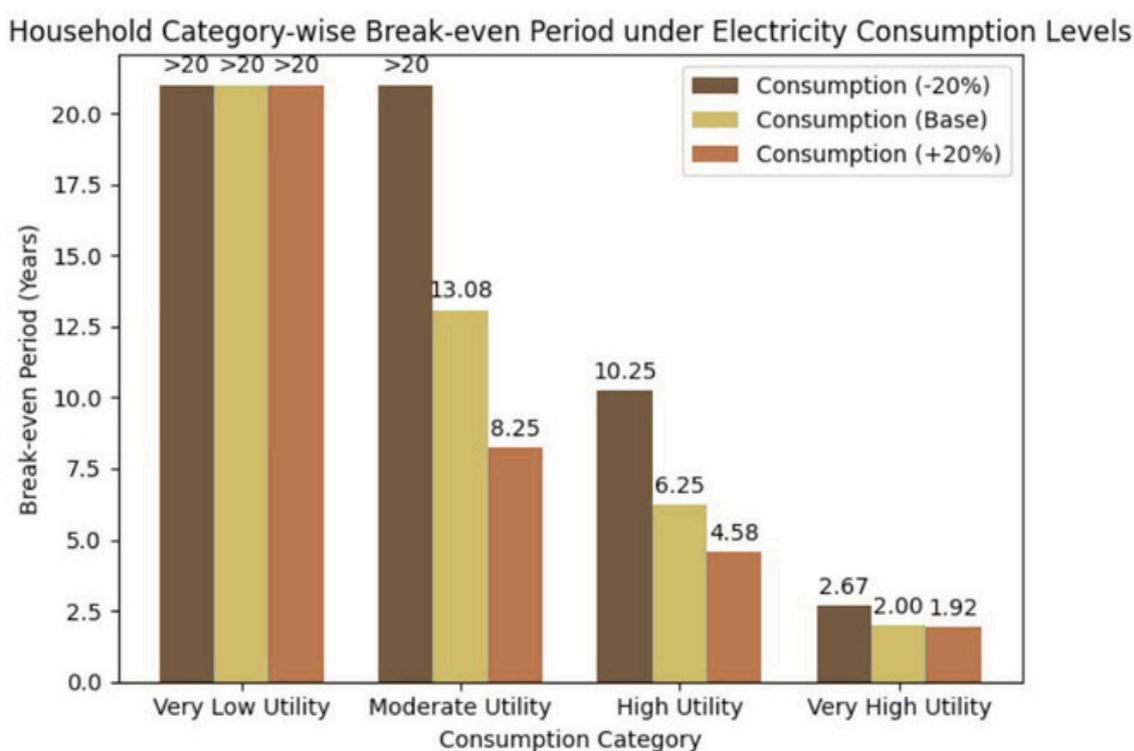
However, for very-low-utility households, the payback period remains greater than 20 years in all scenarios, indicating that solar remains financially unviable under current cost and subsidy structures for this segment.

Overall, the analysis shows that solar rooftop systems become more economically attractive as tariffs increase, and high-consumption households benefit the most.

CONSUMPTION LEVEL VARIATION

Understanding household electricity consumption patterns is essential for assessing the impact of tariffs and designing effective energy policies. Household consumption varies widely depending on income, appliance use, and energy needs, making it important to analyze how different groups respond to changes in electricity availability and pricing. The data presented here categorizes households into Very Low Utility, Moderate Utility, High Utility, and Very High Utility, and examines consumption levels under three scenarios: a 20% decrease, the base scenario, and a 20% increase.

Chart 5: Household category wise Payback period under Electricity Consumption levels



The chart shows that electricity consumption plays a significant role in determining the break-even period for rooftop solar systems. For very low-utility households, the break-even period exceeds 20 years across all scenarios, indicating that solar systems are not financially attractive for this group. For moderate-utility households, the break-even period decreases as electricity consumption increases. It has been more than 20 years since consumption decreased; in the base case, this period is about 13 years, and it falls to around 8 years when consumption increases. For high-utility households, the payback period shortens further, falling from approximately 10 years at low consumption to approximately 4–6 years as consumption rises. Very high-utility households benefit the most, with break-even periods of approximately 2–3 years, making solar highly financially attractive. Overall, the chart shows that higher electricity consumption significantly improves the financial viability of rooftop solar systems.

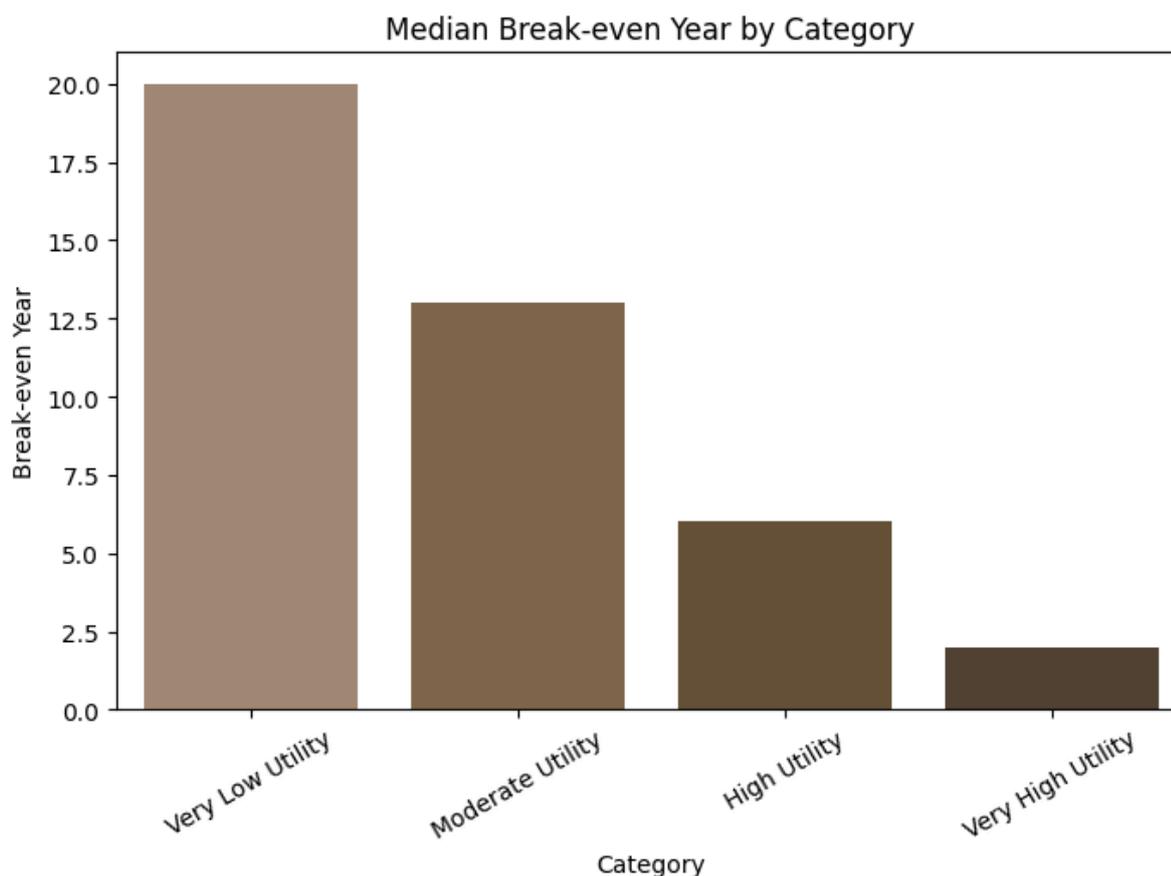
MULTI-SENSITIVITY ANALYSIS

This analysis has been done to test & assess the financial robustness of projects under variations in household consumption and financing costs. The analysis evaluates break-even timelines, Net Present Value (NPV), and overall household/project viability across multiple scenarios.

Table 2: Household Category wise Multi-Sensitivity Analysis

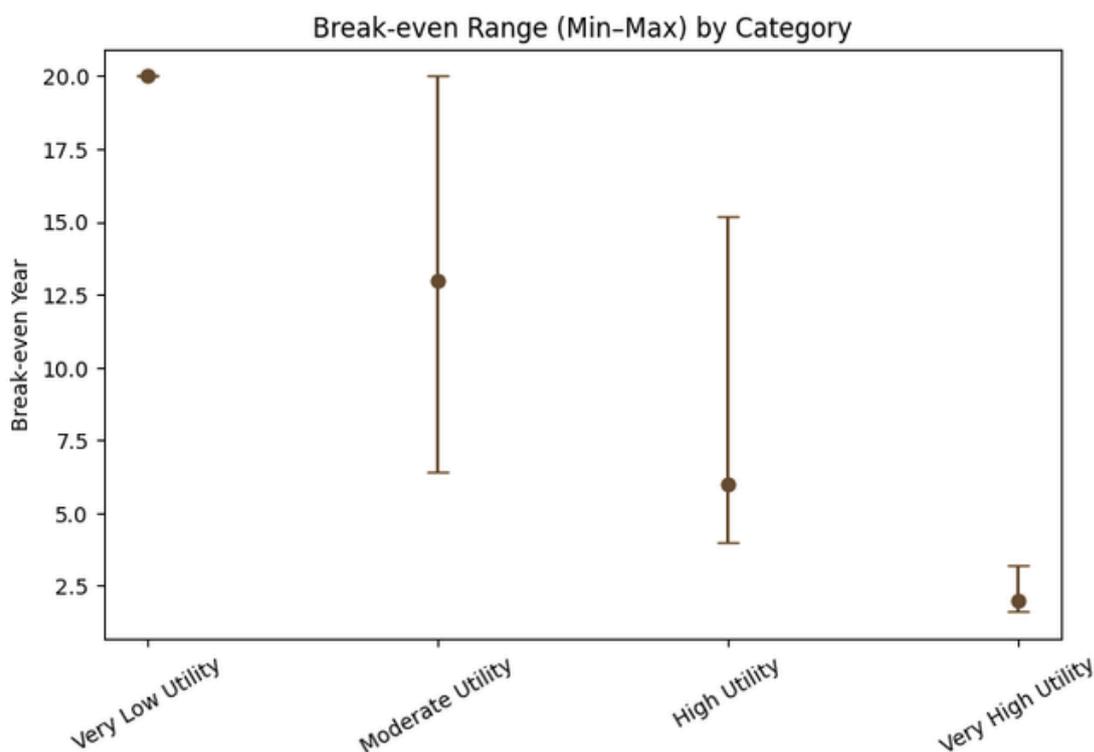
Category	Break-even Median (Years)	Break-even Min (Years)	Break-even Max (Years)	NPV Median (Rs)	NPV Min (Rs)	NPV Max (Rs)	Household Viability (%)	Project Viability (%)
Very Low Utility	20+	20	>20	-52,124	-71,941	-30,061	19	0
Moderate Utility	13.08	6.4	20	-13,137	-93,423	77,170	100	41
High Utility	7.7	4	15.2	99,578	-30,420	2,46,391	100	89
Very High Utility	2	1.6	3.2	5,22,697	3,22,148	7,21,713	100	100

Chart 6: Household Category wise Median Breakeven Period



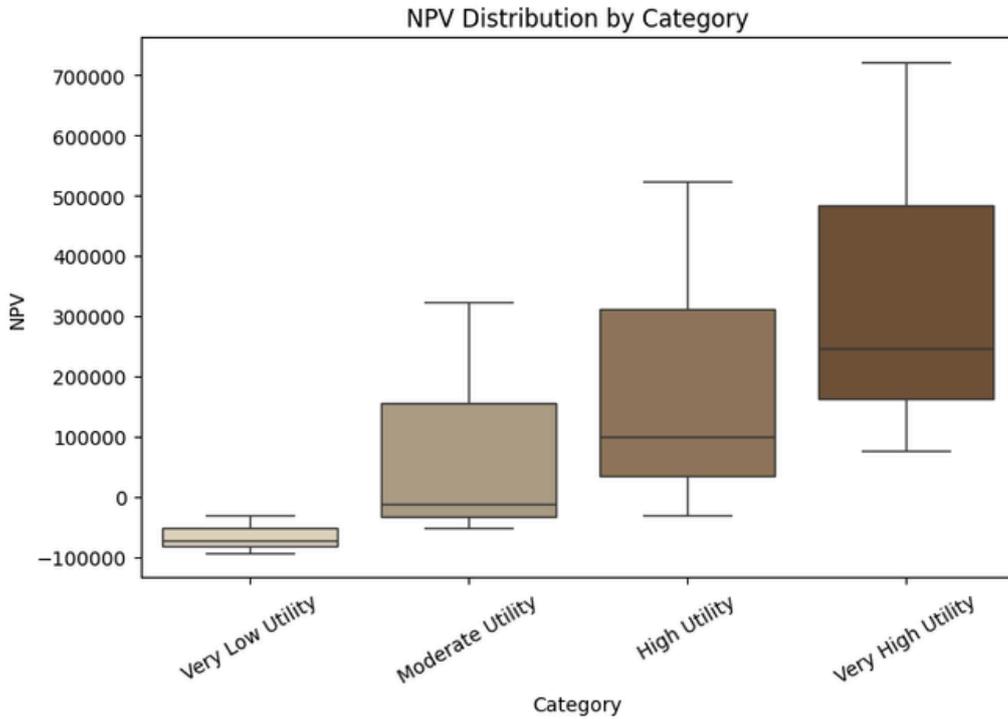
The above bar chart of median break-even year shows that high and moderate utility households achieve financial break-even faster, within roughly 6 to 13 years. Very low utility households have break-even beyond 20 years, indicating high financial risk and the potential need for targeted support or greater financial assistance.

Chart 7: Household Category-wise Breakeven Period Range



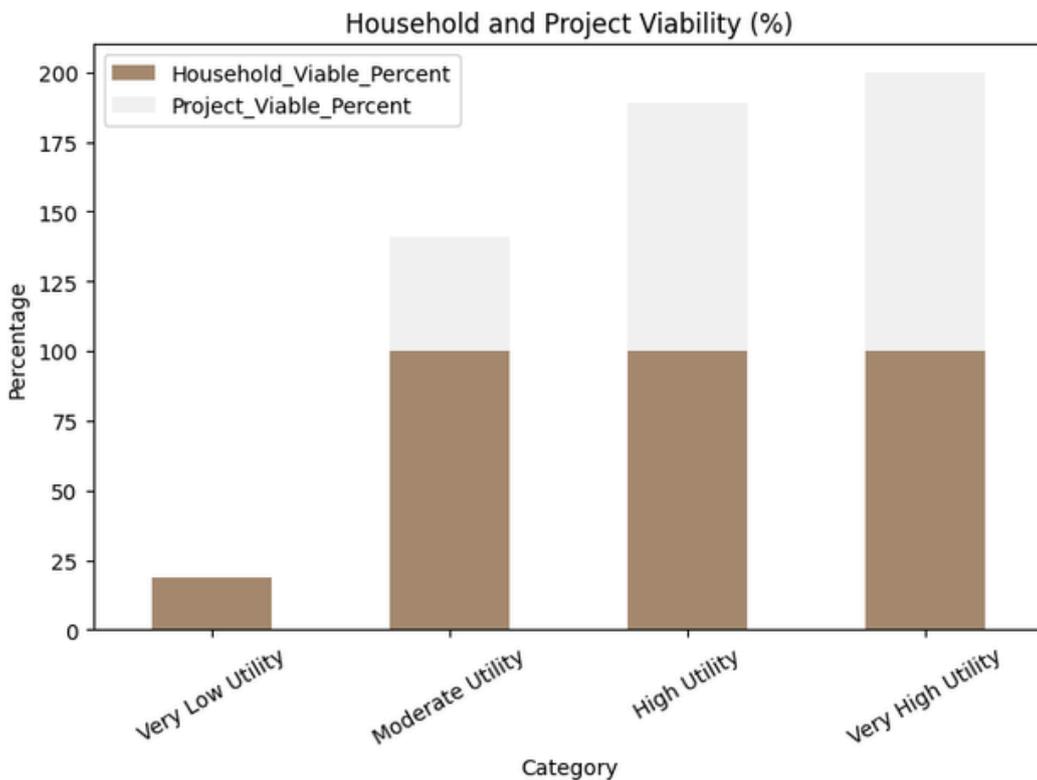
The above chart highlights the range of break-even years under varying assumptions of household consumption and financing. The wide Min–Max range for moderate and very low utility households illustrates that financial outcomes are highly sensitive to changes in consumption or interest rates, whereas high utility households show a narrower range, indicating more predictable financial performance.

Chart 8: Household Category-wise NPV Distribution



The above NPV distribution by category shows positive net present values for moderate and high utility households, indicating profitable projects. Very low utility households have negative NPVs, confirming financial unsustainability without intervention. The spread between Min and Max NPV further emphasises the sensitivity to consumption and financing variations.

Chart 9 : Household Category wise Project Viability



The above chart shows that household and project viability increases with higher utility levels. High utility households achieve nearly 100% viability, while very low utility households have low viability, signaling that additional support mechanisms, such as subsidies or tariff adjustments, are needed to improve outcomes for low-usage segments.

Household consumption is the key driver of financial viability. High and moderate utility households are financially sustainable and resilient under most scenarios, whereas very low utility households are at risk of financial non-viability. Multi-sensitivity analysis identifies these risk segments, providing insights for prioritizing interventions, and planning higher subsidies. Overall, the analysis supports informed decision-making for scaling the project while ensuring robust financial outcomes across different consumption and financing scenarios.

In our field interactions with consumers we found that people generally welcome the scheme due to the promise of reduced electricity bills, the use of clean energy, and government subsidy support. Many express satisfaction when vendors handle paperwork smoothly and the subsidy is credited to their accounts.

However, concerns remain: delays in subsidy disbursements, high initial costs even after subsidies, especially for low-income households (payback period can take approximately two to two and a half years to recover), and bottlenecks in net-metering and approvals. Vendor reliability and after-sales service also vary, leaving some consumers dissatisfied.

Overall, beneficiaries view the scheme as positive but imperfect—a good step toward affordable clean energy, although it is slowed by administrative hurdles and financial burdens, limiting widespread adoption among the poorest households.



CHALLENGES

The PM-SGMBY holds immense promise for India's rooftop solar sector. However, several intricate challenges could impede its smooth implementation and widespread adoption. Let's delve deeper into these complexities:

Financial Hurdles

Although the **PM-SGMBY: Free Electricity Scheme** is an ambitious step towards decentralised clean energy, the financial allocation is modest relative to its goals. The government has allocated approximately ₹75,000 crore to install 10 million rooftop solar power plants (40 gigawatts of capacity) and provide 300 units of free electricity per household per month.³⁰

However, when distributed across installation costs, subsidies, grid upgrades, and administrative expenses, the per-household assistance often falls short of the actual market cost, especially for low-income households lacking access to credit. Additional expenses such as maintenance, inverter replacement, and delays in subsidy disbursement further undermine the scheme's financial viability at the household level.

- **DISCOM Strain:** Most distribution companies (Discoms) in India are already facing financial constraints due to high power purchase costs, outstanding consumer bills, and delayed government subsidy payments. As of June 2025, DISCOMs owed generators Rs581,330 crore (US\$6.78 billion),³¹ creating a severe liquidity crunch for independent power producers, and in turn, stifling credit flows into the sector. This precarious financial situation could be exacerbated by the additional burden of rooftop solar approvals, net-metering, and grid upgrades under the PM-SGMBY. Delays in subsidy disbursements could discourage participation and create financial difficulties for beneficiaries who have already invested in solar panels.

In Maharashtra, the state power distribution company, MSEDCL, has long struggled with delayed payments from agricultural consumers. The additional costs of verifying rooftop solar connections, providing technical approvals, and processing central subsidies have put pressure on its operational finances. Officials often cite "lack of manpower or funding" for the slow implementation of rooftop solar energy systems.

- **Subsidy Sustainability:** The long-term viability of the scheme hinges on the government's ability to maintain subsidies. Fluctuations in government finances or changes in policy priorities could threaten the scheme's long-term continuity. Because many poor families, already under debt, may find it difficult to spend money on this and taking a fresh loan for it may be difficult.

³⁰ <https://www.pib.gov.in/PressReleaseframePage.aspx?PRID=2081250>

³¹ <https://ieefa.org/articles/discoms-continue-exceed-their-3-fiscal-deficit-limit-highlighting-need-state-oversight>

BUREAUCRACY AND AWARENESS

- **Complex Application Process:** Complex Application Process: The complexity of the application process under the PM-SGMBY has emerged as a major obstacle to its effective implementation. Although the online portal was designed to streamline approvals, in reality many applicants—especially those from rural and low-income households—struggle with digital access, documentation, vendor coordination, and subsidy claim processes. Frequent technical glitches, slow verification by discoms, and a lack of support on the ground have further discouraged participation. Some instance/s?
- **Limited Outreach:** Inadequate outreach efforts by government agencies and implementing partners could limit the scheme's reach to targeted low-income and rural populations. Public awareness campaigns that utilise accessible mediums are crucial to ensure the scheme reaches its intended beneficiaries.

TECHNICAL AND LOGISTICAL OBSTACLES

- **Roof Suitability Issues:** Not all rooftops are suitable for solar panels. Factors like orientation, shading (from trees or buildings), and structural integrity need careful assessment. Conducting thorough roof suitability checks, especially in densely populated areas, can be a logistical challenge.
- **Installer Availability and Quality:** The availability of qualified and affordable solar installers might be limited, especially in remote locations. Ensuring the quality and durability of installations is vital for long-term scheme effectiveness. Substandard installations could lead to frequent maintenance needs and reduced efficiency.

GRID INFRASTRUCTURE AND POLICY GAPS

- **Grid Capacity Constraints:** The Indian grid infrastructure may not be fully equipped to handle the significant increase in electricity generation from a multitude of rooftop solar installations. Investments in grid modernisation may be needed to efficiently integrate this distributed solar power.
- **Net Metering Disparity:** Net metering policies, which allow consumers to sell excess solar energy back to the grid, can vary significantly across different states. Inconsistent or unappealing net metering policies could discourage investment in rooftop solar, as individuals wouldn't get a fair return on surplus energy generation.

OTHER PERTAINING ISSUES

- **Even after subsidies, the initial investment for installing solar panels remains high:** Even though the government provides subsidies, the remaining amount (20–40%) for panels, inverters, wiring, and installation is still a significant amount for low-income families. *Example: 2. kW system » Total cost, let's say ₹1.2 lakh; Subsidy ~₹60,000. Still, the family has to pay ₹60,000 outright » This is very difficult for LIG families.*
- **Lack of financial access:** Obtaining loans from banks or financial institutions is challenging for poor families, as paying the monthly EMIs and interest would be challenging.
- **Taking a loan becomes a necessity:** Many families cannot afford this expense with their savings or cash, so they have to rely on loans. But— Banks demand guarantees. Proof of regular income is required. Many families lack a CIBIL score or formal income proof, making it difficult to obtain a loan.
- **The EMI burden is a real challenge:** Low-income families don't have enough monthly income to cover EMIs. They ask: "The electricity bill will be lower, but how will I pay the bank instalments?"
- **The process is complex and time-consuming:** Bank loan approval, DISCOM application, and Net-metering. All these cycles make it even more difficult for poor families to avail themselves of the scheme.
- **Poor families have low risk tolerance:** They already struggle to meet their daily needs. Investing/taking a large amount of money in such a situation further increases their financial insecurity.
- **Lack of technical knowledge:** Many families lack adequate knowledge about solar panels, their care, and their usage.
- **Lack of space:** Slums, densely populated urban areas, or small rural houses have limited rooftop space, making panel installation difficult.
- **Lengthy procedures of electricity distribution companies (DISCOMs):** From application to net-metering and grid connection, the process is complex and time-consuming, discouraging poor families.
- **Challenges of repair and maintenance:** Care, cleaning, and periodic maintenance of solar panels require additional costs, which are difficult for poor families to afford.

- **Lack of awareness and trust:** Many people in rural and low-income communities are not fully aware of the scheme's details or benefits, leading to low participation.
- **Financing Options:** While the scheme offers subsidies, some households might still require financing options to cover upfront costs. The availability of affordable loans or other financing mechanisms could encourage wider participation.
- **Maintenance and After-Sales Support:** A robust after-sales support system is crucial to ensure long-term functionality and proper maintenance of solar panels.
- **Data Security and Privacy Concerns:** Addressing data security and privacy concerns related to beneficiary information and energy usage data collection is vital to building trust and encouraging participation.



CONCLUSION

The PM-SGMBY are required for the widespread adoption of rooftop solar power. By addressing financial, bureaucratic, technical, and infrastructural challenges through collaborative efforts, India can move closer to its renewable energy goals. Continuous public engagement and transparent communication are essential to manage expectations and ensure sustained participation. With a comprehensive approach, this ambitious scheme can significantly contribute to India's clean energy future, setting a precedent for other nations to follow.

By immediately addressing issues like portal glitches and application process delays, this scheme can be made effective from the outset; however, more important is the need to address these issues. For low-income families, they must actually take out loans to benefit from the scheme. The government provides subsidies, but even after the subsidy, the remaining costs are high. For low-income families, the remaining amount (20–40%) for panels, inverters, wiring, and installation is significant.

Many families cannot afford these expenses from their savings or cash, so they must rely on loans. Even to obtain a loan, banks require guarantees and proof of regular income. Many families lack a CIBIL score or formal income proof, making it difficult to obtain a loan. This marketing strategy has not received much attention. The scheme will be fully successful only if: The loan process is simple. The interest rate is almost zero. The initial cost is minimal. Discom/bank cycles are simplified. Special financial assistance is provided to poor families.

However, after a year, actual progress appears mixed. On the one hand, millions of households have transitioned to solar energy, leading to positive outcomes such as reduced electricity bills, increased energy self-sufficiency, and environmental protection. On the other hand, the number of solar plants installed remains low compared to the targeted 10 million households, indicating the slow implementation of the scheme.

Challenges are particularly profound for lower-income groups; If these barriers are not effectively addressed, the scheme will fail to reach the most vulnerable sections of society.

The government appendices regarding the financing and subsidy structure of the installation, and must have more vendors involved to reduce the prices and speed up the practical application. Financial hurdles, such as the strain on DISCOM and the sustainability of subsidies, pose significant risks. Bureaucratic complexities and limited public awareness further impede participation. Technical and logistical obstacles, including roof suitability and the availability of skilled installers, complicate implementation. Moreover, disparities in grid infrastructure and net metering policies across states could hinder widespread adoption. Along with fixing these technical problems, such as grid management and power transport, it is also imperative to have infrastructural efficiency in terms of smart meters and analysis into the effectiveness of the scheme in relation to the current electricity cost and implications on the DISCOM. But while all these can be done in the short-term, the long term must look forward to making this scheme viable throughout the country and making even the lower end of the income spectrum beneficiaries of it. Obviously, India needs a modified plan as we have a greater population as well as a lack of equitable distribution, so it must be kept in mind that, rather than this being a purely economically-driven scheme, the result must always aim to uplift society as a whole.



ANNEXURE 1: METHODOLOGICAL FRAMEWORK FOR HOUSEHOLD LEVEL FINANCIAL VIABILITY ANALYSIS

1. Purpose & Scope of Methodology

This annexure explains the method used to assess whether rooftop solar systems under the PM-SGMBY make financial sense for households. The analysis examines whether installing rooftop solar reduces monthly electricity bills, whether the savings from lower bills are sufficient to repay the solar loan, and whether households gain financial benefits over the system's 20-year lifetime. By focusing on household-level costs, savings, and repayments, the framework helps understand the real economic impact of the scheme on households subscribing to the scheme.

The analysis focuses on urban households in Maharashtra, selected due to the state's varied electricity tariffs, strong rooftop solar potential, and active implementation of the PM-SGMBY. It adopts a household-level perspective, recognising that adoption depends not only on long-term savings but also on affordability and the ability to manage monthly repayments. The model supports policy discussion by showing how financial outcomes differ across income and electricity consumption groups.

2. Overview of the Financial Modelling Approach

The model estimates household electricity savings, loan repayments, net cash flows, breakeven points, and overall financial returns (NPV) over 20 years. Financial outcomes are assessed through two key measures: Household Affordability i.e Whether households can afford monthly repayments, and Project financial viability i.e Whether the system is financially viable over its lifetime. The analysis also tests how results change under realistic variations (Sensitivity & Multi- Sensitivity Analysis) in interest rates, electricity use, and tariffs, helping understand both average benefits and financial risks for households.

3. Household Types & Categorisation

Households are categorised based on typical monthly electricity consumption patterns observed in urban Maharashtra. Representative values are selected as midpoints within realistic ranges.^{32,33}

³² <https://energy.prayaspune.org/our-work/article-and-blog/electricity-consumption-patterns>

³³ <https://cdnbbsr.s3waas.gov.in/s349d4b2faeb4b7b9e745775793141e2b2/uploads/2025/01/2025030788773769.pdf>

We use both ranges and representative consumption values:

3.1 Electricity Consumption Categories

Household Category	Utility Range (kWh)	Representative Value Used
Very Low Utility	0-75	75
Moderate Utility	76-150	150
High Utility	151-300	250
Very High Utility	300-500	400

Note Representative consumption values are selected from the upper end of each slab range rather than strict mid-points. This approach reflects observed urban household consumption patterns, where households typically consume closer to the higher limit of the slab, especially due to appliance usage and seasonal cooling demand*

3.2 Income Categories

Household income levels significantly influence the financial viability of rooftop solar adoption. To evaluate the financial feasibility and affordability of rooftop solar systems, households are classified based on monthly income levels. Income is a critical determinant of both the ability to make the upfront downpayment and the capacity to service a loan under the PM-SGMBY.

Category	Monthly Household Income (₹)	Representative Value
Lower Income	< 15,000	12,000
Lower-Middle Income	15,000-35,000	25,000
Middle / Upper-Middle Income	35,000-75,000	50,000
High Income	50,000 - 90,000	70,000

Note Representative mid-point values are used for each category to model typical household affordability, capacity to make the required downpayment, and ability to service loan EMIs. This classification aligns with urban energy consumption patterns, consistent with household archetype approaches in energy economics literature, which allows for policy-relevant scenario analysis*

4. Technical and Financial Input Parameters

4.1 Solar System Specifications

Variable	Value	Notes / Source
System Capacity	1 kW, 2 kW, 3 kW	Typical rooftop systems for urban households
Installation Cost	1 kW, ₹80,000 2 kW, ₹1,60,000 3 kW, ₹2,00,000	Based on Market Estimates
System Lifetime	20 years	Used for NPV and breakeven calculation
Monthly Generation per kW	137.4 kWh	Maharashtra average: 4.56 kWh/day × 30 days ³⁴

4.2 Subsidy under PM-SGBY

System Capacity	Subsidy Amount
1 kW	₹38,000
2 kW	₹60,000
3 kW	₹78,000

The subsidy is assumed to be received upfront and deducted from the installed cost.

4.3 Residential Electricity Tariff Rates

Consumption Slab (kWh/month)	Tariff (₹/unit)
0–100	5.74
101–300	12.57
301–500	16.85

Tariffs are applied using representative slab rates for simplicity and transparency.

³⁴ https://www.eai.in/ref/ae/sol/rooftop/power_output

4.4 Financing and Loan Parameters ³⁵

Variable	Value
Loan Interest Rate	6.5% per annum
Loan Tenure	7 years
Downpayment	10% of the Project cost
Loan Amount	Installed Cost – Subsidy – Downpayment

Loan EMIs are assumed to be paid monthly, with no prepayment or default.

4.5 Opportunity Cost / Discount Rate

A 6.5% discount rate is used, assuming households compare solar savings with the interest they pay on loans and have limited access to low-cost credit.

4.6 Operations & Maintenance (O&M)

Operation and maintenance costs for small rooftop solar systems are assumed to be minimal. Routine cleaning and minor upkeep are usually managed by households and are therefore not counted as separate expenses in the model.

5. Household-System Matching Assumption on Solar Installation

Households are assumed to select solar system capacity based on electricity consumption levels, ensuring realistic alignment between generation potential and household demand.

Household Category	Representative Consumption	Solar System Installed
Very Low Utility	75 kWh	1 kW
Moderate Utility	150 kWh	2kW
High Utility	250kWh	3kW
Very High Utility	400 kWh	3kW

*Note*Ensures that financial modelling realistically reflects both household electricity offset and investment required.*

³⁴ <https://sbi.bank.in/web/sbi-green/green-loans/personal/pm-surya-ghar-loan-for-solar-roof-top>

6. Modelling Assumptions and Constraints

6.1 Key Assumptions

- Solar generation remains constant over 20 years (no degradation modelled)
- Household electricity consumption is constant within each category, except in the sensitivity analysis.
- Subsidy is received upfront: It is assumed that the household, after the subsidy and downpayment, the remaining amount is financed through a loan
- For base level analysis, it is assumed that the Household takes the loan at 6.5% Annual rate of interest for a tenure of 7 years
- Annual Discount rate is assumed to be 6.5%
- Loan EMIs are paid monthly; prepayments and defaults are not modelled.
- Electricity tariffs remain constant over the project life, except in Sensitivity Analysis
- O&M costs are negligible.
- Sensitivity analysis will vary interest rate ($\pm 1.5\%$), tariff ($\pm 10\%$), and consumption ($\pm 20\%$) to reflect realistic uncertainties.

6.2 Constraints

This analysis is based on a simplified household-level financial model designed to assess the affordability and financial viability of rooftop solar adoption under the PM-SGMBY. While the methodology prioritises transparency and comparability across household categories, several limitations should be noted.

Simplified generation assumptions: Solar electricity generation is assumed to remain constant over the 20-year project lifetime. Technical degradation of solar panels over time is not explicitly modelled.

Static household consumption: Household electricity consumption is assumed to remain constant within each consumption category. Changes due to appliance additions, behavioural shifts, or long-term demand growth are not captured.

Tariff simplification: Residential electricity tariffs are applied using representative slab rates rather than marginal billing structures. Tariffs are assumed to remain constant over the project lifetime except in sensitivity scenarios.

Self-consumption assumption: The model assumes full self-consumption of solar generation and does not separately account for monetisation of surplus electricity exports or variations in net-metering implementation.

Simplified generation assumptions: Solar electricity generation is assumed to remain constant over the 20-year project lifetime. Technical degradation of solar panels over time is not explicitly modelled.

Rooftop and access constraints excluded: Rooftop availability, shading, building design, tenancy arrangements, and administrative barriers to scheme access are not incorporated. Results, therefore reflect households that are technically and administratively able to adopt rooftop solar.

O&M costs excluded: Operations and maintenance costs are assumed to be negligible and are not treated as explicit cash outflows.

Simplified financing behaviour: The analysis assumes full loan repayment with fixed interest rates, no prepayments, refinancing, or defaults. Credit access uncertainty is not modelled beyond sensitivity analysis.

7. Financial Metrics and Evaluation Criteria

This section outlines the key formulas used to evaluate the financial viability of rooftop solar adoption under the PM-SGMBY. The calculations cover monthly electricity savings because of solar installation, loan repayment, net cash flows, breakeven period (Time taken for the solar installation to cover its total costs & begin generating profit) , and Net Present Value (NPV)

7.1 Monthly Savings

Monthly savings represent the reduction in electricity expenditure due to solar generation:

Monthly Saving = Household Monthly consumption * Residential Tariff rate

Note Tariff is matched to the consumption slab of the household.*

7.2 Net Monthly Cashflow

Net monthly cash flow is the difference between monthly savings and EMI on loan taken:

Net Monthly Cashflow (₹)= Monthly Savings – EMI

- Positive values indicate a net benefit to the household.
- Negative values occur when loan repayment exceeds electricity savings

7.3 Breakeven Period

The breakeven period represents the time required for cumulative net cash flows to equal the upfront net investment

$$\text{Cumulative Net Cashflow at Month } t = \sum_{i=1}^t \text{Net Monthly Cashflow}_i$$

$$\text{Breakeven Month} = \min\{t : \text{Cumulative Net Cashflow}_t \geq \text{Net Upfront Cost}\}$$

$$\text{Breakeven Years} = \text{Breakeven months} / 12$$

*Note*If cumulative cashflows do not cover the net upfront cost within 20 years, breakeven is denoted as >20 years (As we have assumed the the Project life time to be 20 years)*

7.4. Net Present Value (NPV)

NPV calculates the present value of future net cash flows over the project lifetime, discounted at the household's opportunity cost

$$\text{NPV (₹)} = \sum_{t=1}^{240} \frac{\text{Net Monthly Cashflow}_t}{(1 + r_d)^{t/12}} - \text{Net Upfront Cost}$$

Where:

- rd = annual discount rate (i.e. 6.5%)
- t = month (1 to 240, for 20 years)
- Net Upfront Cost = Installed Cost – Subsidy

Interpretation:

- NPV > 0 » Project financially viable
- NPV < 0 » Project not financially viable

*Note * Cumulative NPV is reported monthly and aggregated year-wise for clarity in reporting.*

7.5 Financial Viability

Two separate indicators used in the analysis assess viability:

- **Household Viability:** If Net Monthly Cashflow (Month 1) > 0 » Household can manage EMI from savings.
- **Project Viability:** If NPV > 0 over 20 years » Project is financially viable for the household

8. Sensitivity Analysis

Sensitivity analyses are conducted to evaluate the impact of uncertainty, & it provide insight into the robustness of financial feasibility under realistic fluctuations in electricity prices, household behaviour, and financing conditions

Key variations in the parameters are :

Variable	Base Value	Variation Range
Interest Rate	6.5%	±1.5%
Household Electricity Consumption	Representative values	±20%
Tariff Rate	Base slab rate	±10%

Note Monthly savings, net cashflows, breakeven, and NPV are recalculated for each scenario.*

9. Multi-Sensitivity Analysis

- The study undertakes multi-parameter sensitivity analysis to assess the financial robustness of rooftop solar projects under variations in household electricity consumption and financing costs.
- The analysis evaluates changes in key financial indicators, including break-even period, Net Present Value (NPV), and overall household/project viability, across multiple scenarios.
- Unlike single-variable sensitivity analysis, which alters one parameter at a time, this approach examines simultaneous changes in multiple inputs, allowing for a more realistic assessment of project performance under real-world conditions.

9.1 Methodology for Multi-Sensitivity Analysis

- Households are categorised into utility consumption groups: Low, Moderate, High, and Very High.
- For each consumption category, minimum, median, and maximum values of break-even period and NPV are computed to capture variability across scenarios.
- Household viability and project viability percentages are calculated for each scenario to assess the share of households for which rooftop solar remains financially viable under changing conditions.

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