

# Unleashing the Residential Rooftop Solar Potential

Pradhan Mantri Surya Ghar Yojana is a Game Changer

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## Key Findings

**The residential sector will grow at the fastest pace within the rooftop solar space in the next few years.**

**The residential rooftop solar market is becoming commoditised, and financiers are establishing industry-wide tie-ups to offer a one-stop solution.**

**PMSGY scheme will ensure a pan-India growth of residential rooftop solar, with a significant chunk of demand also from tier-2/3 cities and rural areas.**

**It is the ideal time to invest in household rooftop solar: module prices have dropped; there's strong government support and financiers are more willing to loan for rooftop solar projects.**



## Glossary of Terms

Abbreviation	Definition
<b>ALMM</b>	Approved list of models and manufacturers
<b>AT&amp;C</b>	Aggregate technical and commercial losses
<b>AMC</b>	Annual maintenance contract
<b>AC</b>	Alternating current
<b>ADB</b>	Asian Development Bank
<b>BoS</b>	Balance of system
<b>BESS</b>	Battery energy storage system
<b>C&amp;I</b>	Commercial and Industrial
<b>CAGR</b>	Compound annual growth rate
<b>CFA</b>	Central financial assistance
<b>Capex</b>	Capital expenditures
<b>DISCOM</b>	Distribution Company
<b>DCR</b>	Domestic content requirement
<b>EMI</b>	Equated monthly installment
<b>EPC</b>	Engineering, procurement and construction
<b>ESAF</b>	Evangelical Social Action Forum
<b>FIs</b>	Financial institutions
<b>FY</b>	Financial year
<b>GBI</b>	Generation-based incentives
<b>GW</b>	Gigawatt
<b>GRSP</b>	Grid-connected rooftop solar
<b>GNM</b>	Group net metering
<b>GST</b>	Goods and services tax
<b>IT</b>	Information technology
<b>kW</b>	Kilowatt
<b>kWp</b>	Kilowatt peak
<b>kWh</b>	Kilowatt-hour
<b>MW</b>	Megawatt
<b>MNRE</b>	Ministry of New and Renewable Energy
<b>MSMEs</b>	Micro, small and medium enterprises
<b>MIGA</b>	Multilateral Investment Guarantee Agency
<b>NBFCs</b>	Non-banking financial companies
<b>NPRS</b>	National Portal for Rooftop Solar
<b>NPIA</b>	National Programme Implementation Agency
<b>OTP</b>	One-time password

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<b>PPA</b>	Power purchase agreement
<b>PMSGY</b>	Pradhan Mantri Surya Ghar Yojana
<b>P2P</b>	Peer-to-peer
<b>RE</b>	Renewable energy
<b>RESCO</b>	Renewable energy service company
<b>Rs</b>	Rupees
<b>SBI</b>	State Bank of India
<b>SPIA</b>	State Programme Implementation Agency
<b>TPDDL</b>	Tata Power Delhi Distribution Limited
<b>UPPCL</b>	Uttar Pradesh Power Corporation Limited
<b>UPNEDA</b>	Uttar Pradesh New and Renewable Energy Development Agency
<b>VNM</b>	Virtual net metering

## Executive Summary

**The central government's plan to transform India's rooftops into a vast solar resource to secure the nation's energy independence is as laudable as it is ambitious. However, initial progress was slow. That was until the launch of PMSGY in February 2024. The popular new scheme is a quantum leap towards India's bright solar future, increasing the country's rooftop solar capacity by more than 50% in just six months. Yet some critical pieces are still missing from the renewable energy mix before the dream of delivering solar power for all becomes a reality.**

The rooftop solar market in India consists of residential, commercial and industrial (C&I) and government segments. In comparison to C&I, the uptake of rooftop solar in the residential sector has been largely underwhelming. As of March 2024, residential rooftop solar installed capacity in India was about 3.2 gigawatts (GW), or 27% of the total rooftop solar installations in the country, with about three-quarters of this capacity in Gujarat.

In February 2024, the Government of India (GoI) announced a revamp of the subsidy structure for residential consumers opting for rooftop solar systems through Pradhan Mantri Surya Ghar Yojana (PMSGY).<sup>1</sup> The scheme aims to foster an enabling ecosystem for the residential rooftop solar market and cumulative installations of 30GW solar systems in 1 crore (10 million) households in India by March 2027. To do so, PMSGY increased the central financial assistance (CFA) for systems below 3-kilowatt peak (kWp) capacity, set stringent process timelines and integrated itself with the National Portal for Rooftop Solar (NPRS) to provide a digitised user experience to residential consumers. As of August 2024, the scheme has garnered around 1.3 crore (13 million) registrations and 18 lakh (1.8 million) applications, leading to a total of 3.85 lakh (385,000) installations.<sup>2</sup> This translates to about 1.8GW of new residential rooftop solar capacity, or more than half of India's total, in just six months.

With strong impetus from the GoI, the financing options and terms for the residential rooftop solar market have improved significantly. The number of financiers has risen from just a handful a few years ago to more than 25, including all leading private and public sector banks, non-banking financial companies (NBFCs) and fintechs.<sup>3</sup> Several financiers focus on industry-wide tie-ups with project-executing entities and equipment suppliers, offering a one-stop solution to rooftop solar

<sup>1</sup> Public Information Bureau (PIB). [Cabinet approves PM-Surya Ghar: Muft Bijli Yojana for installing rooftop solar in One Crore households](#). February 2024.

<sup>2</sup> Economic Times. [PM Surya Ghar subsidy claims may move in fast lane](#). September 2024.

<sup>3</sup> Fintechs are financial technology companies that use technology to provide financial services and products to consumers. Fintechs can include startups, banks and non-bank financial companies (NBFCs).

consumers. For financiers, this ensures supply chain reliability, enhanced cost dynamics and the ability to tap a broader consumer base by leveraging the skills of multiple entities involved.

With the rooftop solar market attaining technological maturity, market commoditisation has increased noticeably, and several brands, such as Havells, Luminous, Livguard and Oswal, have introduced customised residential kits for swift project installation.

Despite the positive developments, some challenges need to be addressed to ensure the success of PMSGY. The primary challenge is the need for more availability of domestic content requirement (DCR) modules for the residential sector, considering the wide gap between photovoltaic (PV) cell and module manufacturing capacity in India. Additionally, there are some concerns about scheme adoption by its target demographic (i.e. small- to medium-scale electricity consumers), as cost economics and loan availing capability still favour the wealthier and creditworthy residential consumers. In certain states, such as Assam, there is a considerable mismatch between the number of project applications and the availability of vendors, which may affect the near-term growth of installations.

A firm policy and regulatory framework support should be reflected in its implementation to build a resilient and vibrant decentralised energy ecosystem with residential rooftop solar at the forefront. The technical issues and glitches of the National Portal for Rooftop Solar (NPRS), which several users across India have reported, must be resolved immediately. The state government must upgrade the endpoint transmission infrastructure, including the locality distribution transformer and power feeders. The Ministry of Power (MoP) directive to automatically award feasibility approval for project capacities under 10kWp should be implemented across India. In addition, the GoI must consider temporarily relaxing the mandatory usage of DCR modules until the enabling ecosystem of domestic PV cell manufacturing develops.

The adoption of residential rooftop solar is a “win-win” scenario, resulting in significant savings for consumers and state electricity distribution companies (DISCOMs) on cross-subsidisation costs and reduced aggregate technical and commercial (ATC) losses. A large share of demand will come from tier-2 cities and rural areas. According to industry stakeholders, other states apart from Gujarat, such as Maharashtra, Kerala, Uttar Pradesh and Madhya Pradesh, will also add significant rooftop solar capacity in the residential segment. Community solar adoption in India will increase as states levy regulatory acceptance to models such as group net metering (GNM) and virtual net metering (VNM).

The growth of the decentralised energy market in India (of which rooftop solar is a crucial component) will be critical to unlocking energy independence and ensuring energy security. With 8-10GW annual installations targeted under PMSGY, it will contribute immensely to India reaching its overall renewable energy target of 500GW by 2030.



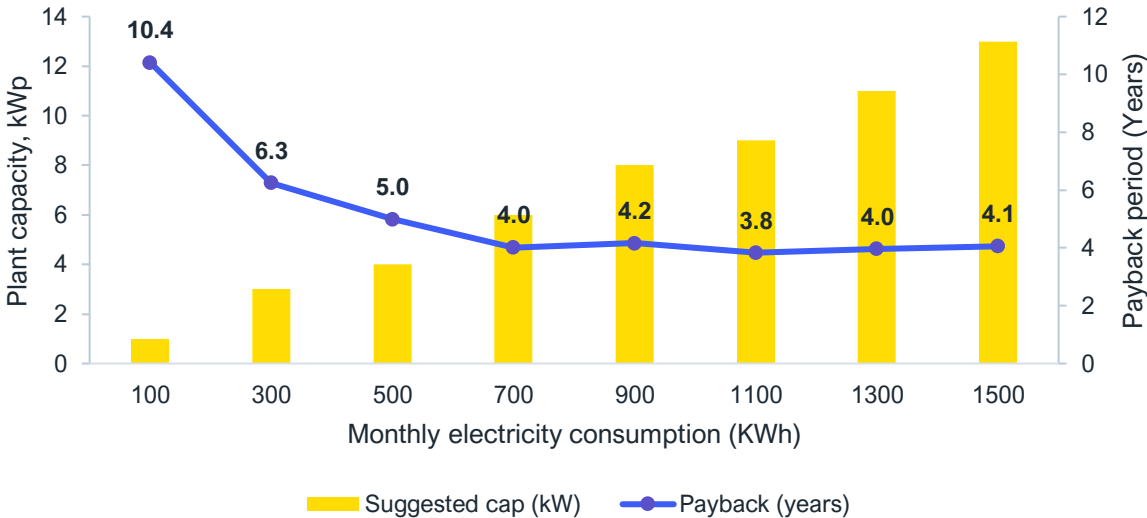
# Introduction

The rooftop solar market in India is divided into residential, commercial and industrial (C&I) and government segments. As of March 2024, the installed capacity of rooftop solar is almost 11.9 gigawatts (GW), with C&I accounting for about 60%.<sup>4</sup>

The residential rooftop solar market in India is seen as a promising area for growth, although it has not reached its full potential. This is primarily due to a lack of awareness and local authorities' inability to bridge the information gap between the government and end consumers. Other key contributing reasons are high upfront costs, lack of financing options and concerns regarding upkeep and maintenance of solar systems.

The Government of India's (Gol's) Grid-connected Rooftop Solar Programme (GRSP) has been crucial in promoting residential rooftop solar systems. However, the subsidy amounts were deemed inadequate for small- to medium-scale households with electricity consumption of less than 300 units, which make up more than 80% of households in India. Lesser unit consumption translates to lesser cost savings when those units are replaced by solar. Even after subsidies, the payback period of small systems (below 2 kilowatt-peak (kWp)) generally exceeds six years. A 2022 report by IEEFA and JMK Research discussed the evolution of India's residential rooftop solar policy landscape in detail.<sup>5</sup> This report focuses on the policy developments since 2022, especially Pradhan Mantri Surya Ghar Yojana (PMSGY) and its impact.

**Figure 1: Solar payback periods for residential consumers by electricity consumption**



Source: JMK Research. Note: Project benchmark cost assumed to be Rs50,000 per kWp until 2kWp and Rs45,000 beyond that.

<sup>4</sup> Ministry of New and Renewable Energy (MNRE). [State-wise installed capacity of Renewable Power as on 31.03.2024](#). March 2024.  
<sup>5</sup> IEEFA and JMK Research. [Indian Residential Rooftops: A Vast Trove of Solar Energy Potential](#). October 2022.

The latest revamp of the subsidy structure, PMSGY, operational from February 2024, has increased the subsidies within a system capacity of 3kWp.<sup>6</sup> This aims to decrease the payback period and increase the adoption of residential rooftop solar systems for small- to medium-scale electricity consumers. PMSGY has also increased the overall residential rooftop solar target from 4GW to 30GW by March 2027.

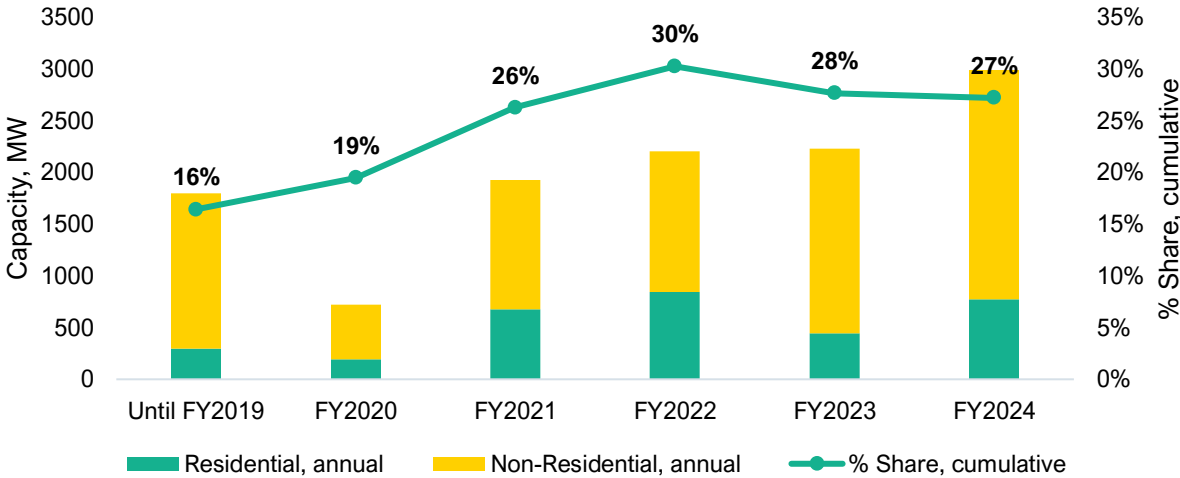
With increased capital subsidy under PMSGY and other factors such as decreasing solar module costs and improved consumer awareness and understanding of rooftop solar technology, the outlook for India’s residential rooftop solar market looks highly promising. The surge in consumer interest is supported by improved financing availability and enabling regulatory and implementation support from state regulators. Almost every state in India provides net metering to residential customers installing rooftop solar systems.

Since 2022, there has been a noticeable increase in market commoditisation, and several brands, such as Tata, Havells, Luminous, Livguard and Oswal, have introduced customised residential kits for swift project installation.

### Installation Trends

As of March 2024, residential electricity consumers in India have collectively installed 3.2GW of rooftop solar capacity, representing about 27% of the country’s total rooftop solar installations. From fiscal year (FY) 2020 to FY2024, annual residential rooftop solar installations increased fourfold from 195 megawatts (MW) to 775MW, with a compound annual growth rate (CAGR) of 31.7%.

Figure 2: Share of residential in rooftop solar, annual trend



Sources: MNRE, JMK Research

<sup>6</sup> MNRE. Guidelines for PM-Surya Ghar: Muft Bijli Yojana. June 2024. Page 5.

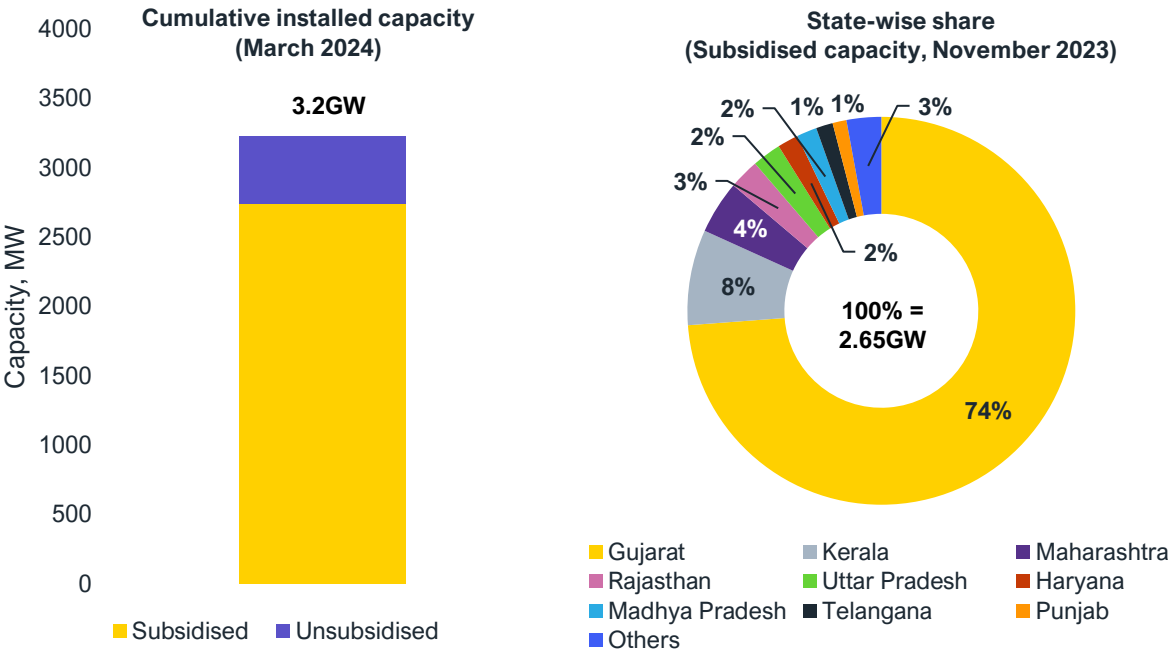
The rooftop solar market is gradually shifting towards residential. The residential sector’s cumulative share of total rooftop solar installations increased from 16% in FY2019 to about 27% in FY2024. After peaking at 30% in FY2022, the growth of the residential rooftop solar market experienced a temporary slowdown over the next two years due to supply chain constraints and the implementation of basic customs duty (BCD).

There is enhanced consumer awareness, and the regulators have understood that the growth of residential rooftop solar benefits all market stakeholders involved. There is a significant potential for cost savings for end consumers as well as for state electricity distribution companies (DISCOMs), which can reduce their cross-subsidisation and technical and commercial losses. The launch of the PMSGY scheme in February 2024 is expected to further boost the share of residential installations in the rooftop solar market.

### State Trends

Gujarat accounts for almost three-quarters of India’s residential rooftop solar market capacity. The state government’s proactiveness in setting up the ecosystem, starting from raising ground-level awareness, digitising the entire application process, and helping consumers finance their solar systems, has made it the outright leader of the residential rooftop solar market. The other top five states are Kerala, Maharashtra, Rajasthan and Uttar Pradesh.

Figure 3: State share of residential rooftop solar capacity



Sources: MNRE, Industry Interactions, JMK Research

Since 2020, several other states, such as Kerala and Maharashtra, have tried to emulate Gujarat's residential rooftop solar success story. The Kerala government has actively worked to remove roadblocks for residential consumers to adopt rooftop solar under its Soura scheme. Under the scheme, Kerala has proposed DISCOM-centric business models, wherein the residential rooftop solar systems are either entirely or partially owned by the local DISCOM.

According to industry stakeholders, several other states, such as Uttar Pradesh, Madhya Pradesh, Kerala and Maharashtra, will also add significant rooftop solar capacity in the residential segment. With the advent of PMSGY, market demand has become pan-India, with even northeast states such as Assam registering a high influx of residential rooftop solar applications.

With subsidy support and a maximum payback period of five years, there is a residential rooftop solar potential of 32GW in India.<sup>7</sup> Maharashtra is the leading state in residential rooftop solar market potential, primarily due to having the highest domestic electricity tariff of all states.

## Residential Rooftop Solar Market Segmentation

A detailed market segmentation analysis of residential rooftop solar in terms of location (tier-1/urban vs tier-2,3/rural), project sizes, grid connectivity (on-grid vs off-grid) and financial support (subsidised vs unsubsidised) is imperative for effective policy design.

Most residential rooftop solar systems in India are 3-5kWp, grid-connected, in urban areas and avail central or state subsidies. However, there are regional differences due to state-specific dynamics. For example, the average project size and share of unsubsidised residential rooftop solar systems in Maharashtra is higher than in Gujarat.

Due to lower grid reliability, off-grid rooftop systems, frequently paired with small lead-acid battery energy storage systems (BESS), are more prevalent in rural regions. According to industry stakeholders, Solar + BESS systems account for 20-25% of India's residential rooftop solar capacity. The market segmentation of Gujarat, the leading state for residential rooftop solar, is analysed, followed by examining trends in the country's overall residential rooftop solar landscape.

## Gujarat Residential Rooftop Solar Segmentation

Table 1 shows the residential rooftop solar market segmentation parameters for Gujarat. With residential systems contributing almost 70% of the total solar capacity, Gujarat is an anomaly among Indian states. Most residential rooftop solar installations there are subsidised and located in urban areas. The average project ticket size is below 4kWp.

<sup>7</sup> CEEW. [India Has 637 GW of Residential Rooftop Solar Energy Potential: CEEW Report](#). November 2023.

**Table 1: Segment-wise distribution of residential rooftop solar in Gujarat**

Installed rooftop solar capacity (July 2024)	Sector Split	Location (residential)	Average project ticket size (residential)	Share of subsidised systems
4,027MW	Residential: 70% C&I: 26% Others: 4%	Urban: 76% Rural: 24%	3.96kWp	88%

Sources: State authorities, JMK Research

## Rise in Market Share of Tier-2/3 Cities and Rural Regions

As evident from the distribution of rooftop solar in Gujarat, most residential rooftop solar systems in India are in tier-1 urban cities. However, with improved awareness arising from PMSGY, higher rooftop space availability in non-metropolitan areas, and enhanced access to viable financing options, market demand will be evenly spread across tier-1 urban areas and tier-2,3/rural regions. The average project size is likely to drop below 3kWp since homes in rural areas have lower power requirements, leading to smaller rooftop solar plant capacity.

## Growth of Unsubsidised Residential Rooftop Solar Systems

According to market stakeholders, 15-20% of residential rooftop solar systems in India are unsubsidised. Until domestic cell manufacturing capacity catches up with module manufacturing, domestically produced content requirement (DCR) modules will remain substantially expensive vis-à-vis non-DCR (50-60% higher) and hard to source for the residential rooftop solar sector.

Consequently, in the near term, for the residential consumers opting for larger rooftop solar systems (>10kWp), the cost-benefit analysis will favour non-DCR unsubsidised routes (e.g. the price differential of about Rs7/Wp between DCR and non-DCR modules offsets the maximum central financial assistance (CFA) of Rs78,000 (US\$928) under PMSGY for a project capacity above 11kWp). Furthermore, consumers opting for unsubsidised systems are likelier to choose high-end products, such as high-wattage bifacial, n-type, tunnel oxide passivated contact (TOPCon) modules, and advanced solar microinverters.

## Regulatory Developments in Residential Rooftop

The Gol introduced the first incentive for residential rooftop solar in March 2016 under Phase-I of the GRSP. Phase-II, launched in February 2019, set a separate target, along with an updated CFA structure, for residential rooftop solar at 4GW by 2022.

Since 2022, the Gol has introduced two significant initiatives for the sector. The National Portal for Rooftop Solar (NPRS), launched in July 2022, offers residential consumers interested in solar

projects a streamlined digital experience through a central online interface. PMSGY, launched in February 2024, has integrated with NPRS and aims to install more than 30GW of residential rooftop solar systems in India by March 2027.

**Table 2: Timeline of landmark residential rooftop solar initiatives**

Title	Issuance Date	Status/Impact	Risks/Challenges
<b>GRSP, Phase-I</b>	March 2016	This scheme introduced the first-ever pan-India incentive for setting up rooftop solar projects.	Lack of awareness and government push impeded the uptake of residential rooftop solar, which was ultimately overshadowed by Phase-II of GRSP.
<b>GRSP, Phase-II</b>	February 2019	Fell short of the 4GW target by 2022, with only 2.65GW installations to December 2023. <sup>8</sup> MNRE revised the CFA under this scheme thrice, most recently in January 2024.	There was a lack of standardised and digitised information, weak financing support and delays in setting up projects through tenders and vendor empanelment.
<b>NPRS</b>	July 2022	The application process has been simplified. The previous methodology of setting up capacity through vendor empanelment tenders was abolished.	DISCOMs' involvement in feasibility approval, inspection and subsidy disbursement is still delaying projects.
<b>PMSGY</b>	February 2024	Since the scheme's launch, residential rooftop solar applications have increased manifold.	Mandatory use of DCR modules may lead to a supply crunch and the risk of slow uptake in states with cheap, subsidised electricity.

Sources: MNRE, JMK Research

## Pradhan Mantri Surya Ghar Yojana (PMSGY)

Issued in February 2024, PMSGY is the most detailed, meticulous and thought-out regulatory intervention for the residential rooftop solar sector. It sets an ambitious target to install rooftop solar on 10 million households with a cumulative installed capacity of 30GW by 2027 by March 2027.<sup>9</sup> Other prior central rooftop solar schemes, such as the GRSP, fall under PMSGY.

<sup>8</sup> PIB. [2.65 GW of Rooftop Solar capacity installed in the residential sector](#). December 2023.

<sup>9</sup> PIB. [Cabinet approves PM-Surya Ghar: Muft Bijli Yojana for installing rooftop solar in One Crore households](#). February 2024.

**Table 3: Salient features of PMSGY**

Parameter	Details
<b>Scheme Targets</b>	Number of households: 1 crore (10 million) Capacity: 30GW Solar electricity generation: 1,000 billion kilowatt-hours (kWh) CO <sub>2</sub> abatement: 730 million tonnes Job creation: 17 lakh (1.7 million)
<b>Issuance</b>	February 2024
<b>Implementation Period</b>	Until March 2027
<b>Eligibility</b>	Grid-connected residential (rooftop/building integrated photovoltaics/group or VNM)
<b>Outlay</b>	Rs75,021 crores (US\$8.97 billion) Of this, central financial assistance (CFA) to residential consumers: Rs65,700 crores (US\$7.86 billion)
<b>Implementing Agency</b>	National Programme Implementation Agency (NPIA): REC Limited State Programme Implementation Agency (SPIA): State DISCOMs/state energy departments
<b>CFA structure</b>	<b>Individual Homes</b> Up to 2kWp: 60% of the benchmark cost 2-3kWp: 40% of the benchmark cost <b>Group Housing Societies</b> Up to 500kWp: 40% of the benchmark cost
<b>Benchmark cost</b>	Up to 2kWp: Rs50,000 (US\$595) (Rs55,000 (US\$654) for special category states including Uttarakhand, Himachal Pradesh, Ladakh, Jammu and Kashmir, Northeast) 2-3kWp: Rs45,000 (US\$535) (Rs49,500 (US\$589) for special category states)

Source: MNRE

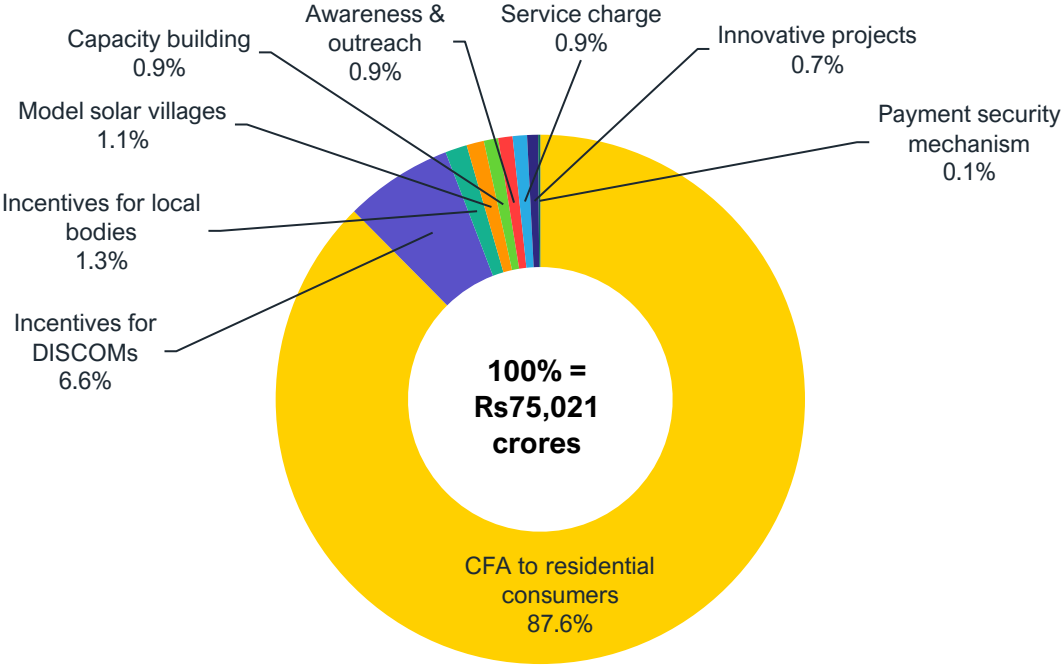
For a residential consumer, the CFA structure adopted for the scheme only provides subsidies for solar project capacities up to 3kWp. The MNRE has also extended CFA to group housing societies with an upper limit of 500kWp on project capacity. With the benchmark costs, the CFA at 3kWp capacity will be Rs78,000 (US\$928) (equivalent to Rs26,000 (US\$ 309)/kWp). The government has integrated PMSGY with the NPRS to streamline the application process and enable swift subsidy disbursement.<sup>10</sup>

The majority (about 88%) of the scheme outlay of Rs75,021 crore (US\$8.97 billion) is assigned as direct CFA to residential consumers. About 8% of the outlay is designated to incentivise local bodies such as urban local bodies, gram panchayats and state DISCOMs to support the adoption of rooftop solar by residential consumers. The rest of the outlay is divided between enhancing awareness,

<sup>10</sup> MNRE. [Guidelines for PM-Surya Ghar: Muft Bijli Yojana](#). June 2024. Page 7.

capacity building, developing model solar villages, developing innovative projects and a payment security mechanism (PSM). Since the launch, the MNRE has issued guidelines for each component.

**Figure 4: PMSGY component-wise financial outlay**



Source: MNRE

The PSM is specifically for renewable energy services company (RESCO) and utility-led aggregation (ULA) business models. According to its draft guidelines issued in September 2024, a Rs100 crore (US\$12 million) fund will be set up to cover non-payment risks by residential consumers to RESCO players or utilities.<sup>11</sup> To participate, RESCO players must contribute a one-time fee of Rs2,000 (US\$24) per installation to the PSM.

To empower residential consumers in choosing rooftop solar vendors, the MNRE also issued a comprehensive vendor rating programme in July 2024 under PMSGY.<sup>12</sup> Vendors will be rated based on the number of installations, consumer feedback on quality and service, inspection, and techno-financial assessment.

The MoP also issued guidelines to accelerate the seamless implementation of PMSGY, such as state DISCOMs maintaining a minimum stock of 100 net meters, digitising their processes, prioritising the

<sup>11</sup> MNRE. [Draft guidelines for implementation of the “Payment Security Mechanism” and “Central Financial Assistance” component for RESCO/Utility led aggregation model.](#) September 2024.

<sup>12</sup> MNRE. [Framework for vendor rating programme.](#) July 2024.



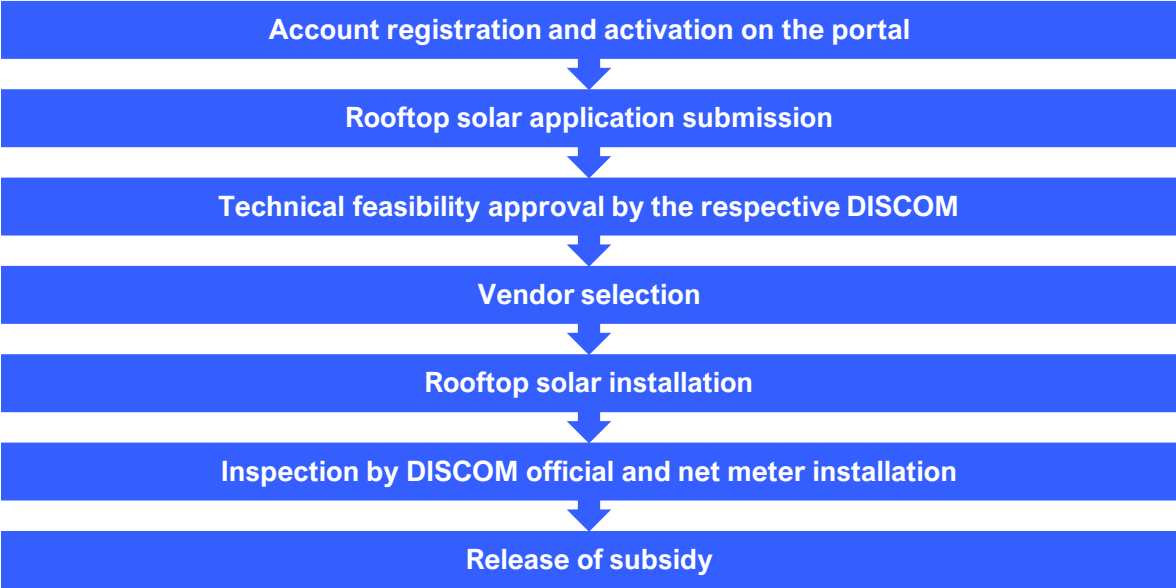
installation of smart meters, and automatically providing enhancement of the sanctioned load for residential consumers up to 10 kilowatts (kW).<sup>13</sup>

Until FY2027, PMSGY will be India’s overarching scheme for all rooftop solar development. Although the scheme also encourages C&I consumers and government buildings to embrace rooftop solar, the lack of financial incentives and support infrastructure, such as the national portal, could impede their rooftop solar adoption.

### National Portal for Rooftop Solar

The Gol launched the NPRS on 30 July 2022, aiming to simplify and digitise the residential rooftop solar application process. The online portal integrates application submission, feasibility approval, vendor selection, plant inspection, and subsidy disbursal, allowing all stakeholders to track and assess the process. The NPRS was facilitating the GCRP until February 2024. Since then, with the launch of PMSGY, NPRS has become its primary consumer-facing implementing interface.

**Figure 5: NPRS residential rooftop solar process flowchart**

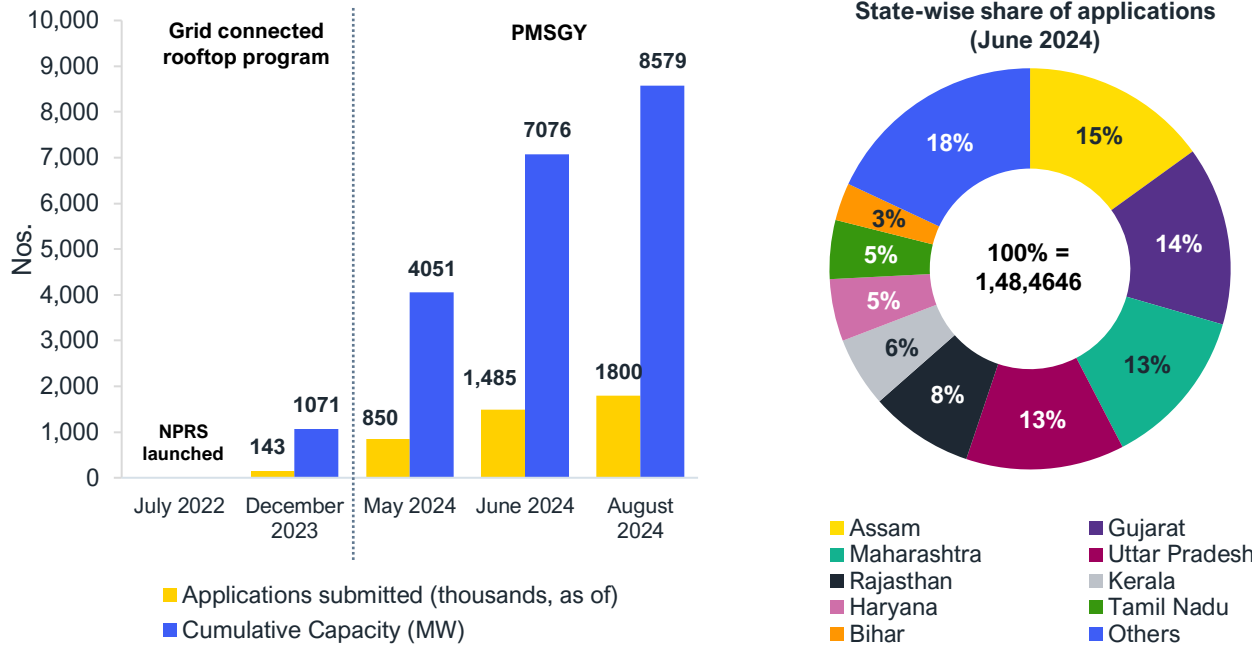


Source: MNRE

In its initial 18 months, the portal received only about 1.43 lakh (143,000) applications from December 2023.<sup>14</sup> However, since the launch of PMSGY, the number of applications on NPRS has surged to about 18 lakh (1.8 million) in the six months to August 2024.

<sup>13</sup> MoP. PM Surya Ghar: Muft Bijlee Yojana. September 2024. Pages 1-2.  
<sup>14</sup> MNRE. National Conclave on Rooftop Solar: Presentation by NIC. December 2023. Page 12.

**Figure 6: Residential rooftop solar applications growth trend on NPRS**



Source: MNRE. Note: State-wise split of the number of applications is available only until June 2024.

Based on the active applications, Assam, Gujarat, Maharashtra, Uttar Pradesh and Rajasthan are the five leading states on the NPRS portal. Assam’s residential rooftop solar push is primarily driven by the state government’s aim to establish the state as a future green energy hub. Despite 2.2 lakh (220,000) applications on the portal from Assam-based consumers, there are just 83 registered vendors in the state. This needs to be higher, especially in comparison with other leading states, such as Gujarat (1,076) and Maharashtra (1,191), which will affect project installations in the near term.

In the two years since its inception, NPRS’s impact on market stakeholders has largely been positive. Residential consumers have commended its user-friendliness and ease of selection of vendors. Engineering procurement construction (EPC) players’ working capital situation has improved since they no longer must avail subsidies on behalf of the consumers, and regulators have a central unified portal to assess and monitor the sector’s growth.

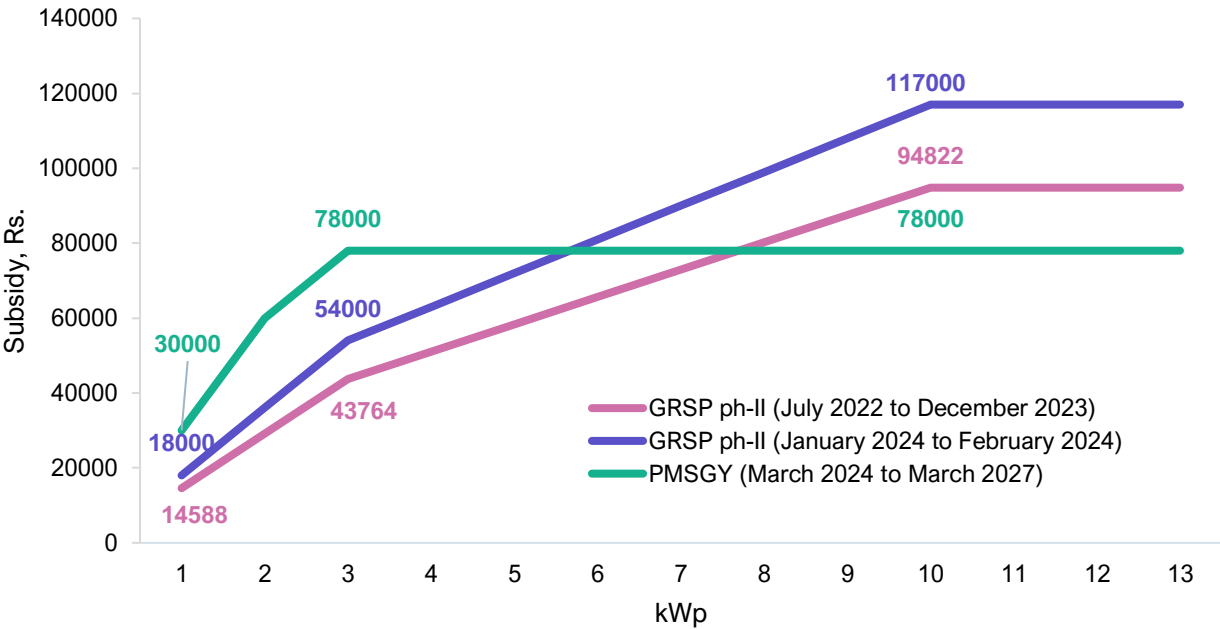
However, some aspects have hindered the widespread adoption of NPRS, particularly in the stages where DISCOMs are heavily involved, such as feasibility approval, vendor onboarding and project inspection after commissioning. Furthermore, since the introduction of PMSGY, the sudden increase

in applications has indirectly caused technical issues on NPRS, inadvertently leading to delays in subsidy disbursement in some states.<sup>15</sup>

### Analysis of Central and State Subsidy Structures

Financial incentives offered through subsidies are a dual enabler to increase rooftop solar uptake and a tool to raise awareness. After February 2024, PMSGY subsumed the erstwhile GRSP to become the primary subsidy disbursal scheme by the Gol for the sector. Consumers can save up to 46% of their capital investment (including GST) in a residential rooftop solar installation utilising the subsidies under PMSGY.

Figure 7: Evolution of central subsidies for residential rooftop solar installations in India



Source: MNRE. Note: All values shown are based on the latest benchmark costs.

Compared with previous subsidy structures (GRSP Phase-II), the Gol has substantially increased the CFA for small project capacities under PMSGY. For a 3kWp project, PMSGY offers a CFA of Rs78,000 (US\$928), about 44% higher than GRSP Phase-II. However, for larger project capacities of 10kWp or more, GRSP Phase-II provided higher CFA.

Several states and union territories, such as Uttar Pradesh, Assam, Delhi and Ladakh, provide subsidy schemes for residential rooftop solar installations. These are offered in addition to CFA.

<sup>15</sup> The Times of India. [After installing solar plants atop houses, consumers struggle to get govt subsidies.](#) June 2024.

However, the GoI advocates for a unified scheme to be operated from a common portal, which is likely to reduce the number of states offering separate subsidies.

## Regulatory Initiatives in States

Several Indian states have mandated the installation of rooftop solar plants for residential consumers, especially for new homes above a minimum threshold in terms of plot sizes or monthly electricity consumption. For example:

- In Haryana, it is mandatory for residential homes on plots above 500 square yards to install rooftop solar. Other states and union territories that have issued similar mandates include West Bengal, Maharashtra, Chhattisgarh, Delhi and Chandigarh.
- The Delhi Solar Energy Policy 2023, formally notified in March 2024, is one of the most progressive state policies for residential rooftop solar development.<sup>16</sup> It has integrated several policy designs and benefits, such as generation-based incentives (GBI), state subsidies (over and above PMSGY) and hybrid RESCO, to enhance the attractiveness of residential rooftop solar. GBI, combined with net metering, can enable consumers to earn extra income (up to Rs700-900 (US\$8-10) for a 2kWp system) from their rooftop solar projects. Hybrid RESCO, introduced as a novel business model under the scheme, enables a solar developer to lease consumer rooftops and sell the power directly to DISCOM under a power purchase agreement (PPA), thereby alleviating the credit risk involved in a traditional residential RESCO business model.

**Table 4: Residential rooftop solar initiatives under the Delhi Solar Energy Policy 2023**

Parameter	Details
<b>Rooftop Target</b>	750MW by March 2027 (up from 250MW in March 2024)
<b>State subsidy</b>	Rs2,000 (US\$24)/kW, up to Rs10,000 (US\$119) per consumer
<b>Net Metering</b>	Yes
<b>Business models supported</b>	Net metering, group net metering, community Solar, virtual net metering, peer-to-peer trading, RESCO, Hybrid RESCO
<b>GBI (for first 200MW)</b>	Rs3 (US\$3.6)/kWh (up to 3kWp), Rs2 (US\$2.4)/kWh (3-10kWp)
<b>Other features</b>	Exemption of taxes and duties on electricity generated from rooftop solar

Source: Delhi Department of Power

<sup>16</sup> Delhi Department of Power. [Delhi Solar Energy Policy 2023](#). March 2024.

- The Kerala government provides a discount of 4% on the interest of bank loans for residential rooftop solar systems.<sup>17</sup> These incentives and the state's focus on enhancing awareness have helped Kerala become one of the fastest-growing states for residential rooftop solar.

## Others

**Feasibility waiver-off:** For years, the Gol has been trying to ease and streamline the application process for residential rooftop solar development. In February 2024, the MoP notified that technical feasibility approval from state DISCOMs would not be required for rooftop systems up to 10kW capacity.<sup>18</sup> Since then, some 19 states/union territories have adopted this mandate, including Gujarat, Karnataka, Assam, Madhya Pradesh, Maharashtra and Tamil Nadu. However, Maharashtra and Tamil Nadu have tweaked the minimum feasibility limit, setting it at 3kWp instead.

**Solar City Programme:** MNRE has requested each state/union territory to select one city to be developed as a solar city. A solar city is envisioned to source all its electricity from solar through a combination of residential/C&I rooftop solar, open access, solar street lighting systems and adoption of energy-efficient devices. As of September 2024, 27 states/union territories had identified solar cities.<sup>19</sup> Some of the declared solar cities where the state government has taken active steps to initiate solarisation include Sanchi (Madhya Pradesh), Thiruvananthapuram (Kerala), Chandigarh and Ayodhya (Uttar Pradesh). Uttar Pradesh has gone a step further to launch a solar city programme of its own, under which the state government will develop 17 additional solar cities.

**Emerging metering mechanisms:** To circumvent the space limitations of onsite solar, group net metering (GNM), virtual net metering (VNM) and peer-to-peer (P2P) trading are emerging as innovative metering frameworks to implement the community solar business model in India.

GNM and VNM enable a solar plant to be set up in a centralised location and feed several service locations of a single consumer or multiple consumers. In February 2023, MNRE issued detailed guidelines to facilitate states' adoption of GNM and VNM as part of their solar and net metering policies.<sup>20</sup> Since then, 10 states have adopted either GNM, VNM, or both as part of their regulations.

P2P trading enables seamless connectivity and transaction of electrical energy between solar rooftops within a DISCOM jurisdiction. Accounting is generally done through blockchain technology, providing transparency and resilience to the entire infrastructure. Three states (Uttar Pradesh, Karnataka and Delhi) have adopted P2P trading as part of their state regulations. P2P trading frameworks in Uttar Pradesh and Delhi were adopted after extensive and detailed pilot project case

<sup>17</sup> The Hindu. [State-run Anert launches ambitious project to make Kerala capital largest solar city in India](#). May 2023.

<sup>18</sup> PIB. [Government amends Electricity \(Rights of Consumers\) Rules: amended Rules will further empower consumers, says Union Power and New & Renewable Energy Minister](#). February 2024.

<sup>19</sup> PIB. [MNRE has asked each State/UT to develop at least one Solar City – Union Power & NRE Minister Shri R. K. Singh](#). March 2023.

<sup>20</sup> MNRE. [Guiding/Helping Standard Operating Procedure \(SOP\) for Implementation of VNM and GNM Mechanism](#). February 2023.

studies undertaken by Uttar Pradesh Power Corporation Limited (UPPCL) and Tata Power Delhi Distribution Limited (TPDDL), respectively.<sup>21</sup>

## Risks and Challenges

Attaining the 30GW target under PMSGY will require a concurrent effort from all stakeholders to address the challenges that previously hindered rooftop solar development in India. These include a lack of consumer awareness, inconsistency of net metering policies across states, delays in approvals and subsidy disbursements, and a dearth of attractive financing options.

### Implementation Risks in PMSGY

According to the Expenditure Budget document for FY2025, the GoI has allocated Rs6,250 crore (US\$744 million) for PMSGY.<sup>22</sup> Considering the overall scheme outlay of Rs75,021 crores (US\$8.9 billion), this is just 8.3% of the total scheme expenditure, underwhelming for the first year of a three-year programme.

In addition to the overarching project implementation issues mentioned in the introduction of the Risks and Challenges section of the document, certain risk factors specific to PMSGY can impede residential rooftop solar adoption.

**Table 5: Implementation risks in PMSGY**

Risk	Description
<b>Availability of DCR modules</b>	PMSGY mandates the usage of DCR modules (wherein both the PV cells and modules are domestically manufactured) in solar installations. However, the PV cell manufacturing capacity in India is just over 8GW, far less than the annual solar demand. Hence, there will likely be a shortage in the supply of DCR modules, especially in the price-sensitive residential rooftop solar segment.
<b>Installation of subpar PV systems</b>	There are no consumer-centric provisions in PMSGY to ensure project quality throughout its lifecycle, which ideally should be at least 20 years. With the scheme's focus on project capacity, subpar systems are likely to be installed. On average, about 10% of the project cost must be spent on design. However, insufficient impetus is generally given to project design in residential rooftop solar, leading to poorly designed systems lacking structural integrity.
<b>Lacklustre adoption by the targeted consumers</b>	The PMSGY aims to increase renewable energy adoption among low- and middle-income electricity consumers with a monthly consumption of 200-250 units. However, due to the complexity of adopting new technology and the financing needs, the initial adopters will likely be the creditworthy, wealthier consumers. This is further verified by

<sup>21</sup> India Smart Grid Forum (ISGF). [Peer-2-Peer \(P2P\) trading of green energy on blockchain platforms](#). October 2023.

<sup>22</sup> MNRE. [Expenditure budget document FY2024-25](#). July 2024.

systems installers who say that the average system size in the applications received on the NPRS under PMSGY is 4-5kWp. Another factor hindering rooftop solar adoption for small consumers is the availability of highly subsidised (or even free) electricity in some states below a set limit of electricity consumption.

**No financial support for alternative business models**

Under PMSGY, there is no direct financial support for emerging yet critical residential market segments of RESCO and solar with BESS. The financial incentives must be distributed to all market segments for more holistic sector development, backed by their long-term importance and growth potential.

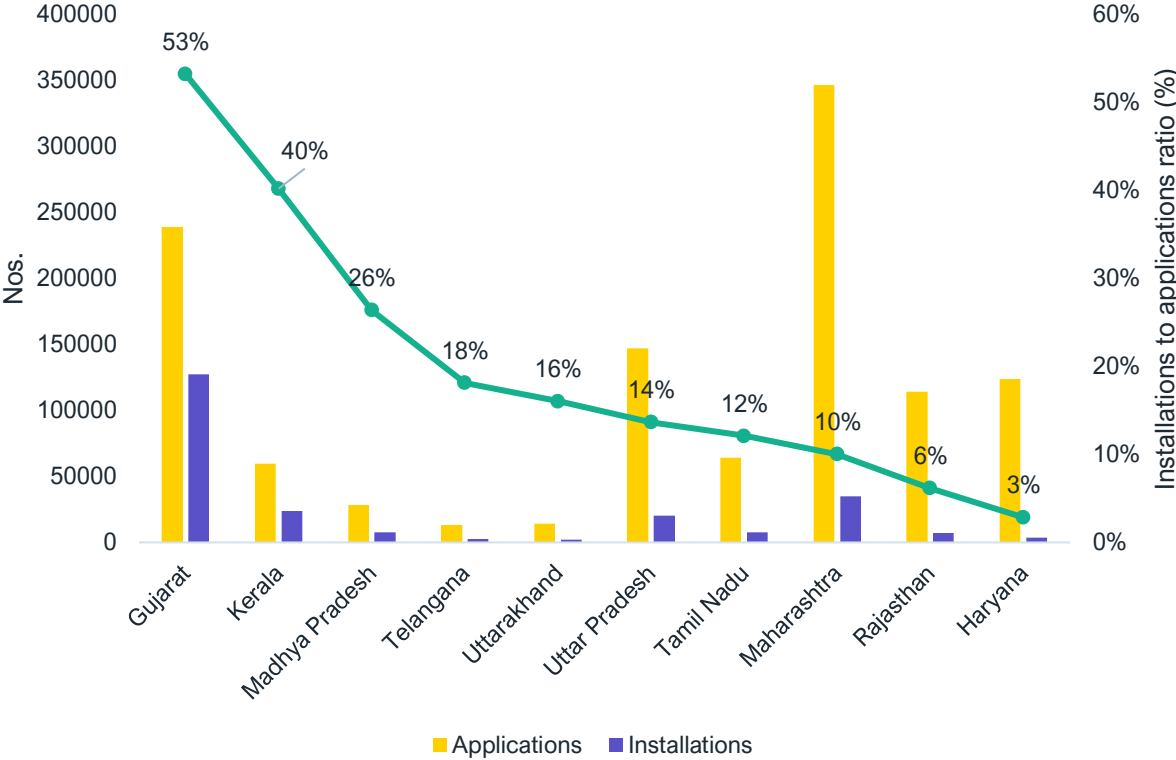
*Source: JMK Research*

## Subsidy Disbursal Issues

Subsidy disbursal delay is a significant setback, leading to cash flow disruption, which strains consumer-vendor relationships and diminishes stakeholders' confidence in the programme. There are two key reasons for its occurrence:

- **Delayed approvals:** The delays happen at two stages: technical feasibility approval from local DISCOMs after application submission and inspection after project commissioning. Sometimes, even after a successful inspection and net meter installation, the DISCOM fails to accord commissioning states to projects, leading to unnecessary delays in final subsidy disbursal. The GoI is pushing to remove the DISCOM approval requirement, at least from the feasibility stage. The installation-to-application ratio in all states (except Gujarat) is less than half, underlining procedural process delays.

Figure 8: Installations to applications ratio across states under PMSGY



Sources: MNRE, JMK Research

The National Payments Corporation of India (NPCI) is working on a payment system to reduce the lead time for subsidy disbursement claims.<sup>23</sup> The NPCI aims to remove the cheque and bank account matching requirement and establish bank-end integration, which can potentially reduce the subsidy claims clearing time from one month to just a week.

- **NPRS portal technical issues:** Consumers and vendors from several states, including Telangana,<sup>24</sup> Goa<sup>25</sup> and Rajasthan, have cited technical glitches and other issues with the portal. These range from faulty OTP authentication for consumer/vendor login to the inability to apply for new systems, inconsistencies in financing options information on the NPRS and Jan Samarth portal, and the inability to track project status. These problems are causing negative publicity for the scheme in certain states, posing a risk to the overall development and adoption of PMSGY.

<sup>23</sup> Economic Times. [PM Surya Ghar subsidy claims may move in fast lane](#). September 2024.  
<sup>24</sup> The Hindu. [PM Surya Ghar fails to illuminate Telangana households due to portal glitches](#). June 2024.  
<sup>25</sup> The Times of India. [After installing solar plants atop houses, consumers struggle to get govt subsidy](#). June 2024.



## Imposition of Additional Charges on Rooftop Solar Installations

In 2021, Tamil Nadu levied a network charge for all energy prosumers in the state. For residential solar systems up to 10kW, the state commission provided an 80% discount on specified network charges and 25% for larger systems.<sup>26</sup> State prosumers consider the imposition of network charges a deterrent to the growth of the nascent residential rooftop solar market, especially when they are already paying fixed demand charges. Removal of network charges can reduce the payback period of residential rooftop solar installations by 10-20% in Tamil Nadu.<sup>27</sup>

Other states, such as Andhra Pradesh and Haryana, impose an extra grid support charge on open-access and rooftop solar prosumers. DISCOMs from states such as Madhya Pradesh, Telangana, Karnataka, and Maharashtra have requested that their state governments apply grid support charges on rooftop solar installations. However, the state commissions have denied their applications. Specifically for Maharashtra, the state commission stated that no additional charge would be imposed until the cumulative rooftop capacity in the state exceeds 5GW.<sup>28</sup>

## Other Market Barriers

In addition to the challenges discussed, Table 6 outlines other relatively minor yet important risks and challenges to the uptake of residential rooftop solar, such as the unavailability of net meters, weak grid infrastructure and under-equipped DISCOM personnel.

**Table 6: Other risks and challenges for the development of residential rooftop solar**

Risk/Challenge	Description
<b>Net meter availability</b>	Even before the launch of PMSGY, the shortage of available net meters and their installation by respective service providers was a major source of delay, taking more than a month. There is a risk of the situation getting worse, considering the exponential rise in rooftop solar applications under PMSGY.
<b>Weak grid infrastructure</b>	Most of India's population still lives in rural areas with weaker grid infrastructure, having scheduled and unscheduled power cuts ranging from 2-12 hours. <sup>29</sup> Until distributed energy storage becomes viable, the uptake of rooftop solar in such areas will be indirectly constrained by their respective grid strength.
<b>Vendor specific challenges</b>	Despite more than 6,500 eligible vendors registered on the NPRS, financiers and commercial banks tend to favour only a few national-level EPC entities. This bias creates

<sup>26</sup> TANGEDCO. [Salient features/Guidelines for the Hon'ble TNERC's Generic Tariff Order for Grid Interactive PV Solar Energy Generating System \(GISS\)](#). October 2021. Page 16.

<sup>27</sup> Auroville Consulting. [Briefing Note: Financial attractiveness of Rooftop Solar Energy for Domestic Consumers in Tamil Nadu](#). November 2023. Page 1.

<sup>28</sup> Maharashtra Electricity Regulatory Commission (MERC). [MERC \(Grid Interactive Rooftop Renewable Energy Generating Systems\) \(First Amendment\) Regulations, 2023](#). November 2023. Page 23.

<sup>29</sup> Bloomberg. [Long Blackouts Hit India as Heatwave Stokes Power Use](#). March 2024.

challenging conditions for small- and mid-sized vendors, even though they have met all eligibility requirements and submitted bank guarantees to register on the portal.

In states with only a few registered vendors and significantly higher residential rooftop solar applications, such as Assam, there is an urgent need to prioritise and expedite the vendor onboarding process.

#### **Under-equipped local officials**

With residential rooftop solar penetration just starting to rise in most states, DISCOMs and their officials are still ill-equipped and unprepared for the intricacies of this emerging technology. This inadvertently leads to approval delays and irregular policy interpretation.

*Source: JMK Research*

## Financing Trends and Industry Partnerships

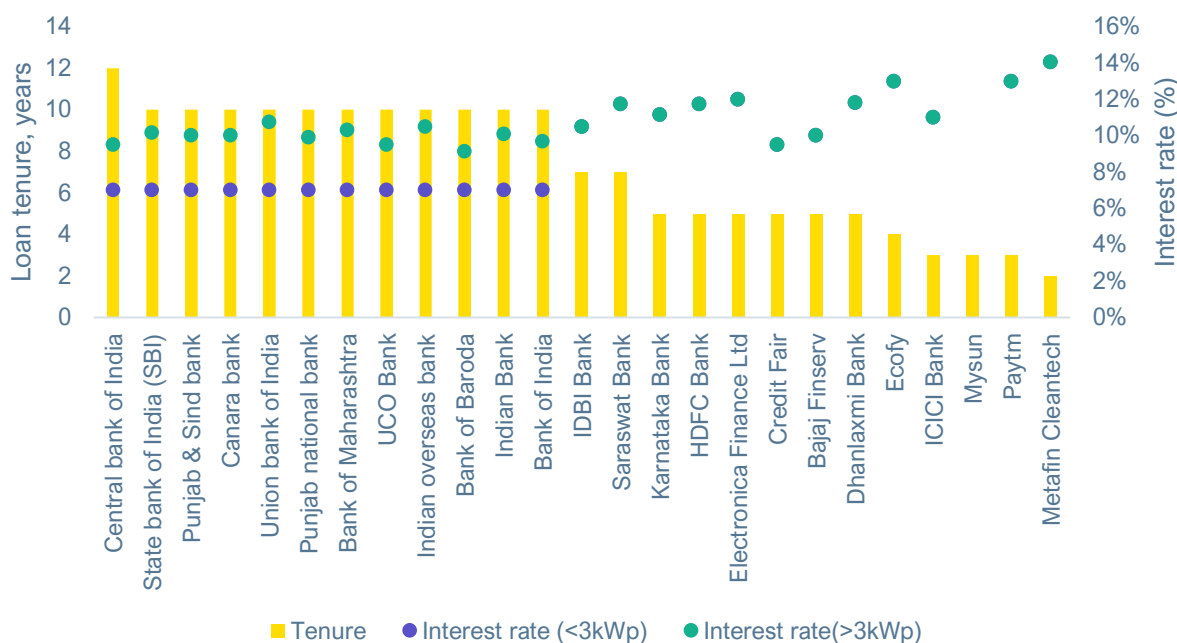
The availability of ample financing options at favourable terms is a critical enabler to unlock the growth of any asset-heavy market sector. However, Indian financiers are generally reluctant to invest in residential rooftop solar, citing small project sizes and a dearth of in-depth understanding of the associated risks.

With the Gol's emphasis on residential rooftop solar and the launch of the ambitious PMSGY scheme in February 2024, market stakeholders – including regulators, investors, financiers, developers and consumers – have substantially increased their focus on this market segment. According to the NPRS, the number of financiers grew from a handful in 2021 to 25 in August 2024.<sup>30</sup>

All leading **public and private sector banks**, including the State Bank of India (SBI), Punjab National Bank, Canara Bank, Bank of Baroda, HDFC Bank and IDBI Bank, have residential rooftop solar loan products. Most banks categorise these loan products as standalone (specifically for solar installations) or composite (solar integrated with consumers' home loans for new buildings). The interest rate is set favourably at just 7% in most schemes to enable wide-scale adoption by small-scale consumers for sub-3kWp systems.

In almost all commercial bank loan schemes, consumers must invest at least 10 to 20% of the project cost. Also, hypothecation of assets is the standard payment security mechanism, wherein the solar project being set up acts as collateral against the loan amount.

<sup>30</sup> MNRE. [Financing options for residential rooftop solar](#), 2024.

**Figure 9: Interest rate and tenure comparison of residential rooftop solar financing schemes**

Source: NPRS, JMK Research. Note: 1. Interest rate upper limit is shown, as specified by the financing entity; 2. Column colour coding: Yellow: Public sector bank; Red: Private sector bank; Orange: non-banking financial company (NBFC) and fintech.

Several **non-banking financial companies (NBFCs) and fintechs** have also entered the residential rooftop solar financing landscape. These include Credit Fair, Ecofy, Paytm, Bajaj Finserv and Electronica Finance Limited. NBFC and fintechs provide a digitised, swift and hassle-free loan application process, making them a popular choice among residential consumers. In addition, the loans are collateral-free and designed so that the monthly savings from solar are at least equal to the equated monthly instalments (EMI). However, these loans offer marginally higher interest rates and lower loan tenures than those from commercial banks.

The loan terms offered under various financing schemes are limited to seven years. This is especially true for NBFCs and FinTechs, which only offer loan terms of up to five years, as the EPC entity provides a project annual maintenance contract (AMC) for only five years. Industry stakeholders emphasise that a minimum loan term of 10 years is essential to ensure positive project cash flow, which is critical for gaining widespread consumer acceptance.

## Industry-wide Stakeholder Partnerships: A One-stop Solution

Several financiers are focusing on industry-wide tie-ups with project-executing entities and equipment suppliers, offering a one-stop solution to rooftop solar consumers. For financiers, this ensures supply chain reliability, enhanced cost dynamics and the ability to tap a broader consumer base by leveraging the skills of multiple entities involved. It results in significantly reduced paperwork for consumers, creating a “win-win” scenario for all stakeholders.

**Table 7: Industry partnerships in residential rooftop solar financing**

Financing entity	Project executing entity/EPC	Does EPC also manufacture photovoltaic (PV) modules?
State Bank of India	Orb Energy	Yes
Union Bank of India	Tata Power	Yes
Indian Bank	Tata Power	Yes
Bank of India	Tata Power	Yes
Ecofy	Tata Power	Yes
	Waaree Energies	
Credit Fair	Tata Power	Yes
	Luminous Power Technologies	
ESAF Bank	V-Guard Industries	Yes

Source: JMK Research

With its pan-India presence and strong distributor network, Tata Power is the dominant project-executing entity in these industry-wide tie-ups. The financiers also prefer Tata Power for its reliability, experience executing rooftop solar installations and strong PV manufacturing base.

To diversify the reach of their financing products, some NBFCs tie up with multiple project-executing entities, such as Ecofy (with Tata Power and Waaree) and Credit Fair (with Tata Power and Luminous Power). In addition, they partner with several localised, small-scale EPC players to generate more project leads.

## Evolution of Concessional Finance for Residential Rooftop Solar

With C&I rooftop solar financing largely attaining maturity, the focus of concessional credit lines has shifted to the riskier market segments of residential and micro, small and medium enterprises (MSMEs). Concessional credit lines, along with suitable credit guarantee schemes to mitigate the contract risks (such as the one issued by the World Bank's subsidiary Multilateral Investment Guarantee Agency (MIGA) in June 2024<sup>31</sup>), will be crucial in kickstarting the development of the residential rooftop solar market.

- In June 2022, the World Bank announced the extension of its rooftop solar concessional credit line by US\$165 million, catering specifically to the residential sector. However, its formal approval by the World Bank board led to an unforeseen delay in its implementation to January 2024.

<sup>31</sup> Multilateral Investment Guarantee Agency (MIGA). [MIGA Supports Innovative Solar Rooftop Systems in India](#). June 2024.

The SBI is the implementing agency for the programme and aims to install more than 450MW of residential rooftop solar systems by March 2027.

- The Asian Development Bank (ADB), which initially launched its concessional credit line of US\$500 million for rooftop solar in 2016, also restructured the programme in 2023 to cater specifically to the residential segment. In July 2024, ADB approved the disbursement of the first tranche of this loan to SBI (US\$90.5 million) and the National Bank for Agriculture and Rural Development (US\$150 million).<sup>32</sup>

## State Attractiveness for Residential Rooftop Solar

The various influencing factors that drive the growth of residential rooftop solar in a state can be categorised as follows:

- **Electricity cost savings/domestic electricity tariff:** A higher electricity retail tariff for domestic consumers in a state will translate to higher cost savings on transitioning to solar.
- **Additional state subsidy:** Only a few states in India offer subsidies above and beyond the CFA, thereby significantly raising the attractiveness of rooftop solar systems for residential consumers.
- **State policy design:** A conducive and proactive state policy design encompassing the various net metering mechanisms, emerging solutions (such as GNM, VNM and P2P trading), favourable surplus injection rates and supportive technical specifications regarding distribution transformer capacity are crucial for overall market growth.
- **Project implementation ecosystem:** A smooth and robust project implementation ecosystem is imperative to increasing the attractiveness of residential rooftop solar. It includes swift approvals from state DISCOMs, availability of net meters, ample state-registered vendors and strong local grid infrastructure.

**Table 8: State-wise attractiveness index for residential rooftop solar**

State	Electricity cost savings	Additional state subsidy	Conducive state policy design	Implementation ecosystem strength
<i>Weightage-&gt;</i>	25%	25%	25%	25%
Uttar Pradesh	Moderate	Yes	High	Moderate
Assam	Moderate	Yes	Moderate	Moderate

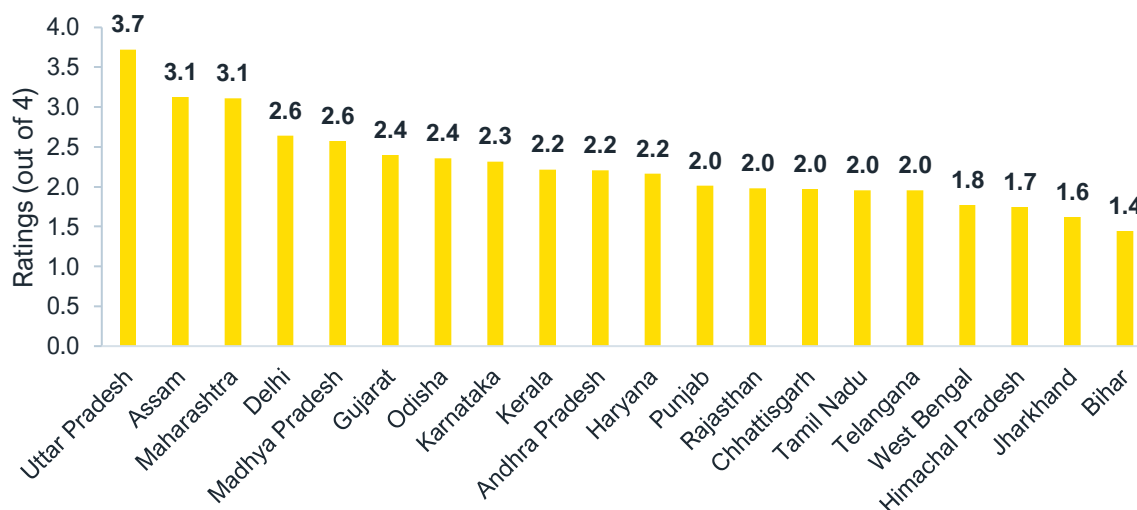
<sup>32</sup> Economic Times. [ADB approves US\\$ 240.5 million loan for rooftop solar systems in India](#). July 2024.

Maharashtra	High	No	High	Moderate
Delhi	Low	Yes	High	Moderate
Madhya Pradesh	Moderate	No	High	Moderate
Gujarat	Low	No	Moderate	High
Odisha	Low	No	Moderate	Moderate
Karnataka	Moderate	No	Moderate	Moderate
Kerala	Moderate	No	Moderate	Moderate
Andhra Pradesh	Moderate	No	High	Moderate
Haryana	Low	No	Moderate	High
Punjab	Moderate	No	Moderate	Moderate
Rajasthan	Moderate	No	Moderate	Moderate
Chhattisgarh	Low	No	High	Moderate
Tamil Nadu	Moderate	No	Moderate	Low
Telangana	Moderate	No	Moderate	Moderate
West Bengal	Moderate	No	Moderate	Moderate
Himachal Pradesh	Low	No	Moderate	Low
Jharkhand	Low	No	High	Low
Bihar	Moderate	No	Moderate	Low

Source: JMK Research. Note: 1. Low -> rating of 0 or 1, Medium -> rating of 2 or 3, High -> rating of 4 or 5; 2. For electricity cost savings, a medium-sized household with monthly consumption of 300-500 units per month is assumed.

Based on the parameters discussed in Table 8, JMK Research analysed 20 states in India in detail and ranked them on the various parameters given above.

Figure 10: State attractiveness overall ratings, decreasing trend



Source: JMK Research

### Key insights from this analysis

- Uttar Pradesh, Assam, Maharashtra, Delhi and Madhya Pradesh are India’s five leading states for residential rooftop solar power. Three of these states (Uttar Pradesh, Assam and Delhi) offer additional state subsidies above and beyond the CFA.
- In some states, grid tariffs and, hence, savings are on the higher side, significantly enhancing the residential rooftop solar attractiveness. For example, Maharashtra has India’s highest domestic electricity tariff for a medium-sized household that consumes 300-500 monthly units.<sup>33</sup>
- Removing state subsidies in states such as Gujarat and Haryana has hampered their overall ranking. Despite the low electricity tariff and absence of state subsidies in Gujarat, its supportive ecosystem and conducive state policy design enhance its overall attractiveness to the residential rooftop solar market.
- Assam is emerging as one of the most favourable states for residential rooftop solar. The state government’s push for additional subsidies and supportive policy has invigorated consumer interest. Thus, Assam has the highest number of active applications on the NPRS of all states.
- Jharkhand and Bihar have the lowest ratings for residential rooftop solar development. In Jharkhand, there is a wide mismatch between the robust state policy framework and other parameters of potential cost savings and the implementation ecosystem.

## Recommendations

The residential rooftop solar market is still early in its development. All market stakeholders must proactively address the upcoming challenges with targeted recommendations for the residential rooftop market. These can be categorised as immediate, medium- or long-term actions based on urgency and impact (Table 9).

Table 9: Key residential rooftop solar market recommendations

Recommendations	Description and Impact
<b>Enhance financial support to very small electricity consumers</b>	<p>Very small electricity consumers with monthly consumption &lt;150 units (comprising 80% of Indian households) face a high payback period after installing solar. The following measures must be implemented to address this issue for consumers going for sub-1kWp systems:</p> <ul style="list-style-type: none"> <li>• Higher subsidies and flexibility to choose an alternate business model apart from capex;</li> <li>• Mandatory GBI to enhance attractiveness;</li> </ul>

<sup>33</sup> MoP. [Key regulatory parameter of power utilities](#). March 2024. Page 22.

	<ul style="list-style-type: none"> <li>Lower taxes, such as reducing effective goods and services tax (GST) from 13.8% to 5%.</li> </ul>
<b>Raise awareness through campaigns and outreach</b>	<p>The adoption of solar and captive electricity generation is still a novel concept for most Indian households. Hence, central and state governments must actively invest in raising awareness through the following means:</p> <ul style="list-style-type: none"> <li>A specialised agency should be formulated or selected to bridge customers and DISCOMs, conducting awareness campaigns and outreach and offering support.</li> <li>States can also issue tenders to hire marketing firms to effectively track awareness efforts. In June 2024, the Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA) issued one such tender to increase public awareness of PMSGY in Ayodhya, Gorakhpur and Varanasi.<sup>34</sup></li> </ul>
<b>Resolve NPRS technical issues as a priority</b>	<p>An efficiently operating national portal is imperative for residential rooftop solar development. Since the launch of PMSGY, the NPRS's technical glitches have marred the consumer experience and affected market uptake. The glitches stem from the influx of applications post-PMSGY and its integration with state DISCOMs and vendors. To address these issues, the backend IT infrastructure must be upgraded with powerful data centres and servers.</p>
<b>Provide DCR relaxation until the enabling infrastructure develops</b>	<p>Until the PV cell manufacturing capacity in India develops, the following measures must be implemented to ensure an adequate supply of PV modules at a reasonable cost:</p> <ul style="list-style-type: none"> <li>PMSGY should include modules on the approved list of models and manufacturers (ALMM).</li> <li>A separate ALMM should be issued for cells and other components with utmost priority. In its absence, tracking and regulating the DCR modules market is difficult, allowing duplicity and unfair practices to grow. On 19 June 2024, MNRE launched a portal to ensure traceability and verify the DCR of solar PV cells.<sup>35</sup></li> </ul>
<b>Promote uniform rooftop solar regulations</b>	<p>Rooftop solar regulations on net metering vary widely across states, leading to unnecessary complications. The following recommendations can help to resolve these issues:</p> <ul style="list-style-type: none"> <li>The GoI must push states to streamline net metering regulations, including capacity upper limits, surplus power compensation settlement cycles and charges.</li> <li>According to the MoP notification, states must automatically award feasibility approval for project capacities under 10kWp.</li> <li>All Indian states must accord regulatory approval to GNM and VNM in their state policies to promote community residential solar development and other emerging models, such as utility-led RESCO and P2P trading.</li> <li>The MNRE should provide clear guidelines to all DISCOMs, instructing them not to levy network charges on rooftop solar consumers.</li> </ul>
<b>Proactively upgrade endpoint</b>	<p>Residential rooftop solar capacity in some areas is constrained by distribution transformer reverse current<sup>36</sup> handling capabilities (usually 20-25% of the transformer's rated capacity).</p>

<sup>34</sup> UPNEDA. [Selection of Firm for Strategy, Planning and Implementation of IEC Activities aiming at increasing Public Awareness of PM Surya Ghar Yojana benefits in Ayodhya, Gorakhpur and Varanasi](#). June 2024.

<sup>35</sup> MNRE. [On-boarding of Solar PV manufactures on DCR Verification Portal reg.](#) June 2024.

<sup>36</sup> Older residential transformers are not built to carry extra power generated from the rooftop panels in the opposite direction. This is because transformers are designed to work at the "knee point" of the core magnetisation curve, and reverse power flow causes greater core losses, resulting in more heat and faster degradation of the windings.



<b>transmission infrastructure</b>	State DISCOMs are generally sluggish in upgrading transformers to a higher reverse-current handling capability, primarily due to budget constraints. To not hinder any future rooftop solar growth, state governments must proactively allocate funds and push state DISCOMs to upgrade endpoint distribution transformers to 70-80% reverse current handling capability.
<b>Introduce financial incentives for off-grid and hybrid systems</b>	<p>Only on-grid residential rooftop solar systems can access financial incentives. Similar incentives must be extended to off-grid residential solar systems, given a substantial portion of India’s population does not have access to electricity or is connected to weaker grids:</p> <ul style="list-style-type: none"> <li>• A separate CFA structure must be introduced for off-grid residential solar systems, incorporating battery energy storage systems.</li> <li>• To unlock market capital for this sector, the Gol must encourage financing institutions to introduce blended finance structures and credit guarantee mechanisms.</li> </ul>

Source: JMK Research. Note: Green: Immediate; Yellow: Medium term; Orange: Long term

## Way Forward

The growth of the decentralised energy market in India (of which rooftop solar is a crucial component) will be a critical enabler to unlock energy independence and ensure energy security. This report has described in detail several trends in terms of project installations, such as the rise of tier-2,3/rural regions and an increase in unsubsidised systems in the near term in certain states. The section on financing also outlines the rising trend of industry-wide tie-ups offering a one-stop solution. With the residential rooftop solar market surge after PMSGY, the entire project installation and commissioning process will be commoditised and streamlined in the coming years.

## Impact of PMSGY

PMSGY has set a target of 30GW residential rooftop solar installations by March 2027, translating to about 8-10GW annual capacity additions from FY2025-2027. Thus, PMSGY will contribute immensely to India attaining its target of 500GW renewable capacity by 2030, requiring at least 30-35GW of annual solar capacity additions.

PMSGY seeks to provide a seamless digitised experience for rooftop solar installations. Improving process transparency allows for easier identification of the reasons behind project delays, often caused by local DISCOMs. As a result, PMSGY will indirectly reduce local DISCOM involvement in project execution, leading to fewer delays and quicker approvals and subsidy disbursements.

## Adoption of Community Solar Business Model Set to Rise

Under community solar business models, a solar plant and its energy generation are shared by the households in a particular community. Despite being a success in countries such as Japan, community solar frameworks (e.g. GNM and VNM) are yet to have any notable on-ground presence in India’s residential rooftop solar market.

The increasing acceptance of regulations (10 states have included GNM and VNM in their rooftop solar policies) and the need to overcome challenges such as limited rooftop space in urban areas will lead to a rise in the adoption of community solar business models. According to industry interactions by JMK Research, EPC vendors in Gujarat are already experiencing a significant increase in demand from medium-sized housing societies to install centralised rooftop solar systems.

## Increased Market Penetration of Microinverters

A microinverter is attached to each solar panel, essentially converting each solar module into an alternating current (AC) power-producing unit. The microinverter improves system safety, enhances modularity, enables real-time monitoring of each solar panel, and optimises performance by isolating production issues of each solar panel, such as shading from nearby structures.

Microinverters, which are about 50-60% more expensive than string inverters, only have a 1-2% market share in India, mainly from premium offerings. In contrast, leading residential markets of the US and Germany rely on microinverters almost exclusively. According to industry stakeholders, with an enhanced focus on safety standards and a need to avoid systems losses due to inadvertent shading issues in congested residential spaces, microinverters' market share in India will rise to 10-15% in the coming years. Enphase (an American inverter manufacturer), Jio Platforms (in partnership with SPARQ Systems, a Canadian manufacturer), and Yonghui Solar (a Chinese company) are India's major microinverter suppliers.

## Conclusion

The progress in the rooftop solar market has been below par compared with other renewable energy sectors. Efforts to integrate rooftop solar into India's mainstream energy sector have faced significant obstacles, such as policy complexities, poorly structured institutional and governance frameworks, weak contract enforcement and technical challenges related to grid connectivity.

To address these issues, the Indian government has launched PMSGY, focusing on residential rooftops. The scheme has garnered a strong response, with active applications on the NPRS increasing manifold within just six months. PMSGY is expected to result in capacity additions across India and serve as a catalyst for addressing sector challenges.

Despite the encouraging developments, some pertinent market challenges remain. There are concerns over a need for more supply-side support in the underdeveloped and overpriced DCR modules market. In addition, technical issues such as NPRS glitches and weak distribution transmission infrastructure negatively affect consumer confidence. Differing regulations across states and their widely varying interpretations by state DISCOMs are ongoing challenges.

According to market stakeholders, a confluence of factors makes it a highly opportune time to invest in rooftop solar systems:

- Solar module prices have dropped
- Strong government support for residential rooftop solar
- Financiers partnering with EPC and module suppliers to establish a one-stop solution for consumers.

Other states apart from Gujarat will add significant residential rooftop solar capacity. These include Uttar Pradesh (separate state subsidy), Maharashtra (highest domestic electricity tariff), and Madhya Pradesh, Karnataka and Kerala (supportive state government policies). Other market dynamics include equitable demand distribution between rural and urban areas and a small yet noticeable increase in unsubsidised systems. Consumers opting for unsubsidised systems will be more likely to install premium offerings, including highly efficient module technology and advanced balance of systems (BoS) such as microinverters and optimisers.

In India's pursuit of solar energy, it's essential to learn from the experiences of other leading residential rooftop solar markets, such as the US, Japan and Germany. Japan's community solar market can serve as a model for India. At the same time, Germany and the US can offer insights into safety, quality standards and process optimisation using advanced technologies such as energy storage and microinverters.

The PMSGY target of 30GW of residential rooftop solar capacity additions by 2027 is certainly ambitious. Even after the initial thunderous response, the scheme's overall impact and ability to realise its target can be correctly gauged only after one year of implementation.

The potential of solar energy on Indian rooftops is immense. Realising this potential will require collaboration and cooperation among all stakeholders in the market, including regulators, distributors, financiers, EPC developers and consumers, to build a vibrant and resilient decentralised energy ecosystem in India.

## About IEEFA

The Institute for Energy Economics and Financial Analysis (IEEFA) examines issues related to energy markets, trends and policies. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy economy. [www.ieefa.org](http://www.ieefa.org)

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