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FROM POLICY TO PRACTICE

Lesson from PM-KUSUM Component A Implementation

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Acronyms

APDCL	Assam Power Distribution Company Limited
CAPEX	Capital Expenditure
CSPDCL	Chhattisgarh State Power Distribution Company Limited
DHBVN	Dakshin Haryana Bijli Vitran Nigam
DISCOM	Distribution Company
EoI	Expression of Interest
FPO	Farmer Producer Organization
GEDA	Goa Energy Development Agency
GEDA	Gujarat Energy Development Agency
GW	Giga Watt
HIMURJA	Himachal Pradesh Energy Development Agency
JAKEDA	Jammu And Kashmir Energy Development Agency
JBVNL	Jharkhand Bijli Vitran Nigam Limited
JVVNL	Jaipur Vidyut Vitran Nigam Limited
KSEB	Kerala State Electricity Board
kWh	Kilo Watt Hour
KYC	Know your customer
LoA	Letter of Award
MNRE	Ministry of New and Renewable Energy
MPUVNL	Madhya Pradesh Urja Vikas Nigam Limited
MSEDCL	Maharashtra State Electricity Distribution Company
MW	Mega Watt
O&M	Operations and Maintenance
OPEX	Operational Expenditure
PEDA	Punjab Energy Development Agency
PM-KUSUM	Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan
PPA	Power Purchasing Agreement
RBI	Reserve Bank of India
RoW	Right-of-way
RPG	Renewable Power Generator
RPO	Renewable Power Obligation
RRECL	Rajasthan Renewable Energy Corporation Limited
SERC	State Electricity Regulatory Commission
SIA	State Implementing Agency
TANGEDCO	Tamil Nadu Generation & Distribution Corporation Ltd.
TSECL	Tripura State Electricity Corporation Ltd.
TSREDCO	Telangana Renewable Energy Development Corporation
UHBVN	Uttar Haryana Bijli Vitran Nigam
UPNEDA	Uttar Pradesh New and Renewable Energy Development Agency

Executive Summary

The Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM), launched in 2019, is one of India's flagship initiatives to accelerate the renewable energy (RE) transition in India's rural and agriculture sector. The Scheme has three components, Component B and Component C focused on decarbonizing agriculture sector by solarizing irrigation pumps, and Component A focused on adopting and scaling of small-scale solar PV plants of size 0.5 MW to 2 MW by farmers and rural landowners on barren and underutilized agricultural land. While the solarization of irrigation pumps has long been part of central and state government programmes, Component A is unique in its approach as it aims to position farmers as energy producers, generating stable and long-term income while contributing towards national RE targets.

Policy interest in rural photovoltaic (PV) and agrivoltaics (Agri-PV), where land is used simultaneously for farming and solar energy generation, has grown in recent years. This is driven by their multiple benefits, clean energy access, income generation, and efficient land use, especially in the context of limited wasteland availability. However, despite growing interest among small and rural entrepreneurs, the target values of Component A of the scheme have not been achieved. Under Component A, more than 10,000 MW of solar capacity has been sanctioned for installation across 18 states, of which ~~only~~ 587 MW have been installed in ~~mere~~ six states as of April 30, 2025.

The Component A's under-realised targets and its overlapping aspects with Agri-PV warranted a detailed assessment. Thus, a study to evaluate the progress of the scheme, profiling of scheme's beneficiaries, their experience in implementation and their interests in venturing into Agri-PV segment was undertaken. The study was predominantly based on primary data through engagement with beneficiaries in four states: Maharashtra, Haryana, Rajasthan and Himachal Pradesh. It entailed telephonic primary surveys of 24 beneficiaries who have installed and commissioned solar project under the scheme and 66 beneficiaries who have been allotted project but are yet to install, along with two detailed beneficiary case studies to generate grounded insights.

>10,000 MW

of solar capacity has been sanctioned for installation across 18 states

The analysis of the primary data revealed certain determining factors and patterns. It reveals that PM-KUSUM Component A has primarily benefited educated, well-resourced individuals with large landholdings, while small and marginal farmers remain largely excluded. Despite high awareness and interest in Agri-PV and RE investments, systemic barriers, particularly related to financing, land eligibility, and unattractive tariffs, continue to limit broader adoption and equitable access. Detailed findings are summarized below:

Table 1: Summary of survey findings across key themes

Theme	Findings
Socio-economic profile of beneficiaries	❯ Majority of surveyed beneficiaries come from non-agricultural professions (corporate, business, services), with reported mean income of ₹ 24 lakh/annum. ❯ Over 80 per cent hold at least a bachelor's degree, while nearly 50 per cent have postgraduate or doctoral qualifications. ❯ Most beneficiaries own substantial land, indicating limited access of small/marginal farmers to the scheme. ❯ Several installed beneficiaries have prior exposure or strong networks in the solar PV sector.
Land use profile	❯ 62 per cent of surveyed beneficiaries have projects on barren land and remaining 38 per cent on agricultural land. ❯ Land use decisions are driven more by feasibility and potential return of investment (relative to its agricultural use) than land classification, for instance land availability near identified substations matters more than land type.
Application, implementation and operations experience	❯ Most beneficiaries with installed projects found the scheme guidelines and application process easy to navigate. ❯ Key implementation challenges included: » Financing delays, high interest rates, and collateral requirements. » Regulatory and technical hurdles like KYC mismatches, land clearance, and RoW issues. » Land identification and suitability, especially in hilly or constrained areas. ❯ Most beneficiaries reported satisfaction with grid connectivity and evacuation infrastructure. ❯ 74 per cent of installed beneficiaries engaged consultants; others had prior solar sector experience. ❯ Over 60 per cent demonstrate high familiarity with O&M, either through training or hands-on experience.
Project financials	❯ Only 11 of 24 beneficiaries with running projects reported satisfaction with PPA tariffs – identified as key factor in influencing future participation. ❯ Tariff dissatisfaction reported to be high in Maharashtra (₹3.10/kWh) and Haryana (₹2.99/kWh), less in Rajasthan (₹3.04/kWh) and Himachal Pradesh (₹3.38–₹3.45/kWh). ❯ Overall, project CAPEX is tightly clustered around ₹4 crore/MW; while OPEX ranges from ₹20,000 to ₹50,000/MW/year. ❯ Reported monthly revenue is ₹3.8–₹5.5 lakh/MW; with a median of about ₹4.5 lakh/MW.
Barriers in Non-Installed Projects	❯ Of the 66 surveyed beneficiaries with non-installed projects, , 73 per cent are awaiting financing support from banks. ❯ Maharashtra and Himachal Pradesh are witnessed to face the most severe financing delays. ❯ Common issues include loan processing delays, high interest rates, insufficient collateral.
Agri-PV Interest & Readiness	❯ All respondents expressed awareness of and interest in Agri-PV but highlighted the need for loan/subsidy support and technical assistance (for system design, crop compatibility, and performance modeling) to enable adoption. ❯ Already 9 beneficiaries reported practicing dual land use, growing vegetables & fodder – indicating strong potential to retrofit or scale Agri-PV within the current scheme.

Source: SIA survey

The survey findings point to critical pathways for enhancing the design and implementation of PM-KUSUM Component A and unlocking the potential for Agri-PV in India. Based on evidence gathered from beneficiaries across four leading states, the following strategic recommendations are proposed:

- **Expand the scope of PM-KUSUM Component A to support Agri-PV projects:** Although Agri-PV is permitted under Component A, it is not proactively promoted. Given the strong interest among beneficiaries, the scheme should be expanded to include a dedicated Agri-PV sub-component, support retrofitting of existing plants for dual land use, and provide targeted financial incentives to make Agri-PV viable and attractive.
- **Improve project targeting to enhance scheme reach and equity:** Participation has been concentrated among well-educated, resource-rich individuals. To deepen adoption within this group and to expand access to small and marginal farmers, FPOs, and cooperatives, the scheme should introduce special windows for collectives, ease eligibility criteria (e.g., land size, substation distance), and provide tailored project development and financial support services.
- **Simplify financing access and ensure project viability:** Financing challenges and low tariffs are major barriers to implementation. To improve viability, the scheme should enable easier access to credit through interest subvention, credit guarantees, and dedicated loan products, while also revisiting tariff structures to reflect project costs, especially for Agri-PV systems.
- **Enhance state-level efforts to build an ecosystem for rural PV and Agri-PV adoption:** Adoption of decentralized rural PV and Agri-PV remains constrained by weak institutional support and regulatory complexity. States must establish dedicated facilitation units, issue clear dual-use land policies, integrate Agri-PV into rural development strategies, and promote innovation through pilots, training, and streamlined approval systems.

These interventions together can significantly improve the accessibility, viability, and equity of PM-KUSUM and catalyse the scaling of Agri-PV as a core part of India's RE transition and rural development strategy.

01 Introduction

India is entering a decisive phase in its clean energy transition, one that must balance the imperatives of economic growth, climate action, and rural development. As electricity demand soars and the country pursues its goal of 500 GW of non-fossil fuel-based capacity by 2030, nearly 60 per cent of which is expected to come from solar energy, the question is no longer whether to scale up renewable energy (RE), but how to do so sustainably and inclusively.

A major constraint in this journey is land. Large-scale RE projects, particularly solar, often compete with agriculture for land, an issue made more complex in a country where farming is the primary livelihood for millions and average landholdings are just over one hectare. This is where agrivoltaics (Agri-PV) offers a transformative solution. Agri-PV, by combining solar energy generation with farming on the same land, offers a powerful solution to ease land-use pressures, boost farm productivity, enhance rural incomes, and accelerate climate-resilient, community- supported renewable energy expansion.

With over 146 million small and marginal farms[1], India has both the need and the scale to become a global leader in Agri-PV. Leveraging this potential will require supportive policies, farmer- centric business models, and investments in innovation. Done right, Agri-PV can become a cornerstone of India's strategy to ensure that the energy transition uplifts, rather than bypasses, its rural heartland.

At present, deployments of solar PV projects in the farm sector in India is being promoted under the Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM) scheme launched by the Government of India in 2019.[2] This flagship initiative marks a major shift in rural energy policy, from simply giving subsidies for small RE applications to supporting larger RE projects that generate income and make farmers active partners in India's clean energy transition. PM-KUSUM's comprehensive framework encompasses three distinct components (A, B and C), each targeting different aspects of rural energy transformation, from off-grid and grid-connected solar pumps to solar plant installations.

Component-A of PM-KUSUM is particularly significant as it introduced, for the first time, the concept of farmer-owned, decentralised solar power plants, ranging from 500 kW to 2 MW, on agricultural land. This component aligns with Agri-PV principles by enabling farmers to earn from solar power while continuing agriculture, with flexible options for ownership or land leasing that suit diverse farmer needs and capacities.

However, despite its innovative design and substantial policy support, PM-KUSUM Component- A has encountered implementation challenges that have limited its progress toward stated objectives. Of the aggregate installation goal of 10,000 MW under the Component, only 587 MW have been installed so far.[3]

Progress has been impeded by a range of technical, financial, regulatory, and social challenges. Understanding these barriers, and identifying strategies to overcome them, offers critical insights for scaling rural RE, particularly Agri-PV. Both the successes and limitations of these early efforts can inform more effective policies, financing models, and deployment approaches going forward. Equally important is examining the profiles and motivations of early adopters, as similar stakeholders are likely to play a pivotal role in driving the initial scale-up of Agri-PV initiatives across the country.

In this context, a comprehensive analysis of PM-KUSUM Component-A installations has been undertaken through this study focusing on four key dimensions:

i. profiling beneficiaries to understand the characteristics of early adopters,
ii. identifying and assessing barriers to wider adoption,
iii. documenting implementation experiences and operational challenges, and
iv. evaluating plant performance and operation & maintenance (O&M) practices.

This multi-dimensional approach is designed to generate actionable insights that can inform future iterations of the Component A scheme as well as guide the strategic deployment of Agri-PV technologies in India.

The research adopts a survey-based methodology to capture the diversity of implementation contexts across Rajasthan, Haryana, Himachal Pradesh, and Maharashtra. It examines beneficiary demographics, motivations, financial outcomes, and user satisfaction, using a combination of quantitative metrics and coded qualitative responses to surface operational challenges and farmer perspectives. This empirical foundation supports the development of evidence-based recommendations grounded in field realities. The study further integrates insights from literature, survey findings, and expert feedback into a coherent analytical framework, supported by data visualizations and technical appendices to ensure transparency and robustness.

The report is structured as follows – Chapter 2 examines the current status and key challenges of PM-KUSUM Component-A; Chapter 3 outlines the study framework; Chapter 4 presents detailed findings from the beneficiary survey; and Chapter 5 synthesises the results and offers policy and implementation recommendations.

02

PM-KUSUM Component-A Scheme and Implementation

India is rapidly advancing its renewable energy (RE) ambitions, targeting 500 GW of capacity and 50% electricity consumption from non-fossil sources by 2030, through a range of policy and implementation measures. One of the most significant and ambitious strides among them is Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM). The scheme was operationalized in 2019 with a dual objective of accelerating India's energy transition and ensuring energy and water security for farmers and rural sector.

The scheme is considered one of the world's largest clean energy initiatives targeting the agriculture sector, with the potential to benefit over 35 lakh farmers. Beyond environmental and economic benefits, it also has significant employment generation potential. It is estimated that approximately 24.5 job-years are created per MW of small-scale solar installation[1] translating to over 7.5 lakh job-years across the scheme's rollout, contributing to both rural livelihoods and green employment growth.

The scheme is structured around three components:

- **Component A**: Installation of 10,000 MW of decentralized solar power capacity through small solar power plants (up to 2 MW).
- **Component B**: Deployment of 20 lakh standalone solar-powered agricultural pumps.
- **Component C**: Solarisation of 15 lakh existing grid-connected agricultural pumps.

While Components B and C directly target irrigation access through decentralised renewable energy (DRE) to solarise pumps in agriculture sector (with Component C-1 aiming solarization of agricultural pumps whereas Component C-2 aiming at solarization of the agriculture feeders.), Component A focuses on small-scale solar plants of capacity 0.5 MW to 2 MW on barren and unproductive agricultural land. It aims at positioning farmers and rural land owners as energy producers.

2.1 PM KUSUM Component A

PM-KUSUM Component A is designed to enable farmers, panchayats, cooperatives, and farmer producer organisations (FPOs) to part take in RE production by setting up small solar power plants of under 2 MW capacity. These installations can be established on barren, fallow, marshy, pasture, or cultivable land, offering flexibility in site selection. In cases where cultivated land is used, the scheme promotes the agrivoltaic (Agri-PV) model, requiring that panels be installed at sufficient height to allow continued crop cultivation underneath, thus ensuring dual land use for energy and agriculture.

The solar power generated under this component is to be procured by distribution companies (DISCOMs) at tariffs determined by the respective State Electricity Regulatory Commissions (SERCs). Farmers have the option to either install the plant themselves or lease their land to developers.

As per the scheme, state DISCOM/State Implementing Agency (SIA) is responsible for providing transmission infrastructure. All solar plants allotted under the scheme are to be located within a 5 km radius of notified substations to reduce transmission losses and infrastructure costs.

One of the core objectives of the scheme was to offer long-term income potential to rural landowners. The scheme estimates annual net income of ₹ 25,000/acre/year by leasing land to developers. In case of complete installation by landowner, the annual net income potential is estimated to be ₹ 65,000/acre/year.

To facilitate access financing of the projects under PM-KUSUM Component A, the scheme has been included under priority sector lending by the Reserve Bank of India (RBI), allowing banks to offer loans at competitive interest rates and soft terms.

Additionally, to support the procurement of power by DISCOM under this component, the Central Government provides an incentive of ₹ 0.40/kWh or ₹ 6.60 lakh/MW/year (whichever is lower) for a period of five years from the plant's commercial operation date. This mechanism ensures maximum procurement-based incentive (PBI) of ₹ 33 lakh/MW over the entire incentive period, creating financial viability for DISCOMs while maintaining cost efficiency. This not only encourages better tariffs provided to beneficiaries but also helps DISCOMs meet their renewable purchase obligations (RPOs)[5].

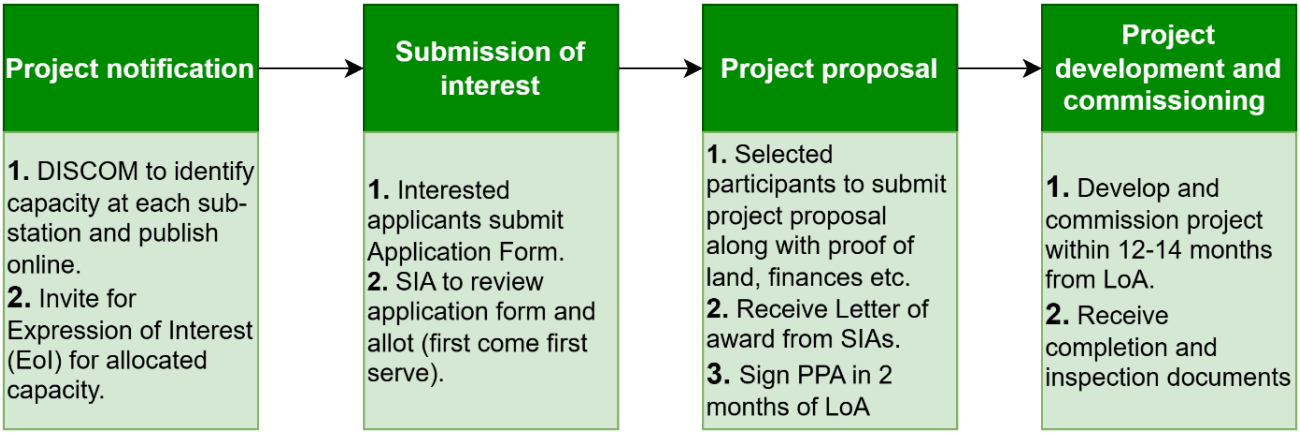
PM KUSUM Component A doesn't offer any direct subsidies to renewable power generators (RPGs). The absence of direct capital subsidies to adopters under Component A reflects the scheme's market-oriented approach, where the focus is on facilitative provisions to support small scale solar plant developers. Measures such as a transparent application and allocation process, DISCOM support for evacuation infrastructure development, with all associated costs borne by DISCOMs, help reduce capital expenditure for developers. Additionally, procurement-based incentives (PBI) to DISCOMs enhance their ability to offer more competitive tariffs to projects under the scheme.

2.2 Implementation mechanism

PM KUSUM A is central government scheme and the implementation is predominantly led by state-level agencies. Ministry of New and Renewable Energy (MNRE) serves as the apex policy- making body responsible for developing scheme guidelines, defining eligibility criteria and PBI framework for DISCOMs. Meanwhile, the implementation mechanisms are left to be decided by the SIAs and the implementation are independently designed and adopted by each state.

Based on the analysis of the implementation mechanisms adopted by multiple states reviewed under this study, a generalised implementation mechanism was mapped.

Figure 2.1: Implementation mechanism of PM KUSUM A



Source: SIA

DISCOMs occupy a central position in Component A implementation, serving simultaneously as SIAs, power purchasers, and ecosystem facilitators. A DISCOM is responsible for identifying capacity at substation(s) and submission of proposals to MNRE, inviting interests and project applications, evaluating application documents and allocating projects under the scheme, followed by overseeing implementation progress, signing of power purchase agreements (PPAs) and regular disbursements of payments to energy sellers.

The DISCOM's facilitation role also includes supporting beneficiaries through project development processes, coordinating with multiple stakeholders, and ensuring smooth project implementation, financing arrangements, and regulatory compliance support. In cases where RPGs lease land from farmers, DISCOMs directly pay lease rent to farmers before the 5th day of each month.

RPGs, whether farmers themselves or RE developers, bear primary responsibility for project installation and operation throughout the PPA period. Their obligations include adherence to technical specifications, regulatory compliance, and consistent performance delivery that ensures reliable power generation and revenue streams.

2.3 Progress and performance

As of April 30, 2025, PM-KUSUM Component A has achieved 587.03 MW of installed solar capacity against a sanctioned target of 10,000 MW, representing 5.87 per cent of the target. So far, Six states have seen project being installed under the scheme. Rajasthan alone has 452.75 MW i.e., 70 per cent of installed capacity under the scheme followed by Himachal Pradesh with 64 MW.

Table 2.1: State-wise sanctioned and installed capacity under PM KUSUM Component A

State Name	State Implementing Agency	Total Sanction (MW)	Total Installed (MW)
Assam	APDCL	2	0
Chhattisgarh	CSPDCL	30	6.5
Goa	GEDA	50	0

State Name	State Implementing Agency	Total Sanction (MW)	Total Installed (MW)
Gujarat	GEDA	0	0
Haryana	DHBVN & UHBVN	158	6.65
Himachal Pradesh	HIMURJA	100	64
Jammu And Kashmir	JAKEDA	0	0
Jharkhand	JBVNL	0	0
Kerala	KSEB	0	0
Madhya Pradesh	MPUVNL	1790	50.13
Maharashtra	MSEDCL	260	6
Nagaland	-	0	0
Odisha	OREDA/DISCOMs	40	0
Punjab	PEDA	0	0
Rajasthan	RRECL	6550	452.75
Tamil Nadu	TANGEDCO	14	1
Telangana	TSREDCO	1000	0
Tripura	TSECL	5	0
Uttar Pradesh	UPPCL	1	0
Total		10,000	587.03

Source: National Portal for PM KUSUM, as of April 30, 2025

As of December 2024, PPAs for 1,100 MW were signed across 11 states. PPA rates vary from ₹3.07/unit to ₹3.51/unit, more than 50 per cent of them are in Rajasthan alone, followed by 17 per cent in Madhya Pradesh and Maharashtra each.[1]

It is also notable that more than 90 per cent of existing or upcoming capacity is on privately self-owned lands, and land leasing is not favored under this scheme due to additional costs of leasing. Rajasthan, parts of Haryana and Madhya Pradesh offer prospects of leased model under PM-KUSUM A due to arid and semi-arid conditions, barren or low-productive agriculture land and lower lease rates.

State-wise land distribution and tariffs under PM-KUSUM Component A

S.No.	State Name	Capacity of PPA signed (MW)		Tariff (₹/unit)
		Owned land	Leased land	
1.	Assam	1.7	0	3.30
2.	Chhattisgarh	14.50	0	3.04 – 3.51
3.	Goa	4.00	0	
4.	Haryana	15.96	26	3.11
5.	Himachal Pradesh	45.75		3.50 up to 1MW, 3.46 above 1 MW to 5 MW
6.	Madhya Pradesh	178.37	19.65	3.07
7.	Maharashtra	187.70	4.50	3.28 – 3.30 for own land 3.10 for Lease land
8.	Rajasthan	553.50	48.50	3.14
9.	Tamil Nadu	1	0	3.28
10	Tripura	2	0	3.31
11	Uttar Pradesh	1	0	3.10

Source: MNRE, as of December 2024

1 https://sansad.in/getFile/annex/266/AU2539_QUbN7Y.pdf?source=pqars

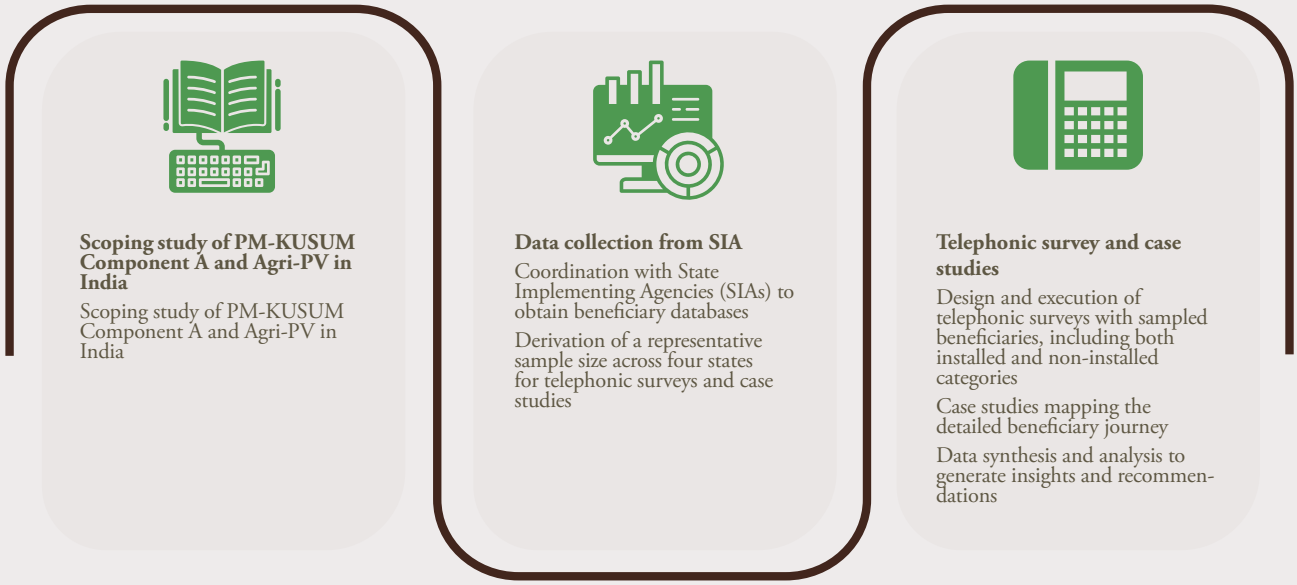
03

Methodology

This study undertook a detailed assessment of the implementation of PM-KUSUM Component A, focusing on beneficiary profiles, project implementation experiences, key challenges and enablers, plant performance, and beneficiary satisfaction. It aimed to generate actionable insights to enhance the current scheme and inform the design of future initiatives, including agrivoltaic (Agri-PV) interventions. So far, there has been limited research assessing PM-KUSUM Component A. This study is one of the first to offer an on-ground evaluation based on beneficiary experiences, with the specific objective of generating learnings to support the development of Agri-PV schemes in India.

The methodology combines both secondary and primary research, with a strong emphasis on primary quantitative data analysis and case studies conducted through telephonic interviews. Secondary research included a scoping review of PM-KUSUM Component A and the current state of Agri-PV in India. However, the availability of secondary data on both subjects remains limited, underscoring the significance of this study in establishing a foundational knowledge base for PM- KUSUM A and agrivoltaics development in the country.

Figure 3.1: Methodological framework of the study



3.1 Beneficiary data collection

The study focused on two categories of beneficiaries; installed and non-installed.

- **Installed beneficiary:** These beneficiaries have been allocated project under the scheme in response to their application, and have successfully installed and commissioned the project.
- **Non-installed beneficiary**: These beneficiaries have been allotted project under the scheme. The projects are either under implementation or delayed due to several factors; approvals, financing delays etc.

As for state selection, Component A projects have been installed across six states, while capacity has been sanctioned in 13 states. To capture insights from both installed and non-installed beneficiaries, four focus states were selected for this study: Maharashtra, Rajasthan, Himachal Pradesh, and Haryana. These states are the leading performers under Component A,

collectively accounting for over 98 per cent of total installations. As beneficiary information is not publicly available, contact details and installation data were obtained directly from the respective State Implementing Agencies (SIAs) through a formal request process.

Table 3.1: Beneficiary data collected from SIAs

State	State Implementing Agency	Installed (MW)	Non-installed (MW)	Total (MW)
Maharashtra	Maharashtra State Electricity Distribution Company (MSEDCL)	1	62	63
Haryana	Dakshin Haryana Bijli Vitran Nigam (DHBVN)	2	56	58
Himachal Pradesh	Himachal Pradesh Energy Development Agency (HIMURJA)	5	98	103
Rajasthan	Jaipur Vidyut Vitran Nigam Limited (JVVNL)	40	0	40
Total		**48**	**216**	**264**

Source: SIA

3.2 Survey instruments

Based on the objectives of the study, unique survey instruments for installed beneficiaries and non- installed beneficiaries were developed.

These structured questionnaires encompassed thematic areas including beneficiary demographics, adoption motivations, implementation challenges, technical performance, financial returns, maintenance practices, and satisfaction levels. Each telephonic interview was designed to last 20– 30 minutes, balancing comprehensive data collection with realistic expectations of respondent availability and attention spans. The instrument incorporated closed-ended questions for quantitative analysis and open-ended questions to capture qualitative insights and contextual factors standardized responses cannot represent.

3.3 Survey sample

Based on the collected state-wise and project status-wise beneficiary data, random proportionate sampling across four states was derived. Considering the smaller data pool of beneficiaries across both categories, a larger survey sample of 34 per cent of the available beneficiary population was considered to reflect representatives and statistical robustness.

Table 3.2: State-wise and project status-wise surveyed sample

State	Installed	Non-installed	Total
Haryana	1	18	19
Himachal Pradesh	5	28	33
Maharashtra	1	20	21
Rajasthan	17	0	17
Total	**24**	**66**	**90**

Table 3.3: Size of surveyed projects

Size (MW)	Installed	Non-installed
0.5	5	16
0.6		1
0.65	1	
0.75		1
0.85	1	1
1,0	7	18
1.1		1
1.5	2	1
1.7	1	
2.0	7	25
3		1
4		1

3.4 Primary data collection

Primary data collection for the study consisted of structured telephonic surveys/interviews with sampled beneficiaries. A team of four data collectors/enumerators with requisite skills and sound knowledge of the scheme were involved in these surveys.

In addition to the surveys, two detailed case studies via telephone were also conducted, which focused on mapping the beneficiaries' journey, experience of undertaking the project under the scheme and their views and perspectives towards the scheme and future aspirations in agrivoltaics.

Strong data collection protocols were maintained to ensure consistency, reliability, and ethical compliance throughout the surveys. Data sanity check was conducted to maintain quality control. Each call was recorded with due consent from the respondents.

3.5 Analytical frameworks

The analytical framework employed both quantitative and qualitative analysis techniques to extract meaningful insights from the collected data. Quantitative analysis included data cleaning and analysis of primary data across categories of installed and non-installed beneficiaries. Analytical tools included; descriptive statistics, pivot tables and charts and comparative analysis across states and different respondent categories to profile beneficiaries and establish relationships between variables.

Qualitative analysis involved systematic coding of open-ended responses, thematic analysis to identify recurring patterns and issues, and narrative construction to provide contextual understanding of quantitative findings. This mixed-methods approach ensured comprehensive coverage of both measurable outcomes and nuanced experiential factors that influence Component A implementation success.

3.6 Limitations

While this study provides valuable insights into PM-KUSUM Component-A implementation experiences, some limitations must be acknowledged to ensure appropriate interpretation and application of findings.

3.6.1 Methodological limitations

The telephonic survey methodology presents certain inherent limitations that may affect data quality and comprehensiveness. Respondent reluctance to engage in detailed discussions over telephone calls had posed a challenge, as many respondents express hesitancy about sharing information with unknown callers. This reluctance stems from multiple factors including past experiences with fraudulent calls, concerns about data misuse, and general wariness about unsolicited telephone contacts.

Fear of scams represents a particularly significant barrier, as rural populations have increasingly become targets of various telephone-based fraud schemes. This legitimate concern led many potential respondents to either refuse participation entirely or provide guarded responses that may not fully reflect their actual experiences and perspectives. The prevalence of such concerns required additional effort to establish trust and credibility during initial contact phases.

Respondents' unwillingness to dedicate 20-30 minutes for detailed telephone conversations posed another practical limitation. Respondents often had limited availability during optimal calling hours due to daylight activities, family responsibilities, or other commitments. This time constraint may have resulted in abbreviated interviews that cannot capture the full depth of implementation experiences or may lead to sample bias toward respondents with greater availability, who may not be representative of the broader beneficiary population.

3.6.2 Data quality concerns

The potential for respondents to provide incorrect information, particularly regarding critical socio-economic details, represented a significant data quality concern. Individuals were reluctant to share accurate information about income levels, landholding sizes, or financial outcomes due to privacy concerns. This reluctance may be particularly pronounced for sensitive topics such as actual returns from Component-A installations, informal financial arrangements among many.

The remote nature of telephonic data collection limits opportunities for verification or cross-checking of provided information through direct observation or document review. Unlike field- based surveys where enumerators can observe installation conditions, verify technical specifications, or request documentation, telephonic interviews rely entirely on respondent self- reporting without independent verification mechanisms.

Despite these limitations, the study provides valuable insights into Component-A implementation experiences that can inform policy refinements and Agri-PV deployment strategies. The limitations outlined above should be considered when interpreting findings and developing recommendations based on study outcomes.

04 Survey Insights

The detailed analysis of survey of beneficiaries under the Pradhan Mantri Kisan Urja Surakshaevam Utthaan Mahabhiyan (PM-KUSUM) Component A scheme across Haryana, Himachal Pradesh, Maharashtra, and Rajasthan offers critical insights into the scheme's on-ground implementation. These four leading states, together accounting for over 98% of total installations, provide a robust foundation to examine the scheme's impact, challenges, and opportunities. The survey explores key aspects such as beneficiary profiles, project implementation experiences, barriers and enablers, and interest in future investments, particularly in emerging areas like agrivoltaics (Agri-PV).

Structured interviews were conducted with 24 beneficiaries who have successfully installed and commissioned solar plants, and 66 beneficiaries whose projects are either under installation or yet to begin *(see Chapter 3 for details on methodology).* This combined perspective of installed and non-installed projects sheds light on the social, financial, and procedural dimensions shaping the scheme's uptake and offers evidence-based inputs to inform the design of future interventions. The insights that follow focus on demographic characteristics, implementation experiences, and farmers' outlook toward scaling or diversifying through Agri-PV applications

4.1 Demographic and socio-economic profile of surveyed beneficiaries

The demographic and socio-economic profiling of surveyed beneficiaries helps identify the ideal target population for the scheme based on socio-economic and demographic verticals including; age, education, occupation, landholding size, and income levels. The findings from the demographic and socio-economic profiling can also help identify the inclusivity measures and necessary support structures needed to make future interventions more inclusive and effective.

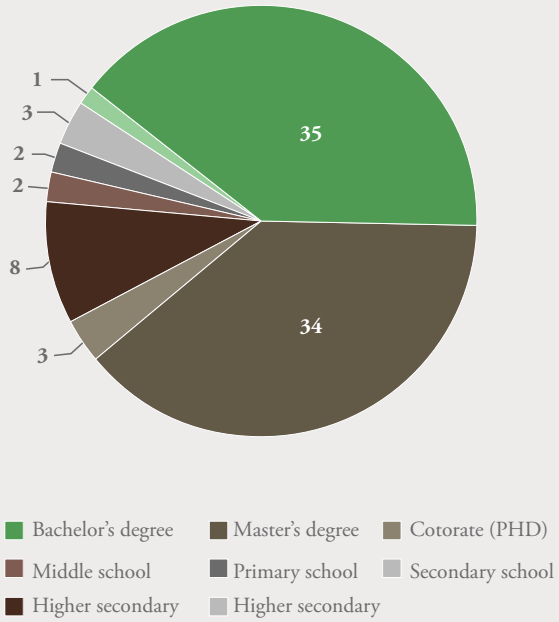
Education

Over 80 per cent (72 of 90) of the respondents hold at least a bachelor's degree, with a substantial, almost 50 per cent of those having postgraduate/master's and doctoral qualifications. .

Primary occupation

The primary occupation mapping of the surveyed beneficiaries suggests that a majority of beneficiaries come from non-agricultural occupations, with only 30 of the surveyed beneficiaries practicing agriculture as their primary occupation. Majority of surveyed beneficiaries are engaged in full-time professions outside of agriculture, including roles in the service sector, such as corporate executives, engineers, and teachers etc., as well as in business, such as contractors and local entrepreneurs. A few beneficiaries are also actively involved in politics as their primary occupation.

Figure 4.1: Education profile of surveyed beneficiaries



N=88; Data not shared by 2 pondents
Source: SIA survey

Table 4.1: Primary occupation of surveyed beneficiaries

Primary occupation	Installed	Non-installed	Total
Agriculture	11	19	30
Business	10	21	31
Charter accountant	-	1	1
Contractor	-	6	6
Director	-	6	6
Engineer	1	2	3
Lawyer	-	1	1
Politician	-	2	2
Teacher	2	4	6
Did not respond	-	4	4
Total	**24**	**66**	**90**

Source: SIA survey

The profiling of primary occupation suggests that non-agriculture professionals who own land and other requisites dominate participation in the scheme.

- **Household income**

  The profiling suggests that the median income of surveyed beneficiaries is ₹15 lakh/annum and the mean income of ₹ 24 lakh/annum, indicating several high-income outliers also partaking in the scheme. The median income of 24 installed beneficiaries is higher, i.e., ₹ 20 lakh against ₹15 lakh among 66 non-installed beneficiaries.

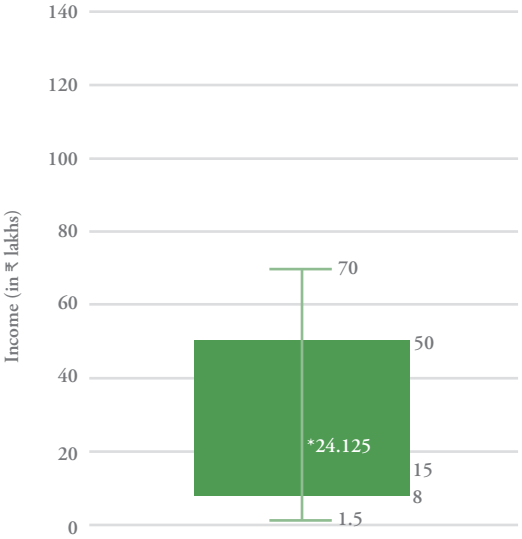
  The income distribution of surveyed beneficiaries underscores the capital-intensive nature of Component-A projects, which require capital investment of ~ ₹4 to ₹5 crores per MW[6]. These projects involve substantial upfront equity investment, debt mobilization, complex procurement, gestation periods of up to 2 years and payback periods of up to 8–10 years. Thus, a strong financial footing is effectively a prerequisite for participation.

- **Land holdings**

  The majority of surveyed beneficiaries own at least 8 acres (median) land and the average land holding size is 13 acres, indicating scheme is primarily accessed by medium to large landowners. Ground-mounted solar is land-intensive, requiring approximately 4-5 acres per MW. PM-KUSUM also requires land holding within 5 km of the allotted substation, rendering many landholders ineligible, allowing only large landowners, and farmers owning land in the vicinity of identified substation only to participate in the scheme.

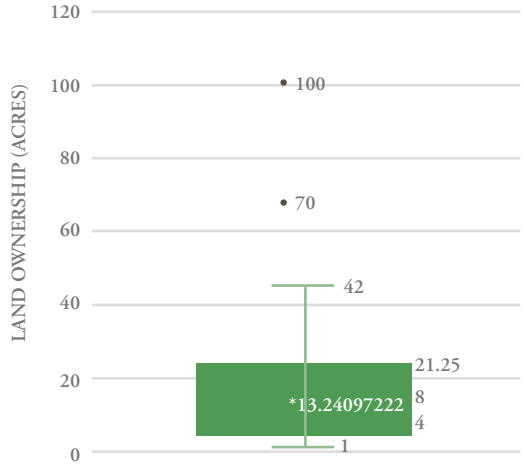
  Conversely, small landholders owning land 4 acres or below are under-represented in the beneficiaries; they form less than 25 per cent of surveyed beneficiaries. Limited land parcel and distance from the substation restricts the ability of farmers to meet project size criteria without compromising agricultural productivity.

Figure 4.2: Household income profile of surveyed beneficiaries as reported



N = 87; Data not shared by 3 respondents
Source: SIA survey

Figure 4.3: Land ownership among surveyed beneficiaries

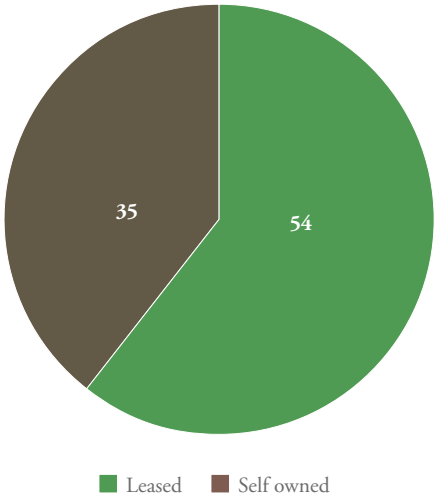


N = 74; Data not shared by 16 respondents
Source: SIA Survey

Amongst the surveyed beneficiaries, 54 (60 per cent) have used their land for solar PV plant, while 35 (40 per cent) have taken land on lease. It is also important to note that, of the 24 installed projects, 20 projects are on self-owned lands and only 3 projects are on leased lands, suggesting undertaking on land ownership is preferred over leased land most likely due to higher costs of leasing lands.

Thus, land ownership is not just a socioeconomic marker, but a gatekeeping criterion for accessing the benefits of PM-KUSUM Component A. Addressing this inequity is essential if the objective is to make the scheme inclusive.

Figure 4.4: Land ownership and land leased among surveyed beneficiaries



N=89; Data not shared by 1 respondent
Source: SIA Survey

Age profile

The above socio-economic analysis can be interpreted along with age profiling of surveyed beneficiaries. Majority of surveyed beneficiaries fall between age 37.5 and 58 years, with a median age of 54.5 years. This indicates that the scheme is primarily accessed by middle-aged and older individuals, who are likely to have financial stability, multiple sources of income (including passive), land ownership and are seeking long-term investments and passive income sources, finding 25-year PPAs attractive.

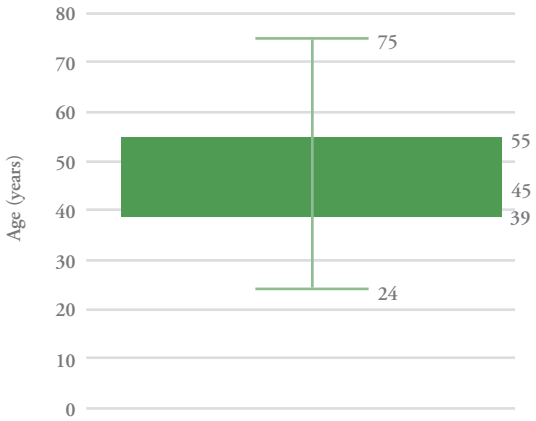
Inference

Assessment of demographic and socio-economic profile: The overall socio-economic and demographic profiling of surveyed beneficiaries suggests that, though scheme targets farmers, the participation of beneficiaries practicing agriculture as primary occupation is limited and highlights potential barriers for that category of population; in terms of accessibility to awareness of the scheme, technical know-how of solar PV, capital and financial instruments among many.

Instead, the survey suggests that typical beneficiaries are educated and socio-economically sound population who practice business or other economic roles as primary occupation, and are well equipped with rural land holdings, financial resources with two of more income sources, technical know-how and capacity to undertake capital intensive projects.

Higher and technical education is observed to play a critical role. Educated beneficiaries are more likely to belong to higher-income households with better access to information about government schemes. They are also better positioned to understand the techno-economics of setting up and operating a solar PV plant, and to mobilize equity and debt financing for project development. Moreover, education equips beneficiaries with the skills needed to monitor plant performance, manage operations and maintenance, navigate regulatory requirements, assess financial viability, and engage effectively with vendors and service providers.

Figure 4.5: Age profile of surveyed beneficiaries



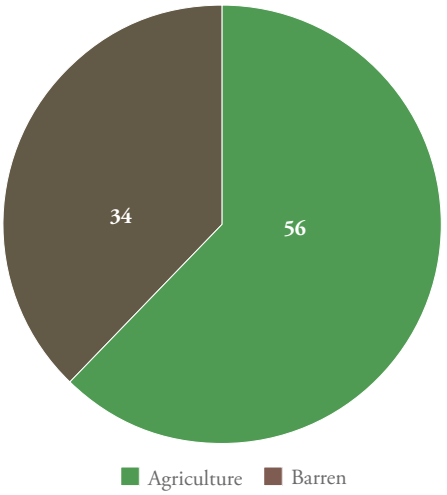
N=90
Source: SIA survey

- **Land use profiling**

  The study also evaluated the land-use and land conversions under PM-KUSUM A, as one of the key objective of the scheme is to utilize barren/fallow and low productive land within the vicinity of substations. However, the profiling of land being utilised for solar PV suggests that substantial land from agriculture is being diverted towards solar PV. Out of the surveyed 90 beneficiaries, 56 (62 per cent) have reported to utilise barren land for solar PV. While 38 per cent of surveyed beneficiaries reported to use agricultural land.

  Note: The reporting of conversion of agriculture land use for solar PV could be under-reported as the scheme favours conversion of barren land over productive land for solar projects.

Figure 4.6: Previous/current land use under PM-KUSUM A surveyed beneficiaries



N=90
Source: SIA Survey

Table 4.2: State-wise previous or current land use under surveyed beneficiaries

Current/previous land use	Haryana	Himachal	Maharashtra	Rajasthan	Total
Agriculture	1	13	8	12	34
Barren	18	20	13	5	56
Total	**19**	**33**	**21**	**17**	**90**

N = 90
Source: SIA Survey

Observations from the data and primary engagement with surveyed beneficiaries suggest that in states like Rajasthan, Maharashtra and Himachal Pradesh previous land use is not the critical determining factor to opt for participation in the scheme; other key factors such as land ownership in the vicinity of identified substation and resources to undertake investments precede land use considerations. This could be attributed to insufficient agricultural income and non-irrigated land in these areas.

In the case of Haryana, strong preference is given for barren land over agricultural land due to well-irrigated land and comparatively high agricultural income, deterring conversion of agricultural land to be solely used for solar PV purposes.

4.3 Awareness and interests in Agri-PV

Across both installed and non-installed surveyed beneficiaries under PM-KUSUM Component A, there is already widespread awareness and strong interest in adopting Agri-PV and the surveyed beneficiaries are willing to adopt dual land use.

All the surveyed beneficiaries reported that they are aware about the Agri-PV and willing to invest in Agri-PV projects. However, while the intent is high, the data shows that beneficiaries require substantial support to transition into Agri-PV systems. Out of the 90 respondents:

- 39 beneficiaries expressed a need for loan and subsidy support, making it the most common requirement. This reflects the known capital-intensive nature of Agri-PV, where the costs of elevated panel structures, irrigation systems, and crop integration demand accessible, low-interest financing and targeted incentives.
- 22 respondents specifically requested combined financial and technical support, especially in Himachal Pradesh and Rajasthan, where land terrain and farming patterns are more complex. This indicates the need for end-to-end wholistic assistance, from feasibility studies and plant design to crop compatibility and revenue modelling.
- A smaller group (5 respondents) asked for only technical support, suggesting confidence in their financial capabilities but uncertainty about system design, shading impact, or integration with farming operations.
- Ease of regulation was noted by 3 respondents, reflecting concerns over approvals, compliance, or possible conflicts between land use norms and energy infrastructure.

Table 4.3: Support needed to undertake Agri-PV

Support needed	Haryana	Himachal	Maharashtra	Rajasthan	Total
Ease of regulation	1			2	3
Financial and technical support	1	15		5	22
Financial support	7	13	20	3	39
No support needed	6	2			8
Technical support				5	5
Didn't respond	4	3		2	9
Total	**19**	**33**	**21**	**17**	**90**

Source: SIA Survey

Dual use of land: A small but significant number of surveyed PM-KUSUM Component A beneficiaries, 9 out of the 24 who have installed projects, reported to simultaneously practice agriculture along with solar plant installations on same land. The predominantly cultivated crops include horticulture crops such as coriander, carrot, tomato, cucumber, brinjal, chilies and peanut/groundnut, and animal fodder. These early adopters are engaged in commercial farming of these crops. This suggests a promising model for installed plants under PM-KUSUM A to retrofit with Agri-PV models.

4.4 Beneficiary experience

The evaluation of beneficiary experience in implementing projects under PM KUSUM Component A is key in identifying enablers, challenges and barriers faced by beneficiaries, which will inform recommendations for enhancing and/or upgrading the scheme for potential adopters.

- **Application experience**

  Among the surveyed 24 beneficiaries who have installed solar plant under Component A, majority of the beneficiaries reported they did not face major hurdles in understanding the guidelines and application process, and in applying for the scheme.

  Of the 24, 15 beneficiaries reported they had not faced any challenges in understanding the guidelines and undergoing application process. However, 7 respondents have faces challenges and/or inconvenience in the due process.

  Note: The accounts of experience of application process reflects beneficiaries who have successfully completed application and have successfully installed. Applicants of the scheme who have faced barriers in application process might have not successfully completion application,

- **Implementation experience**

  Surveyed beneficiaries reported facing several challenges, during design and implementation phase:

  - Financing remains the most critical barrier, with issues including delays in loan approvals and disbursements, high interest rates and collateral requirements, cumbersome bureaucratic processes, and weakened financial viability due to cost overruns.
  - Technical and regulatory hurdles, such as approval delays, KYC mismatches, and ROW clearances, also obstructed implementation in several cases.
  - Land identification and suitability presented practical challenges, particularly in regions with limited or contested non-agricultural land.
  - Despite many beneficiaries having good technical knowledge, structural and procedural bottlenecks were reported to have hindered adoption.

  These findings point to the need for financial de-risking mechanisms, improved inter-agency coordination, farmer-centric process simplification to unlock the scheme's full potential and ensure equitable access.

- **Satisfaction with PPA**

  Among the 24 surveyed beneficiaries with installed plants, responses to the Power Purchase Agreement (PPA) experience were mixed. Of the total, 11 beneficiaries expressed satisfaction with their PPA tariffs offered by DISCOMs. However, 9 respondents indicated dissatisfaction.

A third group, 4 respondents suggested it was too early to comment on their PPA. These include mostly respondents whose plants have recently begun operations.

The tariffs offered in the PPAs is the major factor influencing participation in the scheme. The qualitative discussion in the later part of the report also suggests that tariffs are not attractive to lure significant investments into the scheme, given that the scheme also doesn't offer any direct benefits/subsidies.

From the surveyed beneficiaries, only respondents from Rajasthan and Himachal Pradesh reported their satisfaction with PPA offered. Rajasthan has offered tariff of ₹ 3.04/kWh and Himachal Pradesh offers tariff around ₹ 3.38/kWh to ₹ 3.45/kWh. Surveyed respondents from Maharashtra and Haryana reported dissatisfaction PPA price offered. Maharashtra and Haryana offered ₹ 3.10/kWh and ₹ 2.99/kWh respectively.

- **Delays in grid connectivity**

  DISCOMs are responsible for providing grid connectivity to installed beneficiaries, and majority of beneficiaries have been satisfied with provided evacuation infrastructure. Only 4 of the surveyed beneficiaries have reported inconveniences; mostly delays in development of evacuation infrastructure.

- **Familiarity with O&M practices**

  Among PM-KUSUM Component A beneficiaries, familiarity with operations and maintenance (O&M) of solar plants varies but is generally positive. Out of 24 respondents, 4 consider themselves to be very familiar, 11 are familiar, and 5 report to be moderately familiar. This indicates an overall strong understanding of O&M of solar systems.

  This pattern aligns with the findings on high educational levels, suggesting that better-educated beneficiaries are more proactive and self-reliant in managing technical systems. Their familiarity includes routine cleaning, basic fault identification, and monitoring generation through dashboards or meters. Half of the respondents have also received training from their engineering, procurement, and construction (EPC) contractors on O&M practices.

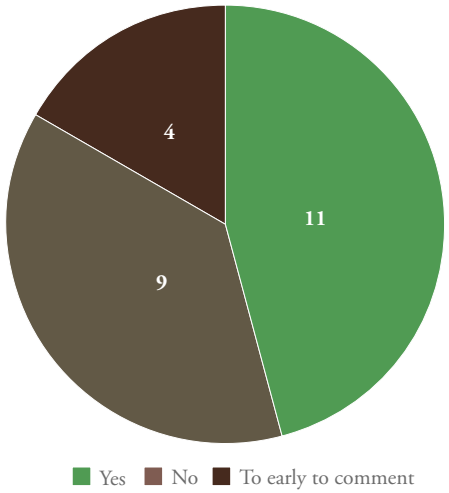
4.5 Investment and financial profile

Data from 24 beneficiaries who have successfully installed solar project under PM KUSUM Component A is evaluated. The investment and financial profiling of projects is useful in building case for future beneficiaries, enhancement of financial terms of existing scheme and inform design of future alike schemes.

- **Engagement of contractor and consultant for installation**

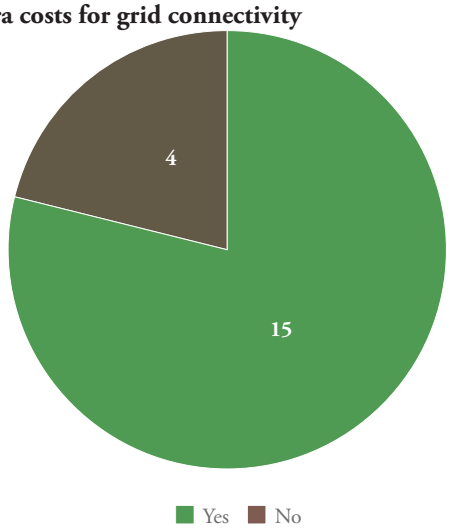
  Amongst the beneficiaries with installed plants, 17 (74 per cent) reported engaging a consultant or contractor to support

Figure 4.7: Satisfaction with PPA among surveyed beneficiaries



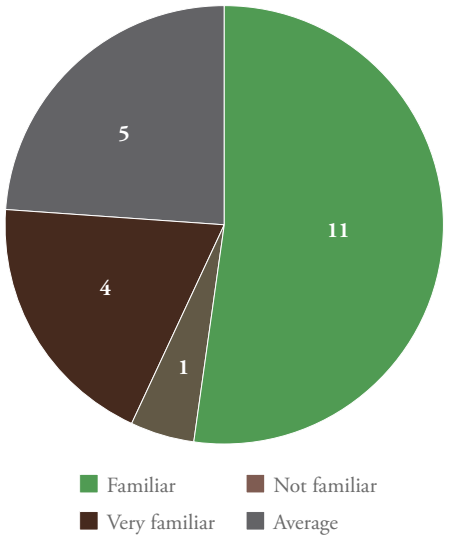
N=24
Source: SIA Survey

Figure 4.8: Challenges of delays, disputes and/or extra costs for grid connectivity



N=24
Source: SIA Survey

Figure 4.9: Familiarity with O&M practices

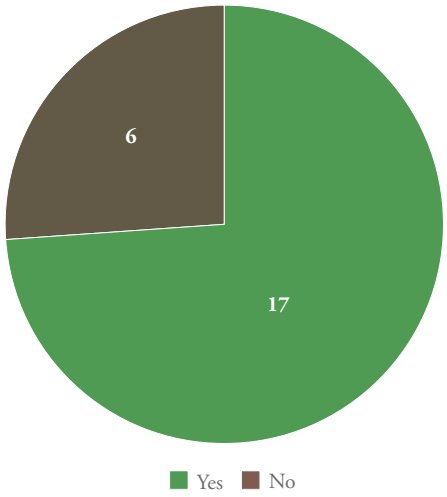


N=21; Data not provided by 3 respondents
Source: SIA Survey

design and installation of solar power plants. In contrast, only 6 beneficiaries (26 per cent) managed the process independently or without external support. It was also observed that beneficiaries who did not engage consultants are already closely associated with the solar PV business.

Many of the beneficiaries also did not hire consultants during the application process, suggesting their ability to manage administrative processes independently. This points to a strong link between education and procedural accessibility, where educated individuals are better equipped to engage with regulations and formalities. In contrast, those facing difficulties likely had lower exposure to administrative systems or technical language.

Figure 4.10: Engagement of consultant/ contractor

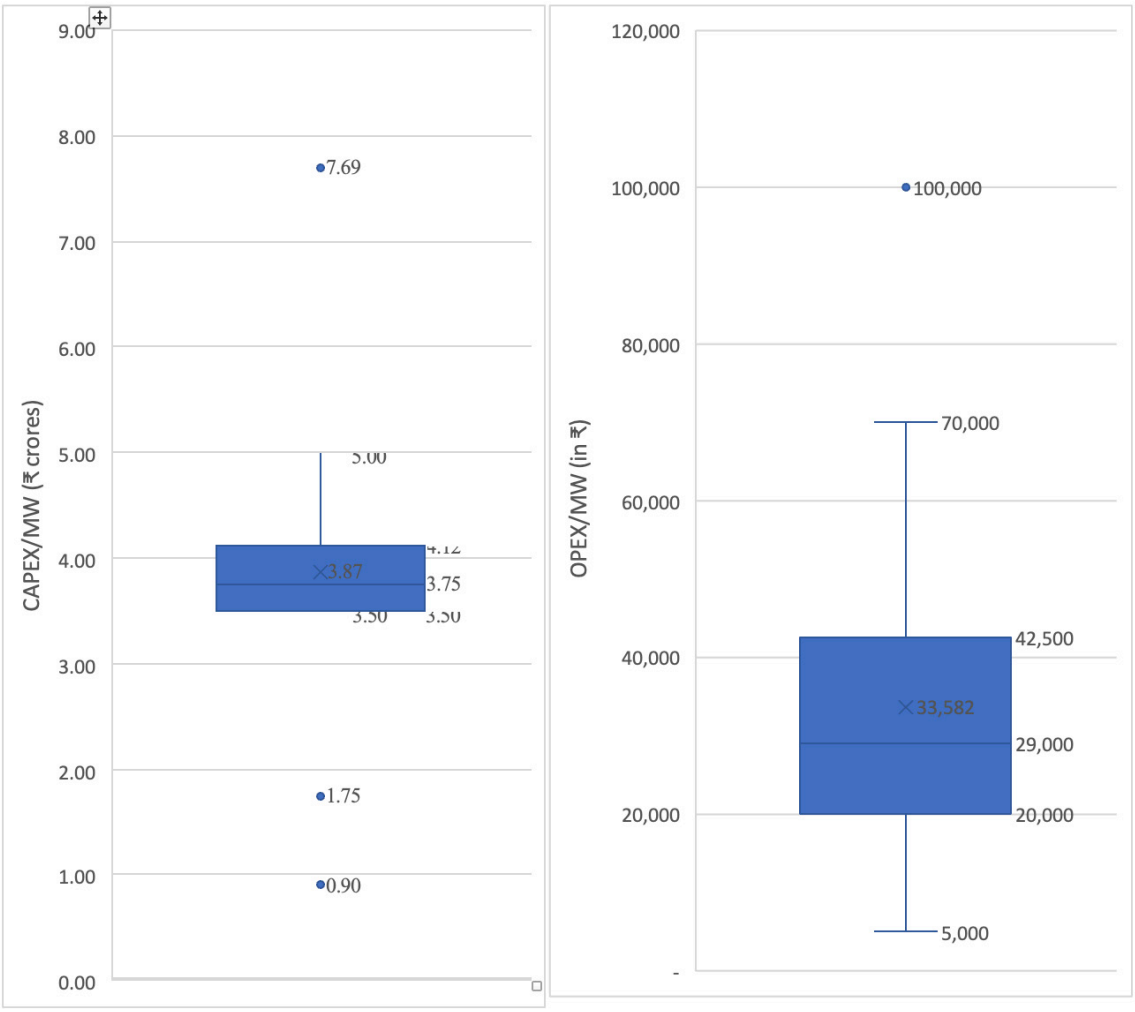


N=24
Source: SIA Survey

CAPEX and OPEX

The majority of reported CAPEX costs are tightly clustered around ₹ 4 crore/MW, indicating a consistent benchmark among most beneficiaries. This aligns with typical market estimates for small scale solar projects in India. Some of the outliers and discrepancies are resulting from variations in land ownership (owned vs. leased) and inclusion/exclusion of additional civil works on site etc. While OPEX costs ranged between ₹ 20,000–₹ 50,000/MW, indicating a reasonably predictable cost band around the typical market cost of ₹ 30,000/MW.

Figure 4.11: Distribution of CAPEX and OPEX among surveyed beneficiaries



N = 23; Data not shared by 1 respondent
Source: SIA survey

Average revenue from plants

Three-fourth of the surveyed beneficiaries with installed plants report monthly revenue between ₹3.8 lakh to ₹5.5 lakh/MW, with a median of ₹4.5 lakh/MW/month, which aligns with market standards and observations from case studies.

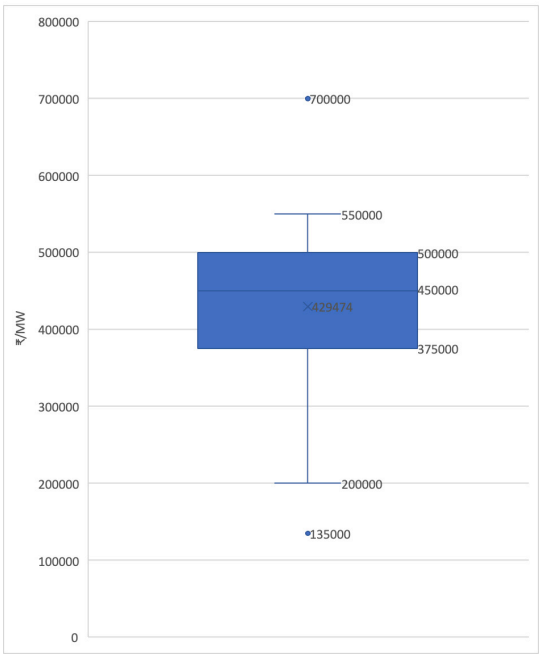
4.6 Delays in yet-to-be installed projects

The 66 beneficiaries who have been allotted capacity under the scheme but have not implemented/operationalised projects for various reasons broadly fall into three major categories: pending approval, pending financing, and installation in-process.

Delays in the installation of the projects is common across states. However, Maharashtra has prolonged delays as late as 2022, predominantly due to financing challenges. Projects in Haryana are hindered mostly due to approval challenges. Himachal Pradesh fares better in comparison to

Maharashtra and Haryana, where delays arise from financing and approval challenges, but also has several projects in pipelines and awaiting to be commissioned.

Figure 4.12: Revenue per MW from surveyed beneficiaries



N = 19; Data not shared by 5 respondents
Source: SIA survey

Table 4.4: Allotted dates of non-installed solar plants from surveyed beneficiaries

State	2022	2023	2024	2025	Total
Haryana		16	2		18
Himachal Pradesh			11	16	28
Maharashtra	13	1	6		20
Total	**13**	**17**	**19**	**19**	**66**

N = 66
Source: SIA survey

Table 4.5: Status of non-installed projects among surveyed beneficiaries

Status of non-installed projects	Haryana	Himachal Pradesh	Maharashtr a	Total
Awaiting approval	13	9		22
Awaiting approval and financing		2	4	6
Awaiting financing	2	14	14	30
Awaiting installation		3	2	5
No response	3			3
Total	**18**	**28**	**20**	**66**

N = 66
Source: SIA survey

The largest group of non-installed projects are stuck at the financing stage, especially in Maharashtra and Himachal Pradesh wherein projects since 2022 remain lagging. This converges with the broader findings where beneficiaries cited loan disbursement delays, high interest rates, and lack of accessible credit as major challenges. It reinforces the critical need for streamlined financial processes and better bank coordination.

An in-depth look at the financing status of the 66 non-installed projects across Haryana, Himachal Pradesh, and Maharashtra reveals that financing is the single most critical bottleneck in project implementation. Despite strong interest and awareness

among beneficiaries, financing of projects due to longer process of loan, inadequate collaterals and higher interest rates among many.

Table 4.6: Status of financing of non-installed survey beneficiaries

Financing status	Haryana	Himachal Pradesh	Maharashtra	Total
In process	4	15	13	32
No	1	10	5	16
Yes	13	3	2	18
Total	**18**	**28**	**20**	**66**

N = 66

Source: SIA survey

Of the 66 surveyed non-installed beneficiaries, 18 have received approval of financing, while the majority of projects are either awaiting financing (32, 73 per cent) or have been denied (16). This aligns directly with earlier findings where 30 out of 66 respondents identified financing as their main hurdle.

Haryana performs relatively better, with 13 of 18 projects financed, but also shows 4 pending cases. Himachal Pradesh and Maharashtra face serious challenges wherein only 3 and 2 uninstalled projects have received financing among surveyed beneficiaries. In Himachal Pradesh, 25 out of 28 projects are either pending, in process, or denied financing.

These patterns mirror findings on overall financing challenges – long loan processing times (up to a year) and higher-than-permitted interest rates, as well as requests for loan and subsidy support (39 respondents).

In addition to financing, approval concerns also remain a significant concern. Projects held up in Haryana are from period 2023 are largely due to delays approval reasons.

4.7 Case studies

To further build upon the surveys, two detailed case studies through telephonic interactions were conducted with two beneficiaries. These detailed interactions dealt with mapping of their experience and journey in undertaking these projects, further probing into views and perceptions on the scheme, their motives and interests in opting the scheme their future interests in this and similar schemes, including Agri-PV.

Case study 1

Ram (name changed) is a 52-year-old IT executive in India. He heads the service delivery for a multi-national IT firm. Ram is very motivated in social and environmental causes.

Driven by a strong personal commitment to sustainability and clean energy, Ram commissioned a 2 MW solar power plant under the PM-KUSUM Component A. His project, commissioned in June 2023, was the first to be commissioned under the scheme in Maharashtra.

Ram comes from a very well-to-do economic background, with an annual household income of up to ₹ 2 crores. He is a silver category taxpayer. He holds a bachelor's degree in electronics and communications and has been in the IT industry for over 30 years. He also simultaneously manages agriculture on his ancestral land holding. Along with Agri-PV, he also harvests rainwater and recharges groundwater on his land. His project was showcased as a social and sustainability service initiative by his IT firm.

The solar plant was commissioned with a cost of ~ ₹ 8.3 crores, for which Ram took a loan of ₹

5.82 crores along with his capital of ₹ 2.5 crores. He hired a reputed EPC provider, to install this plant. He says this cost was higher than earlier estimations, as he faced cost overruns due to some civil works.

Perspectives on PM-KUSUM A and Agri-PV: Ramwas always very keen on venturing into solar PV business. It's been over a year since his solar plant was commissioned and since then his views have changed. He believes scheme is not a priority for the government – the focus is on scaling RE is over emphasized on developing large solar parks and very minimal attention given to schemes targeting small entrepreneurs like himself.

Despite his long-standing interest in solar and having invested in this scheme, he sees very limited incentives for broader adoption and for scaling of the scheme. He suggests some corrective measures are needed for addressing the financial viability and implementation mechanisms.

Experience: Ram is very well aware of the solar PV, had a long-standing interest and is well- connected to consultants and service providers in the solar PV industry. He regularly monitors the plant performance, oversees O&M activities along with 6 full time staff on site, and has outsourced compliances audits/checks.

He spends up to ₹ 15 lakhs/year on O&M and related activities. If completely outsourced, he says the O&M costs can go as high as ₹ 25 lakhs/year. During the installation of the solar plant, Sumat faced several challenges including difficulties in receicing timely line of credit despite strong financial profile and prolonged delays in converting agricultural land to non-agricultural status (despite the deemed approval status under the scheme).

Ram feels current PPA terms of ₹ 3.10/kWh are not financially attractive, especially for smaller or independent entrepreneurs. He says monthly revenue from this plant is ₹8.5–9 lakh/ month while EMI for his loan is ₹6.5 lakh/ month, and with O&M costs of ₹1 to 1.5 lakh/ month, his net income is ₹1.5 to 2 lakhs. He says this is not very lucrative, his estimated payback period of 9 to 10 years is now up to 15 years.

Interest in Agri-PV: Ram is very interested in Agri-PV. He views it as a complex model, especially regarding maintenance and cleaning; and stresses on the need for more advanced and farmer-friendly technologies that can be operated easily at lower costs.

Recommendations: Based on his experience in undertaking project under PM-KUSUM Component A, Ram finds financial viability a key determining factor for investment under the scheme, as currently offered tariffs don't make these investments very viable.

He suggests, instead of higher tariffs, incentives can be performance linked or at least increase of tariffs over time to counter rising O&M costs and inflation.

Along with making investments financially viable, he suggests that the scheme should proactively encourage small entrepreneurs by ensuring a strict beneficiary scrutiny to prevent larger RE developers from over-populating the scheme.

Ram's experience exemplifies the potential and pitfalls of PM-KUSUM Component

A. While the scheme enables meaningful private investment in the RE sector, it requires reforms in financing, regulatory simplification, and targeted support to become truly inclusive and scalable.

Case study 2

Rajesh (name changed), a 55-year-old male resident of Rampura village in Jaipur district, Rajasthan, is owner of a 0.5 MW solar plant installed under the PM-KUSUM A scheme. He has a primary school education and comes from an agrarian background; however, his family members and close associates include individuals with higher education. His primary occupation is agriculture, while his secondary income source now comes from the solar business. These factors reflect a degree of economic stability. His participation in the PM-KUSUM A scheme was motivated by diversifying income and venture into RE business.

His 0.5 MW solar power plant, commissioned in October 2023, is located on one acre of land in the same village he lives in. Prior to its installation, the land was actively used for agricultural purposes. Rajesh engaged an individual contractor to assist with the design, planning, and commissioning of the plant. The total capital expenditure (CAPEX) for the plant was approximately ₹2 crore. There are no recurring OPEX, as he personally handles the maintenance of his small plant.

Financing and other hurdles: The installation was primarily financed through a bank loan of ₹1.35 crore at an interest rate of 10 per cent, resulting in a monthly EMI of ₹1.6 lakh/annum. The solar plant generates an average monthly income of ₹1.8 to ₹2 lakh. However, Rajesh expresses dissatisfaction with the tariff offered under the scheme, indicating a need to reassess pricing mechanisms for better returns to small producers.

During the pre-installation stage, he found the scheme's terms and guidelines a bit difficult to understand. However, major hurdle faced was with regards to financing, as he was initially refused the loan, and it eventually took around 8–10 months for him to clear the application process and secure finance. Furthermore, he also discussed that support received from DISCOM was very limited, and possibly a reason for the delay in commissioning the project.

Experience with operations: Since he operationalized his 0.5 MW plant, he has not experienced any challenges with respect to evacuation of power, O&M, plant performance, and functioning of components. He is also planning to invest in a second plant under the PM-KUSUM Component A scheme, showing strong confidence in the initiative, provided better PPA terms. He has also referred the scheme to his relatives, helping spread awareness and participation.

Awareness of Agri-PV: Rajesh is very well aware of Agri-PV. On his 0.5 MW land, he also simultaneously practices agriculture in parallel with solar generation. He cultivates tomato, cucumber, brinjal, and chillies on part of land under solar plant and adjoining area of 13 hectares. He is also interested in the idea of integrating the existing plants under PM KUSUM A with Agri-PV.

Recommendations: To further scale PM-KSUSUM A and agrivoltaics, Rajesh suggests that greater financial support and simplified regulatory and approval processes are key.

Disclaimer: *The names and personal details of case study respondents presented in this report have been changed to maintain confidentiality and protect the privacy of participants.*

05

Synthesis and Recommendations

The PM-KUSUM Component A is one of the few central government initiatives focused on scaling small-scale solar plants for farmers and rural entrepreneurs. However, the scheme has not been able to meet its targets. Evaluating its implementation, examining both enabling factors and key barriers, is therefore critical to improving the current scheme and informing the design of future initiatives, including for Agri-PV.

The findings from the evaluation of the implementation of the scheme reflect a wide range of on- ground realities, ranging from socio-economic characteristics of target population, experience of beneficiaries undertaking small-scale solar projects, role and support of SIAs, DISCOMs and government departments in implementing schemes, financing, regulatory, technical and other enablers or barriers that has influenced the implementation.

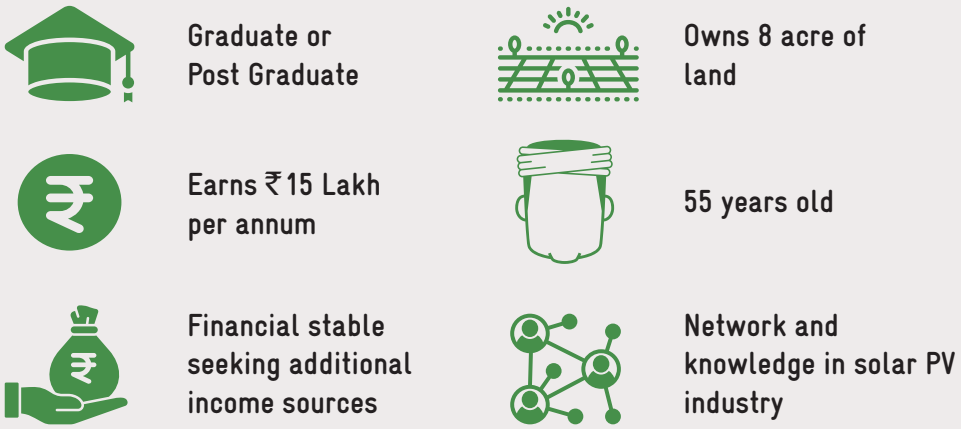
This chapter synthesizes the key findings from data analysis of PM-KUSUM Component A beneficiaries, case studies and literature review, with a focus on drawing actionable insights. It outlines the core patterns that emerged, regarding beneficiary demographics, challenges and experience under the scheme, future interest in agrivoltaics and related new ventures among many. By analyzing both installed and non-installed beneficiary experiences, the chapter highlights critical enablers and systemic barriers. Building on this evidence, the chapter offers a set of recommendations aimed at addressing the financial viability, accessibility, and scalability of Agri-PV schemes in India.

5.1 Insights on PM-KUSUM Component A

The beneficiary profiling of PM-KUSUM Component-A reveals key defining factors for participation in scheme. The typical population participating in the scheme are revealed to be highly educated and financially sound individuals, with substantial land holding and high annual incomes. The socio- economic profile also suggests that the surveyed beneficiaries had strong social and professional networks in field of business, especially solar PV. A strong educational background enhanced beneficiaries' ability to understand solar PV operations, navigate scheme procedures, and access financial resources effectively.

Although institutional participation is permitted under the scheme, no institutional beneficiaries were identified in the list of beneficiaries shared by SIAs.

Figure 5.1: Typical profile of surveyed beneficiary



Overall, setting up projects under the scheme is a major investment decision for participants, who are seeking long-term and continuous returns. In this view, financial viability and resources to finance projects have been the major determining factors for implementation of the scheme.

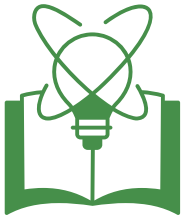
While the majority of the surveyed beneficiaries with successfully installed projects were of sound financial background, they still faced significant hurdles in securing project financing. In this regard, access to credit, shorter loan processing periods, relaxed interest terms and collateral requirements can help improve access to the scheme. The scheme can also benefit from dedicated line of credit created with commercial banks, with a payment security fund set up for covering risks.

The tariffs for projects under PM-KUSUM A are notified to be marginally higher than tariffs for large-scale solar projects, to account for the small scale of the projects. However, for individuals operating on these small-scale solar projects of up to 2 MW capacity, the costs and margins are still quite thin. Surveyed beneficiaries' perception on PPA terms is mixed, and they typically seek additional financial benefits in terms of direct subsidies, performance linked incentives, better financing terms and/or higher tariffs to make projects viable. Notably, the current payback period for several beneficiaries is estimated to be over 10 years, which is very high compared to payback period in utility scale projects as low as 3 to 4 years.[7]

In addition to financing and financial viability constraints, project implementation is also reported to be hindered by regulatory delays related to land conversion and grid approvals, as well as lack of support from SIAs and administrative hurdles. This is reasoned by inadequate implementation capacity in SIA and lack of operational directives to implementing staff. PM KUSUM Component A being the central government scheme needs stronger implementation directives and measures to address these challenges.

5.2 Design recommendations for future Agri-PV interventions

Agri-PV is gaining increasing interest in India, and insights from primary discussions with PM- KUSUM Component A beneficiaries indicate that awareness of the concept is already widespread among this group. As a key segment of the potential target population for Agri-PV adoption, these beneficiaries have shown a strong willingness to invest in Agri-PV, provided adequate technical, financial, and regulatory support is available. Key recommendations and insights in this context are as follows:



Expanding the scope of PM-KUSUM Component A to support Agri PV projects

- While PM-KUSUM Component A permits the development of Agri-PV projects, the scheme currently lacks dedicated provisions or incentives to actively promote this dual land-use model.
- Given the growing interest and readiness among beneficiaries, as reflected in the survey where all respondents expressed willingness to adopt Agri-PV, there is a strong case for expanding and institutionalizing Agri-PV within the scheme's framework.
- Component A can further be expanded with a specific focus on Agri-PV, targeting both existing and new installations:
  - SSupport retrofitting of existing PM-KUSUM A plants to incorporate agricultural activity, through financial and technical assistance for additional effort.
  - Introduce dedicated sub-component within Component A focused exclusively on Agri-PV, with clear annual targets for deployment across states
  - Offer additional incentives for new Agri-PV plants, including capital subsidies or higher tariff and/or interest subvention, to offset the higher costs of dual-use infrastructure.

Improve project targeting to enhance scheme reach and build equity

PM-KUSUM Component A has predominantly attracted educated, financially sound individuals with substantial landholdings and high annual incomes, reflecting the capital-intensive nature of setting up small-scale solar plants. This segment remains crucial for scaling Agri-PV adoption, however broader adoption, particularly by small and marginal farmers, farmer-producer organizations (FPOs), and cooperatives, is essential for inclusive growth. This can be achieved by:

- **Deepening adoption within the current profile:**
  - Develop pre-approved financing packages with streamlined documentation and faster disbursals for high-credit borrowers, enabling quicker uptake within the current target group.
  - Enable multi-plant ownership or capacity expansion for performing beneficiaries, including incentives for retrofitting plants with Agri-PV components.
  - Create peer-learning platforms where successful plant owners mentor potential new adopters within their region or social networks.

- **Expand access to small and marginal farmers, FPOs, and cooperatives**
  - » Introduce a special window for FPOs, cooperatives, and collectives to apply for shared solar plants under Component A, with group land pooling provisions and joint PPAs.
  - » Redefine eligibility criteria to allow smaller land parcels and land slightly beyond the current 5 km substation limit, especially where pooled or leased land is used.
  - » Provide project development services (PDS) that assist smallholders and FPOs through the full lifecycle, from feasibility studies to financing, construction, and O&M training.

Simplify financing access and ensuring project viability:

Access to affordable and timely finance remains the most critical barrier for beneficiaries under PM-KUSUM Component A. A majority of non-installed projects across surveyed states are delayed or stalled due to loan approval challenges, high interest rates, and inadequate collateral. Additionally, the viability of projects is undermined by low or uncompetitive PPA tariffs, with substantially higher payback periods than large power plants. This is crucial to be addressed as Agri-PV plants are even more capital intensive.

To address these twin challenges of financing and viability, a two-pronged strategy is needed:

- **Improve access to affordable financing**
  - » Mandate dedicated loan products for PM-KUSUM through public sector banks, NABARD, and cooperative banks with simplified eligibility criteria, streamlined documentation and faster disbursal timelines.
  - » Offer equity support or blended finance models through convergence with other government schemes (e.g., FPO support programmes, rural infrastructure funds, DMF funds etc.).
  - » Introduce credit guarantee mechanisms to reduce borrowing costs and mitigate lender risk, particularly for first-time borrowers.
- **Enhance Project Viability Through Tariff Reforms**
  - » Revisit PPA tariffs to ensure they reflect actual project costs, especially in high-CAPEX contexts like Agri-PV or leased land installations.
  - » Allow states to adopt variable tariffs (e.g., higher tariffs for Agri-PV or retrofitted systems) to encourage specific adoption models.

Enhance state-level effort to create an ecosystem for rural PV and Agri-PV adoption

While PM-KUSUM Component A has initiated momentum around decentralized solar in rural areas, widespread adoption of rural PV, particularly Agri-PV, remains limited due to the lack of technical guidance, enabling regulations, and local ecosystem support. Most farmers and rural entrepreneurs face challenges such as unclear land-use permissions, limited access to tailored technical support, and fragmented institutional coordination.

- **Build technical and institutional support systems**
  - » Set up dedicated rural solar and Agri-PV facilitation units within state renewable energy development agencies to support system design, project planning, and farmer outreach.
  - » Partner with agricultural universities and Krishi Vigyan Kendras (KVKs) to develop localised Agri-PV models, suitable crop-panel combinations, and productivity baselines.
  - » Conduct training programs for rural entrepreneurs, cooperatives, and local contractors on solar installation, O&M, and dual-use land management.

- **Simplify land and regulatory frameworks**
  - » Streamline land conversion processes to allow agricultural land to be used for solar deployment with minimal approvals and clear dual-use guidelines, as despite deemed conversion provisions landowners face procedural challenges.
  - » Issue state-level policy notifications on permissible structures, minimum panel height, and crop compatibility under Agri-PV to provide regulatory certainty.
  - » Create land banks near substations with mapped potential for rural PV and shared access to grid infrastructure for cooperatives and small farmers.
- **Integrate rural PV and Agri-PV into broader rural development agenda**
  - » Incorporate rural PV deployments including Agri-PV into state-level renewable energy, agriculture, and rural livelihoods policies, promoting cross - departmental alignment and budgetary convergence.
  - » Pilot model projects in different agro-climatic zones to demonstrate scalable and replicable models, especially for marginal and smallholder farmers.
  - » Foster local innovation and entrepreneurship by supporting start- ups, community solar developers, and FPO-led solar initiatives in rural areas.
  - » Develop single-window clearance systems for land conversion, approvals, and grid connection infrastructure. Designate state-level nodal officers or district Agri-PV coordinators to assist applicants and track project progress.

5.3 Conclusion

The design recommendations for future Agri-PV interventions emerge directly from the lived experiences of PM-KUSUM A beneficiaries and the structural barriers observed in its implementation. The analysis highlights that while interest in Agri-PV is already high among potential adopters, systemic gaps in financial access, tariff design, regulatory clarity, and institutional support continue to constrain both the pace and inclusivity of adoption.

Expanding the scope of Component A to explicitly integrate Agri-PV—through dedicated sub-components, capacity building and retrofitting support—will be central to mainstreaming this dual land-use model. Equally critical is improving equity by widening access to small and marginal farmers, farmer collectives, and cooperatives through tailored financial instruments, land pooling mechanisms, and project development support.

Addressing financing challenges via credit facilitation alongside tariff reforms that reflect true project costs, will directly improve viability and reduce risk perceptions for both farmers and financiers.

Finally, state-level facilitation must evolve to provide the regulatory certainty, technical guidance, and institutional ecosystem needed for Agri-PV adoption at scale. This includes simplifying land-use permissions, building technical capacity, and embedding Agri-PV within broader rural development frameworks. Taken together, these recommendations present a comprehensive roadmap that moves beyond incremental adjustments to PM-KUSUM A, and toward a more inclusive, viable, and scalable Agri-PV program that aligns India's renewable energy goals with sustainable agricultural development and rural livelihoods.