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kotak karma

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LIST OF ABBREVIATIONS

APPC	:	Average Power Purchase Cost
Agri-PV	:	Agriphotovoltaics
BOB	:	Bank of Baroda
BOI	:	Bank of India
CapEx	:	Capital Expenditure
CFA	:	Central Financial Assistance
CUF	:	Capacity Utilization Factor
DISCOM	:	Distribution Company
EMI	:	Equated Monthly Instalment
FiT	:	Feed-in Tariff
FLS	:	Feeder Level Solarisation
HT	:	High Tension
IARI	:	Indian Agricultural Research Institute

IPS	:	Individual Pump Solarization
IRR	:	Internal Rate of Return
JVVNL	:	Jaipur Vidyut Vitaran Nigam Limited
KVKs	:	Krishi Vigyan Kendras
kWh	:	Kilo Watt hour
MNRE	:	Ministry of New and Renewable Energy
mm	:	Mili meter
MP	:	Madhya Pradesh
MPPCL	:	Madhya Pradesh Power Generating Company Limited
MPPKVCL	:	Madhya Pradesh Poorv Kshetra Vidyut Vitaran Co. Ltd
MUPVNL	:	Madhya Pradesh Urja Vikas Nigam Limited
MW	:	Megawatt
NABARD	:	National Bank for Agriculture and Rural Development
NPV	:	Net Present Value
O&M	:	Operations and Maintenance

PLFS	:	Periodic Labour Force Survey
PM-KUSUM	:	Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan
PPAs	:	Power Purchase Agreements
PV	:	Photovoltaics
RCC	:	Reinforced Cement Concrete
RE	:	Renewable Energy
SBI	:	State Bank of India
SERC	:	State Electricity Regulatory Commission
SOPs	:	Standard Operating Procedures
UBI	:	Union Bank of India
WUA	:	Water User Association

FOREWORD

India's development journey over the coming decades will be influenced by its ability to address three interconnected challenges: ensuring energy security, revitalizing agriculture, and building resilience against climate change. Too often, these objectives are pursued independently, despite synergies across sectors that hold the potential for generating multiple benefits from the same investment. Agriphotovoltaics (Agri-PV), which combines agricultural production and solar energy generation on the same parcel of land, represents one such opportunity.

Agriculture remains the backbone of rural livelihoods, supporting a substantial share of India's workforce. Yet the sector continues to face challenges arising from low and volatile farm incomes, fragmented landholdings, resource degradation, and increasing climate risks. At the same time, India is accelerating its clean energy transition in pursuit of its renewable energy and net-zero commitments. The challenge before policymakers is not simply to expand renewable energy capacity, but to do so in a manner that strengthens rural livelihoods and promotes inclusive growth.

This report, Harvesting Sun and Soil: India's Agri-PV Future, examines how Agri-PV can contribute to this broader development agenda. By enabling the simultaneous production of food and energy, Agri-PV offers a pathway to transform agricultural land into a source of diversified and resilient income. It has the potential to improve land-use efficiency, reduce conflicts between food and energy production, strengthen climate resilience, and enable farmers to participate directly in India's clean energy transition.

The report recognizes that there is no universal model for scaling Agri-PV. Its success will depend on context-specific business models, institutional arrangements, and enabling policy frameworks. Through an assessment of community-owned, developer-led, and farmer-owned approaches, the study explores the opportunities and challenges associated with different pathways to scale.

Particularly noteworthy is ICRIER's work in designing and supporting one of Rajasthan's first farmer-owned Agri-PV demonstration pilots under PM-KUSUM. Developed from the ground up as a proof of concept, the initiative seeks to demonstrate how solar energy generation and agriculture can coexist on the same land while improving the economic viability of farming. The pilot reflects ICRIER's commitment to complementing policy research with field-based evidence and practical solutions that can inform future policymaking.

A recurring message emerging from this research is that technology alone will not determine success. Supportive policies, affordable financing, effective institutional coordination, and farmer-centric design principles will be equally important. As India seeks to build a more sustainable and inclusive development pathway, Agri-PV offers an opportunity to align clean energy expansion with agricultural prosperity.

It is our hope that this report will stimulate informed dialogue among policymakers, researchers, financial institutions, developers, and development partners. More importantly, we hope it will encourage a broader conversation on how India can build a farmer-centric clean energy future that strengthens livelihoods, enhances resilience, and unlocks new opportunities for rural transformation.

SHEKHAR AIYAR
Director & Chief Executive
ICRIER

ABSTRACT

India's transition to clean energy is gaining momentum, but the agricultural sector-despite being a major land user and energy consumer has yet to fully participate. Agri-PV, the co-location of solar panels and agriculture on the same land, offers a powerful opportunity to bridge this gap. It enables dual income streams for farmers through crop cultivation and energy sales while optimizing land use and supporting India's renewable energy goals.

This report from ICRIER examines the evolution, business models, and future scalability of Agri-PV in the Indian context. We define Agri-PV as the simultaneous use of farmland for grid-connected energy generation and agriculture, with both income streams being central to its design and implementation.

The study explores the commercial applicability of Agri-PV by studying different business models that are currently operational on farmers' field or are going to be implemented in the near future. Two in-depth case studies illustrate the potential and challenges of the farmer-owned model under PM-KUSUM. One highlights a 4.5 MW Agri-PV plant in MP set up by an individual farmer. The second case study explores an Agri-PV project in Rajasthan. Both use the PM-KUSUM-A policy platform and demonstrate economic feasibility, while revealing hurdles such as payment delays and regulatory fragmentation.

The report highlights that scaling Agri-PV requires flexible business models, clear policies, viable financing, and strong inter-agency coordination. When grounded in farmer realities and backed by effective implementation, Agri-PV can make India's energy transition more inclusive, equitable, and sustainable.

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EXECUTIVE SUMMARY

India stands at the cusp of a transformative energy and agricultural shift. As the country intensifies its efforts toward achieving net-zero carbon emissions by 2070, the agriculture sector traditionally seen as a consumer of energy-must now be viewed as a potential contributor to clean energy generation. Agriphotovoltaics (Agri-PV) that entails the co-location of solar infrastructure and agricultural activity on the same land, offers a unique opportunity to align India's twin goals of energy transition and agricultural transformation.

This report explores the evolving landscape of Agri-PV in India, drawing from field evidence and emerging policy frameworks. The report attempts to capture the current state of Agri-PV deployment and the forward-looking strategies necessary for its scalable adoption.

The study starts by tracing the evolution of Agri-PV from a research-led concept to a practical, commercially viable model in the Indian context. Globally, Agri-PV has been interpreted in fragmented ways, some emphasizing energy generation with minimal regard for crop viability, and others focusing narrowly on shade provision without exploring its economic return potential. India with its vast agrarian population and growing energy needs, a siloed approach is neither sustainable nor desirable.

Recognizing these diverging interpretations, the Indian Council for Research on International Economic Relations (ICRIER) offers a grounded, balanced, and inclusive definition of Agri-PV, the simultaneous use of farmland for solar energy generation and agricultural production, with the goal of enabling dual income streams through crop cultivation and sale of surplus electricity to the grid. Our framing ensures that agriculture remains central to the model, while empowering farmers to become active stakeholders in India's renewable energy journey.

This study through multiple case studies attempts to initiate discussion on business models for commercial-scale Agri-PV deployment, recognizing that financial and institutional design will shape the success and scalability of such initiatives. We examine three emerging ownership and implementation models:

Developer-Owned Agri-PV Model: where private solar developers set up Agri-PV infrastructure on leased farmland compensating farmers through fixed rentals or revenue-sharing arrangements.

Community-Owned Agri-PV Model: where Farmer Producer Organizations (FPOs) or cooperatives collectively own and manage the Agri-PV infrastructure, enabling distributed benefits and more democratic governance structures.

Farmer-Owned Agri-PV Model under Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM) A: where individual farmers, supported by debt-equity financing and government incentives under Component A of PM-KUSUM, set up grid-connected solar plants on their agricultural land.

This report focusses on the farmer-owned model under PM-KUSUM A, given its potential for direct farmer empowerment and decentralized energy generation. To ground this model in empirical reality, we present two in-depth case studies.

The first case examines one of India's largest Agri-PV plants a 4.5 MW installation spread over 15 acres in Madhya Pradesh (MP). Developed by a progressive farmer using the PM-KUSUM A platform, this plant exemplifies how commercial scale solar can be integrated with high-value crop cultivation. The case explores the technical configuration, irrigation practices, biodiversity implications, and economic viability in terms of payback period and Internal Rate of Return (IRR).

The second case study, situated in Rajasthan, focuses on a forthcoming Agri-PV deployment through the same scheme. This model highlights how existing policy frameworks, if well-coordinated, can support Agri-PV adoption even in semi-arid contexts. These case studies also outline some of the policy and operational challenges such as energy evacuation delays, DISCOM payment lags, and interdepartmental bottlenecks that must be addressed to enable scale.

These models and case studies underscore that a "one-size-fits-all" approach to Agri-PV is inadequate. Instead, flexible business models-tailored to regional contexts, land ownership structures, and farmer capacities are needed to catalyse widespread adoption.

The study echoes one consistent message: Agri-PV, if designed and executed with local realities in mind, can be a transformative strategy for India. It has the potential to address energy access gaps, improve discoms finances, alleviate rural incomes, reduce land-use conflicts, and make agriculture more resilient in the face of climate change.

For Agri-PV to reach its full potential, several enablers must be strengthened. These include clearer policy guidelines, better coordination among central and state agencies, flexible financing models for small and marginal farmers, and improved integration of research with implementation. Furthermore, capacity building for farmers and DISCOM officials, demonstration pilots in ecologically diverse regions, and incentives for agri-friendly solar infrastructure design are essential next steps.

At ICRIER, we view this report as a contribution to an emerging field that sits at the intersection of clean energy, sustainable agriculture, and inclusive rural development. Our research aims to inform practitioners, policymakers, and development partners about the real-world potential of Agri-PV, not as a one-size-fits-all solution, but as a modular, adaptable approach capable of serving diverse agro-ecological and socio-economic contexts.

As India looks ahead to its clean energy and sustainable development targets, Agri-PV offers a compelling model for convergence. Through this report, we hope to spark dialogue, foster collaboration, and encourage more inclusive policy and investment catering to the country's agrarian populace.

INTRODUCTION

India is at the crossroad of becoming a strong economy and achieve the vision of *Viksit Bharat*. According to the Periodic Labour Force Survey (PLFS) report, nearly 43 percent of the workforce engaged in agriculture for their livelihoods (PLFS Report, 2024-25), making this sector a cornerstone of India's development story. Revitalizing agriculture is not just a policy choice; it is an essential economic imperative. However, Indian agriculture continues to struggle, with the age-old problem of low and volatile farm incomes, a challenge compounded by the growing impact of climate change.

To bridge the gap between agriculture distress and India's potential for development, a pressing necessity is to re-envision rural development using holistic, cross-sectoral solutions. The traditional approaches of addressing energy, agriculture, and livelihoods in silos is no longer valid in the framework of complex climate and economic pressures. Instead, approaches that create synergies between clean energy and climate-resilient agriculture can potentially unlock new avenues for rural sustainable transformation. In this context, one of the most feasible solutions is Agri-PV, integrating solar power generation with farming. According to this solution, land's dual purpose is made possible, with farmers having the ability to grow crops along with electricity generation. Agri-PV makes farms more profitable and land-use more efficient. The sunlight's partial shadowing by solar panels minimizes heat stress and evaporation, yielding a more stable microclimate, especially useful in arid and semi - arid climates.

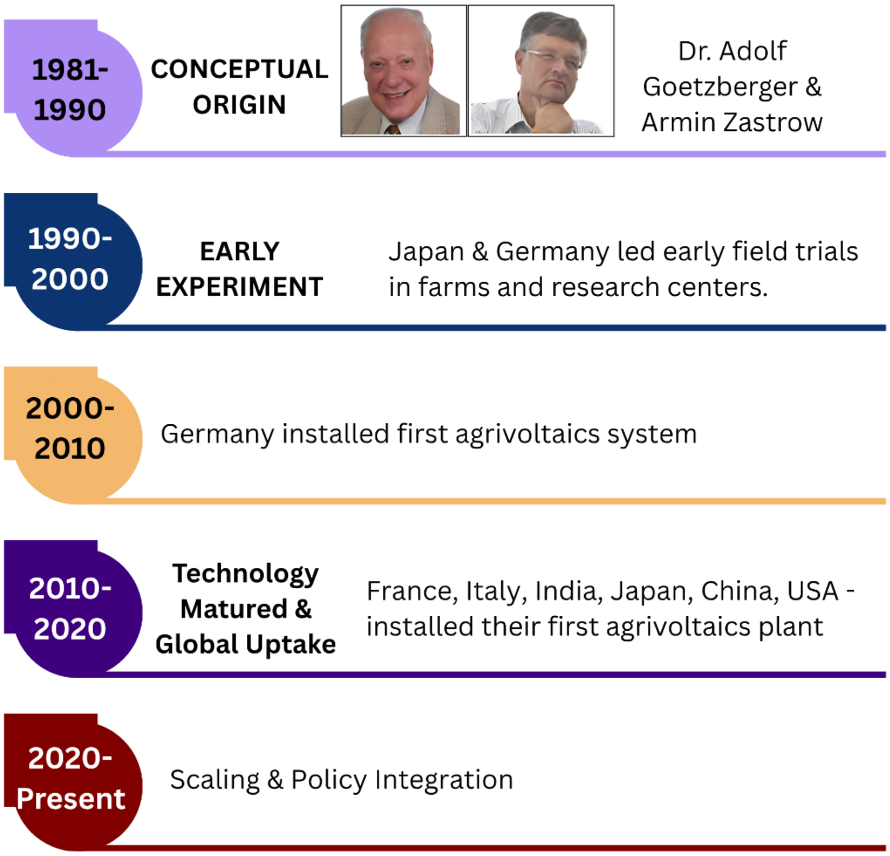
The concept of Agri-PV is not new. It was first introduced more than four decades ago - originally brainstormed in the early 1980s by German scientists Dr. Adolf Goetzberger and Armin Zastrow. They came up with the idea of integrating Photovoltaics (PV) electricity generation with agriculture on the same land in their ground-breaking 1981 paper. Their vision was to meet the conflicting requirements of land utilization by allowing double-use purposes - using solar energy and sustaining agricultural production. While the concept did not gain much attention then, it built the foundation towards what is now an increasing trend at the nexus of sustainable agriculture and renewable energy.

Figure 1: Representation of Agri-PV System

Source: Agri-PV Plant in Sagar, Madhya Pradesh

In the following years, countries such as Japan and Germany conducted pilot experiments. While Germany took the lead by installing an operational Agri-PV system in 2004. The past decade was the revolutionary time for the Agri-PV as prominent countries such as France, Italy, China, Japan, and the United States started adopting it as part of their agricultural and energy policy systematically. India ventured into this business in 2012, with the inauguration of the first Agri-PV plant in Gujarat. Several pilot projects were commissioned across various regions in India since then. While the global discussion is gradually evolving towards commercial scaling and policy mainstreaming, India is still operating at the nascency of experimentation stage, with commercial scaling up yet to take place.

Figure 2: Phases of Agri-PV Across the Globe



Source: Authors 'Own

Although few pilot initiatives have been implemented by academic institutions and private developers and have shown positive results, there is currently no national policy or scheme that explicitly targets on Agri-PV as a distinct strategy for sustainable land use and doubling farmers' income. As a result, efforts remain fragmented and largely experimental.

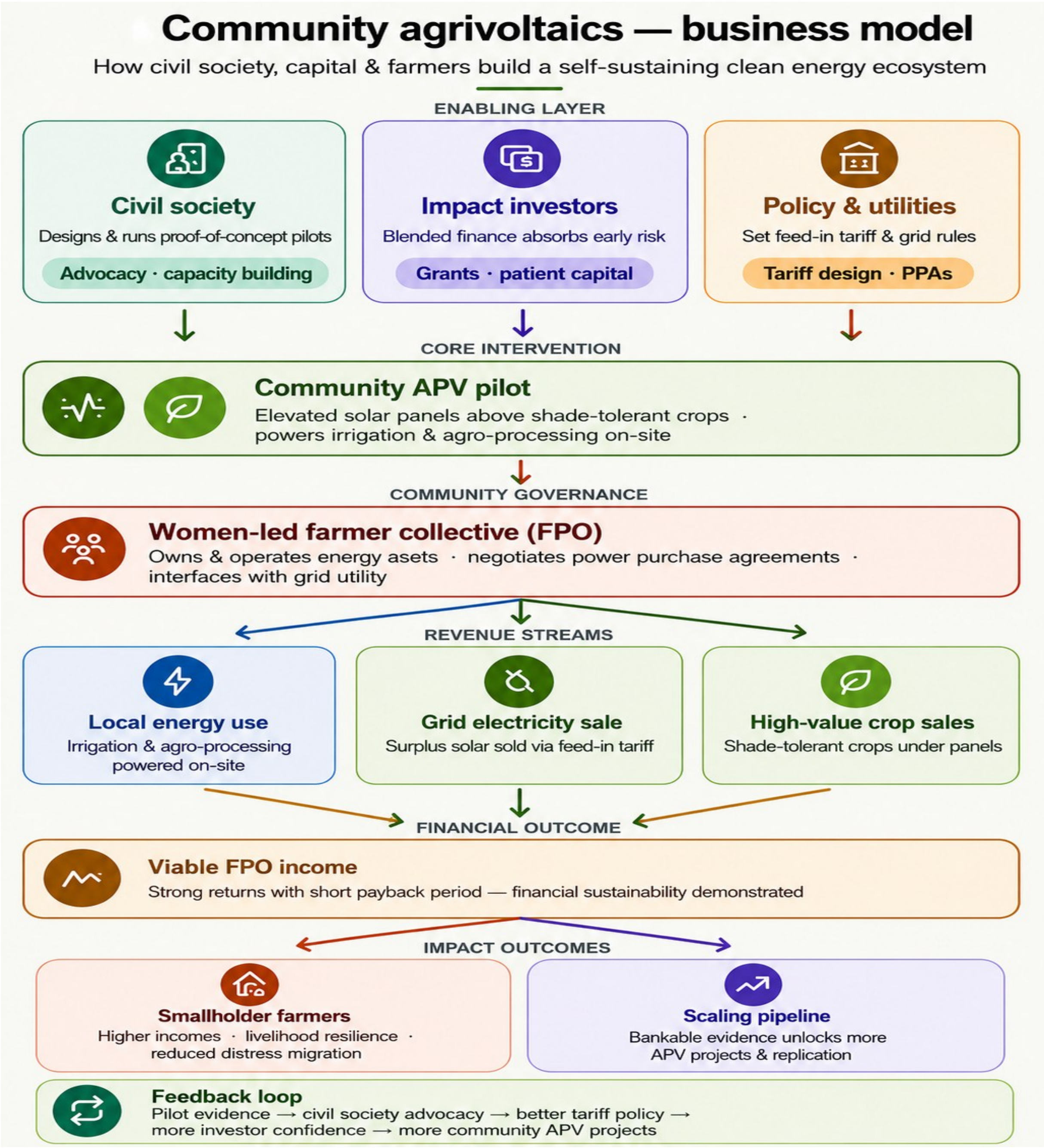
Absence of a comprehensive institutional approach presents various key challenges. There is a lack of standardized technical guideline for system design, crop compatibility which hinders farmers' participation. Restrictive land use regulations, such as zoning restrictions that prohibit non-agricultural activity on farmland, create legal ambiguities for dual use projects. One of the major bottlenecks is lack of financial instrument tailored for Agri-PV systems that can accommodate the agricultural and solar returns. An obstacle is the lack of convergence between agriculture and energy departments, might lead to disjointed implementation of photovoltaics plants on agricultural land. Compounding these issues is the low awareness among farmers about the potential and financial viability of Agri-PV, limiting the demand on ground. Without a clear institutional push via dedicated guidelines, cross sectoral coordination, and attractive incentives, Agri-PV in India is confined to isolated pilots instead of scaling up into a transformative land-use strategy to boost farmers' income and support energy and food security goals simultaneously.

This fragmented and policy-deficient landscape has also given rise to multiple interpretations, varied definitions, and implementation models of Agri-PV. Some view Agri-PV primarily as a land optimization strategy, focusing more on energy generation, at the cost of agricultural production. Others view Agri-PV for shading or irrigation support, with limited emphasis on energy or agriculture returns. Considering these divergent interpretations, ICRIER offers a well-defined balanced and inclusive Agri-PV definition; rooted in ground realities and farmers' needs. The definition of Agri-PV should focus on the simultaneous use of farmland for solar energy generation and agricultural production, with the goal of enabling dual income streams through crop cultivation and sale of surplus electricity to the grid. This dual-focus framework ensures that agriculture remains central to the model while turning farmers into an active actor in India's clean energy transition.

The farmer-first framing becomes even more important as India charts its path toward a low-carbon, climate-resilient future. Agri-PV is a promising tool to solve the twin problem by making rural life better and clean energy more accessible. With its ability to produce power and agriculture on the same land, Agri-PV is in sync with India's desires for energy security, land use sustainability, and farmers' income diversification. But its scalability and success rely on the models of ownership and implementation use. Ranging from large-scale projects driven by private developers to decentralized systems managed by local communities, to farmer-owned plants encouraged under schemes like PM-KUSUM, various models are being experimented in India's agro-climatic diversified regions. Each model comes with its own set of trade-offs: financial, institutional, and operational; making it essential to study them closely and inform policy design that ensures long-term viability, equity, and scalability.

EMERGING MODELS IN INDIA

2.1 Community Owned Agri-PV Model



A community-owned agrivoltaics (Agri-PV) model places farmers at the centre of the clean energy transition. Unlike conventional developer-led solar projects, where farmers often lease out their land for a fixed rent, community Agri-PV enables local institutions such as Farmer Producer Organisations (FPOs), cooperatives, or community trusts to own and manage the energy asset while continuing agricultural production on the same land. This ensures that the economic benefits generated from both farming and solar power remain within the community.

In this model, elevated solar panels are installed above agricultural fields, allowing farmers to continue cultivating crops beneath the structures. The electricity generated can serve three purposes: powering local productive uses such as irrigation, cold storage, and agro-processing; supplying surplus power to the grid through a power purchase agreement; and supporting community enterprises. At the same time, the land continues to generate agricultural income through the cultivation of suitable crops. The result is a diversified income stream that reduces dependence on a single source of livelihood and strengthens resilience against climate and market uncertainties.

A defining feature of this approach is community governance. The FPO or farmer collective acts as the project owner, manages operations, engages with utilities, and oversees benefit sharing among participating farmers. Revenues from energy sales and agricultural production can be reinvested into local development priorities, strengthening the institution and creating long-term value for members. Over time, such projects can also support rural enterprises, improve energy access, and create new opportunities for youth and women in agriculture.

However, community-owned Agri-PV projects face a significant challenge: high upfront investment costs. Agri-PV systems are typically more expensive than conventional ground-mounted solar plants due to elevated structures and agricultural integration requirements. In many underserved regions, smallholder farmers and community institutions have limited purchasing power and cannot mobilise the required capital on their own. As a result, grant funding, philanthropic support, viability gap funding, and patient capital often play a critical role in the early stages of implementation. These resources help de-risk the first projects, build local capacity, and demonstrate viable business models.

The ultimate objective is not to create permanent dependence on grants, but to generate evidence that can attract commercial finance and supportive public policies. When backed by appropriate tariffs, affordable financing, and strong community institutions, community-owned Agri-PV can become a scalable model that delivers clean energy, stronger farmer incomes, and more resilient rural economies.

2.2 Developer Owned Agri-PV Model

The developer-owned (Agri-PV) model represents a unique convergence of private capital and rural livelihoods. In this setup, solar developers take agricultural land on lease from farmer typically for a duration of 25-27 years, offering him a fixed annual rent. Unlike community owned Agri-PV, where farmers have ownership, here, the developers invest in and retain full ownership of the Agri-PV plant, allowing him to optimize its design, technology choice, and power generation strategy for maximum returns. Since developers earn from electricity sales and potentially from crop cultivation under the panels, he is incentivized to maintain both energy and agricultural productivity. Farmers benefit from a fixed and stable income with no risk of capital investment, operations, or regulation and crop failure. It can be very attractive in regions of high solar irradiance, good transmission infrastructure, possibly in peri-urban regions of the country.

What makes this model interesting is its potential to accelerate large-scale Agri-PV deployment while keeping farmers in the equation, although in a limited role. To maximise the returns, developer grow high value crops. Although the model enhances farmers' income by providing fixed rental income, there is an inherent power imbalance, as farmer here in this model is land lessor and not co-beneficiary of the Agri-PV ecosystem. This makes the model suitable where scale (in terms of installed capacity), efficiency, and return on investment are the primary drivers, and where community engagement is relatively limited. To make the model more inclusive, the crop-sharing agreements, encouraging local employment and linking power supply for rural productive loads can be included. The developer owned Agri-PV model demonstrates that private sector participation, if structured inclusively, can be an important lever in mainstreaming Agri-PV in India.

India has approximately 40 Agri-PV plants so far and a substantial number of such plants are owned by private developers. In the section, the developer-led Agri-PV model in Najafgarh, Delhi is examined in detail. This case involves a private solar developer who has leased a parcel of agricultural land from a local farmer named Harpal Singh, to establish an Agri-PV plant. It offers valuable insights into the economic returns from solar energy generation, and the agricultural productivity maintained under the solar panels. By analysing this case, the section highlights the dual revenue potential of such projects, while shedding light on the practical dynamics of land leasing, energy tariffs, and crop viability within a developer-driven Agri-PV framework.

2.2.1 Land-Lease Based Agri-PV Model at Najafgarh, Delhi

Location: Sunmaster Plant, Najafgarh, South-West Delhi
Scheme: Private Agri-PV Deployment
Stakeholders: Landowner (farmer), Private Solar Developer (Sunmaster), BSES Rajdhani

This case study explores a privately deployed Agri-PV plant, installed by Sunmaster, a solar developer company, in Najafgarh, South-West Delhi. This plant was developed independently by a private solar developer on the land of a local farmer from Ishapurva Village. The case offers insights into a land-lease-based Agri-PV model, covering aspects such as land-use partnership, infrastructure and agricultural operations, income sharing from both agricultural produce and energy sales.

In India, discussions around Agri-PV have gained momentum in recent years, due to its dual potential: contributing to clean energy goals while improving rural livelihoods. While schemes like PM-KUSUM promote farmer-owned models; private-sector-led models are emerging as a viable alternative, mainly for farmers who may lack the capital and technical capacity to invest in solar infrastructure. These models allow farmers to lease their land to developers, thereby reducing their financial and capital risk while benefiting from land-lease income. This region has been facing persistent geogenic salinity issues in its groundwater, resulting in low crop productivity. When Sunmaster approached a local farmer with a land-lease proposal, the farmer saw an income opportunity and agreed to choose a passive yet stable income model over direct involvement in agriculture or energy production. In this scenario, the private developer manages solar infrastructure and agricultural activities, offering steady rental income to the farmer while maximizing land-use productivity through dual use.

Figure 3: Land-Lease Based Agri-PV Model

Source: Captured by the Authors during their field visit to Najafgarh, Delhi

Before the installation of the Agri-PV system, monocropping was the only land use by the farmer, cultivation restricted only to the *rabi* season, wheat and mustard primarily on his field. His agricultural revenue from these crops annually was approximately INR 41000 per acre. Due to the high salinity of the groundwater and labour-intensive cultivation, he didn't cultivate *kharif* crops at all. This caused seasonal non-productivity of the land during the *kharif* crop season. Together with water shortages, labour-based cultivation measures; created a trapped income cycle, constraining the economic potential of the land. This income trend is reflective of the general experience faced by smallholders in semi-arid, peri urban areas, where environmental and resource constraints moderate the farming potential of the land.

When the farmer as a landowner received a proposal from Sunmaster regarding a land lease agreement for 25 years, he accepted the offer as land lease income was higher than the pre-Agri-PV agricultural income. Here he retained ownership of the land. The company mounted solar panels as high as 5 meters, with an installed capacity of 2.5 MW on leased 4.5 acres of land, making energy production and high-value farm underneath the panels. The farmer was given a guaranteed yearly income of INR 1 Lakh per acre with 1 percent of yearly rental increment.

Sunmaster is responsible for installing and managing the Agri-PV infrastructure, enabling crop cultivation beneath the panels. To enhance land productivity, Sunmaster also introduced high-value crops such as turmeric and potato under the solar panels. It also uses fresh water for crop cultivation to improve crop productivity and generate high revenue. The crops generated an average agricultural return of INR 1.5 lakh per acre annually. The income from energy and agriculture sales go directly to the Sunmaster. This land lease-based model unlocked high additional value from the same land but also allowed farmers to increase their annual income by more than twice. He also did not have to invest or take on new risks. He does not have to worry about risks of energy market or agricultural yields. He prefers this predictable income over any uncertain returns from growing low margin food crops.

Table 1: Economic Feasibility of Sunmaster Agri-PV Plant, Najafgarh, Delhi[1]

Payback Period (Years)	6
IRR (in %) for 25 Years	25%

Source: Authors' Analysis

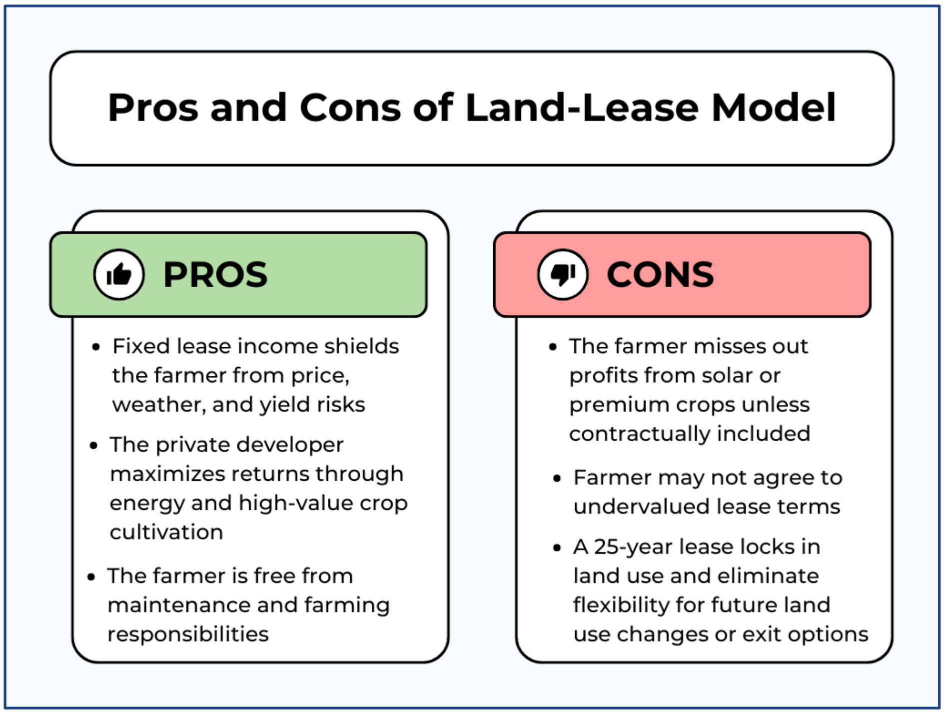
This land use change is facilitated by the financial viability of the Agri-PV system. The 2.5 MW plant installed over 4.5 acres of land involved an initial outlay of INR

[1] The figures reported in this study are based on information provided by officials associated with the pilot project during the field visit conducted in September 2024.

11.25 crores. This was funded by a debt-equity ratio of 70:30, loan tenure of 7 years, and interest rate of 8.5%. With a lifespan of 25 years, the system generates approximately INR 41.3 lakh units of power annually, which is being sold at a feed-in tariff (FiT) rate of INR 5.10 per unit, resulting in an annual revenue of approximately INR 2.17 crore per annum. Besides, farm crops under the sunshade; yield an additional INR 6.75 lakh per year. The project possesses great financial effectiveness, which is evident through its short payback duration of 6 years.

This Agri-PV model offers an attractive integration of clean energy infrastructure and sustainable land use. For the farmer, the model guarantees a fixed, risk-free rental income and increases the productivity and value of historically seasonally underused land. It is an exhibition of an economy-of-scale solution to rural land change especially for peri-urban areas where agriculture alone can no longer be enough to yield adequate returns.

Figure 4: Pros and Cons of Land-Lease Model



Source: Authors' Analysis

This plant stands as a strong case for scaling developer-led Agri-PV in India, proving that clean energy generation and agricultural production can coexist profitably, even on small land parcels. The Najafgarh Sunmaster farm is a prime example. It demonstrates how a lease-based Agri-PV system can operate in peri-urban areas where direct farming is no longer economically feasible. In this case, the farmer made no capital investment and faced minimal risk. Yet, he managed to earn more than double his income. All of this was possible while retaining ownership of his land. If structured equitably, such models offer an inclusive way to integrate smallholders into India's renewable energy and rural development agenda especially where full ownership models are not feasible. In India, most small and marginal farmers are left out of capital-intensive schemes such as PM-KUSUM to install their own commercial solar plants due to huge financial barriers, limited technical knowledge, and uncertain returns. As a result, these schemes feel out of reach. In such cases, a lease-based model seems to be a promising alternative that enables these farmers to have a steady rental income. The private developers make the investments, handle plant operations and benefit from energy sales.

Such models create revenues for farmers and unlock the dual use potential of land-generating clean energy while cultivating high-value crops. Such Agri-PV models are long-term sustainable but are dependent on a strong policy and regulatory framework. Without standardized contracts, legal protection, and close institutional surveillance, farmers are likely to face land use arbitrage and exploitative lease conditions. To make these Agri-PV models contribute to the clean energy transition and rural livelihood development, policy must adapt to protect farmer interests, allow for cooperation, and enable equitable benefit-sharing.

2.3 Farmer Owned Model Under PM- KUSUM

While developer-led and community-owned Agri-PV models represent two ends of the spectrum- one prioritizing scale and efficiency, the other rooted in collective voice and participatory governance. The farmer-owned model under the PM-KUSUM scheme offers a pragmatic and grounded middle path. It is a policy-aligned pathway that empowers individual cultivator to participate in the clean energy transition without losing control over their land or entering any complex institutional arrangements. Though the term "Agriphotovoltaics" is not explicitly mentioned in the scheme, yet its Component A effectively creates an enabling framework for it. By allowing individual farmers to install grid connected solar systems on their own agricultural land and generate dual income from farming and clean energy. Here a farmer becomes energy producer without giving up land ownership or leasing it out to third parties. It democratizes the clean energy transition by embedding it within the lives and livelihoods of those most impacted by energy poverty. The Agri-PV layout is tailored to preserve crop productivity, often spacing panels to ensure adequate sunlight and allowing for intercropping.

From a financial perspective, this model is suited for farmers who can afford the high capital investment, either through bank loans or from their own resources. It requires an enterprising mindset and the financial capacity to shoulder upfront costs, even though policy support-such as a 70:30 debt-equity structure backed by banks like Bank of Baroda (BOB), Central Bank of India (CBI), State Bank of India (SBI), Union Bank of India (UBI), Bank of India (BOI), RBL Bank Ltd, and AU Small Finance Bank can help mitigate this burden. Long-term Power Purchase Agreements (PPAs) of as much as 25 years generate a consistent cash flow stream by enabling the sale of excess electricity to the grid. Supported by attractive FiTs and stable grid connectivity, this model has the potential to boost farmers' incomes-especially significantly when applied together with the growth of high-income crops under or between the solar panels.

From a design perspective, the Agri-PV model is specifically structured to preserve and enhance agricultural productivity. The system incorporates elevated solar panel structures, optimized light (lux) penetration, rainwater harvesting features, and layouts compatible with mechanized farming. These design elements enable continued cultivation, intercropping, and the production of high-value horticultural crops such as vegetables, turmeric, and ginger beneath the panels. In doing so, the model transforms farmers into decentralized energy producers without compromising agricultural output. Unlike conventional ground-mounted solar parks, where land is typically leased and locked out of agriculture for around 25 years, this approach avoids long-term land-use displacement and the risks associated with leasing farmland for energy-only production.

Farmer-owned Agri-PV model under PM-KUSUM is a large-scale, inclusive, and eco-friendly solution for adoption of energy agriculture in India. To induce large-scale adoption, it will require flexible policy support and capacity building and localized demonstration projects.

2.4 PM-KUSUM: A policy Springboard for Farmer-led Agri-PV

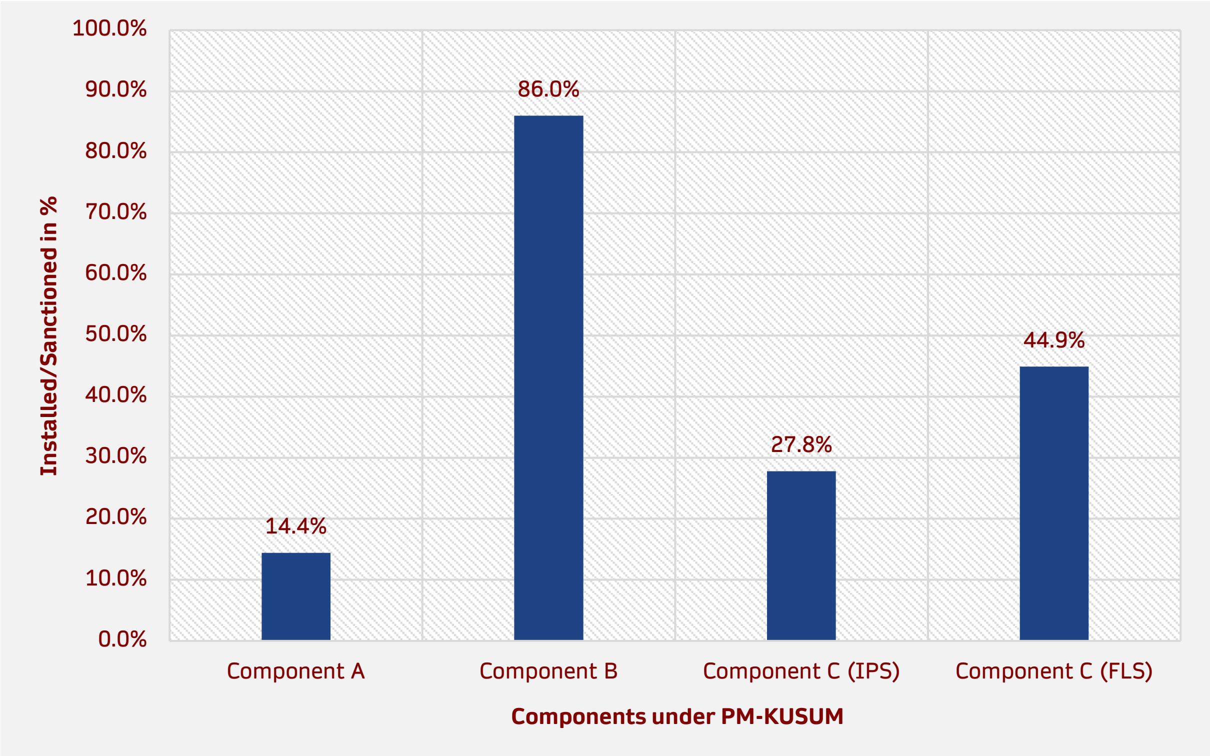
The farmer owned Agri-PV model finds its strongest institutional cornerstone in PM-KUSUM scheme, India's flagship policy initiative launched in 2019 to solarize Indian agriculture for farm income augmentation through harvesting an additional crop, i.e., the sun. While the scheme was designed to reduce the reliance on diesel-based irrigation on agriculture and promote decentralized solar power generation, it also aims to transform farmers from energy consumers "*Urja Upbhogta*" to energy producers "*Urja Data*." The scheme consists of three components, Component A (for setting up decentralized, grid - connected solar power plants), Component B (for standalone solar pumps) and Component C (for solarizing existing grid connected agricultural pumps). The Component C allows the solarization of individual grid-connected pumps (IPS) or an entire feeder (FLS). All three components of the scheme aim to add solar capacity of about 34,800 MW by March 2026 with the total Central Financial Assistance (CFA) of INR 34,422 crore *(**CFA is restricted to component B & C)*. The key word in PM-KUSUM scheme is "grid". Its component A and C allow farmers to evacuate surplus energy to the grid to earn an additional income based on the feed-in tariff decided by the State Electricity Regulatory Commission (SERC).

While Agri-PV is not explicitly named in the policy, Component A of PM-KUSUM implicitly supports its integration by enabling farmers to deploy grid connected solar systems on cultivable land without displacing agriculture. This implies that PM-KUSUM is not just a renewable energy scheme, but is a critical enabler of India's Agri-PV journey, to link clean energy generation with rural livelihoods.

2.4.1 Status of PM-KUSUM

This section talks about the current status of PM-KUSUM. It is not just a matter of tracking progress rather it will help in diagnosing the on-ground realities that can shape the future of Agri-PV in India.

Figure 5: Installed/Sanctioned Percentage under Various Components (31.05.2026)

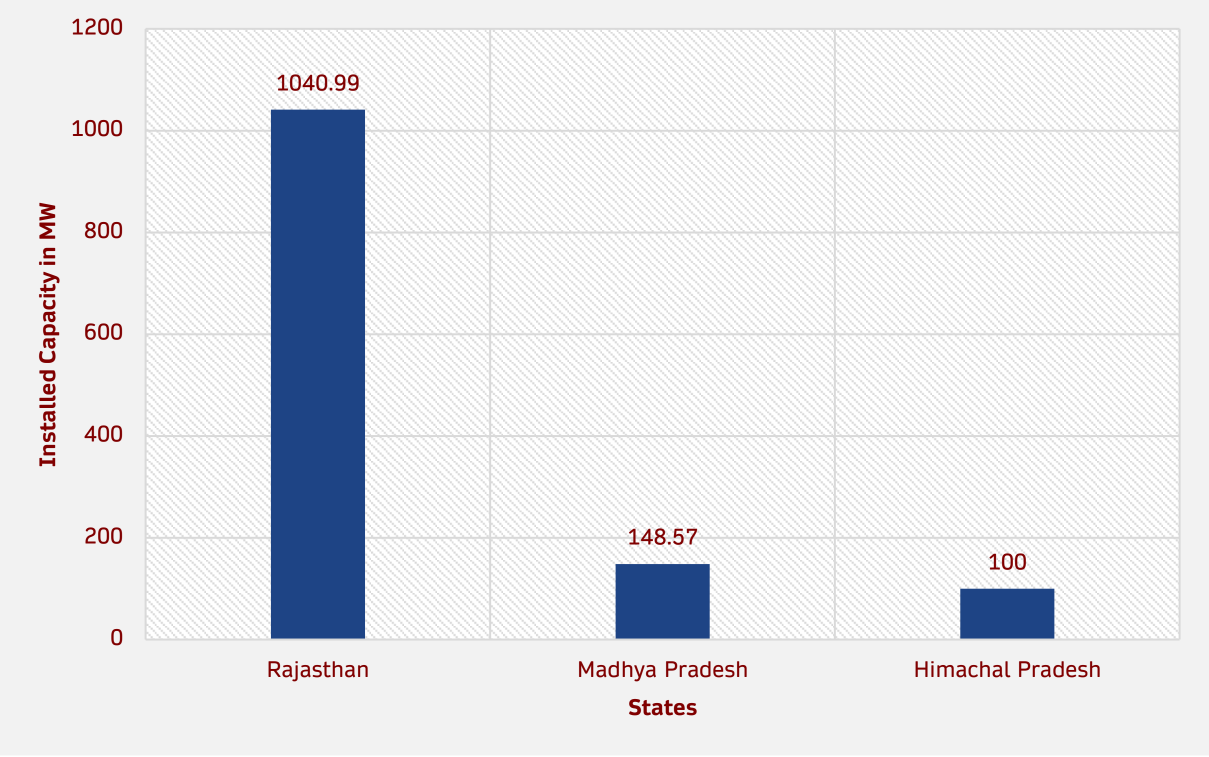


Source: PM-KUSUM Portal

Despite the ambitious vision, PM-KUSUM's implementation shows the stark variation across its three components. Component B, which focuses on standalone solar pumps, leads with 86 percent implementation of sanctioned capacity whereas the Component A which holds the most potential for Agri-PV through decentralized grid connected solar plants has only 14.4 percent implementation of the sanctioned capacity installed. Components under Component C for solarizing existing pumps also show very limited progress, 27.8 percent for IPS (Individual Pump Solarisation) and 44.9 percent for FLS (Feeder level solarisation).

This figure below represents the status of solar plant installation under Component A of the PM-KUSUM scheme as of 31st May 2026. Rajasthan is the top performer with an installed capacity of 1040.99 MW. This indicates that there has been a strong adoption of decentralised solar plants in the state with proactive DISCOMs support, land availability, farmers' and developer's interest. Madhya Pradesh follows at second place but with a smaller installed capacity of around 148.57 MW. At third position, Himachal Pradesh comes with an installed capacity of 100 MW, indicating moderate progress under Component A. Apart from these three leading states, these are four more states who have made some progress in their installed capacity i.e., Haryana (60.21 MW), Telangana (50 MW) and Maharashtra (21 MW).

Figure 6: Leading States under Component A - Installed Capacity in MW (31.05.2026)



Source: PM-KUSUM Portal

Despite sanctioned capacities across states, the uptake of PM-KUSUM remains uneven. Nearly half the states report zero installed capacity, reflecting a significant gap between allocation and execution. The uneven performance of the states and components reveals, where the policy intent is being translated into impact and where it is lagging. Component A, despite being central to Agri-PV vision, remains underutilized signaling a huge gap between potential and practice. To bridge this lag and unlock the full potential of Agri-PV, it is important to understand underpinning reasons for under performance. This gap between allocation and execution stems from a range of structural and institutional bottlenecks: high upfront capital costs deter farmer participation, especially in Component-A; land acquisition and conversion delays persist; and many state DISCOMs show reluctance to sign Power Purchase Agreements due to financial stress or power surpluses. Additionally, bureaucratic delays, lack of implementation capacity within state nodal agencies, limited awareness among farmers, and unclear or unattractive feed-in tariffs further hamper uptake. These challenges are compounded by shifting policy guidelines and misalignment between central targets and state-level priorities, collectively stalling the transition from sanction to execution. If Agri-PV is to scale meaningfully under PM-KUSUM, unlocking Component A through streamlined implementation and targeted incentives is essential.

2.4.2 PM-KUSUM Agri-PV Model in Sagar, Madhya Pradesh

Location: Kaneradev, Sagar District, Madhya Pradesh

Scheme: PM-KUSUM Component A

Stakeholders: PM-KUSUM Beneficiary, Khare energy Pvt. Ltd. as an EPC and Central Bank of India (CBI).

About Sagar

Sagar, which is in the central Indian state of Madhya Pradesh, has a tropical savanna climate with well-defined seasonal differences. Summers are usually hot and dry with frequent temperatures over 40°C, while winters are temperate and more conducive to human activities and farming cultivation. The area receives an average amount of precipitation of approximately 1,200 mm, largely falling between monsoon months from June to September. Year-round availability of rainfall favours rain-fed agriculture but also requires effective water storage and irrigation facilities to benefit cultivation all year round. High monsoon cloud cover and high humidity can occasionally decrease solar PV efficiency, but the pre-monsoon and post-monsoon periods more precisely from March to June have high solar irradiance suitable for solar energy production. The twin challenge of withstanding seasonal vagaries and tapping renewable energy potential confers Sagar with the best possible suitability for integrated Agri-PV solutions. Sagar farmers organize their agriculture marketing primarily in Sagar and surrounding urban places like Bhopal and Jabalpur for sale of output, purchase of inputs, and utilization of agri-services.

Case Synopsis

This case study is focused on the adoption of Agri-PV, the co-location of solar energy production and agriculture in the context of India's PM-KUSUM scheme. One of the earliest adopters of this innovation under PM-KUSUM Component A, was implemented by an IIT-Roorkee alumnus Mr. Anand Jain, who identifies himself as a farmer. Situated in Kaneradev village, Sagar district, MP, the project covers about 15 acres of land and is one of India's largest Agri-PV pilots. The project started functioning in 2025 under the PM-KUSUM-A component, it is equipped with solar infrastructure placed above and integrated with diversified agriculture. Not only does it generate renewable energy, but it also demonstrates the economic value and practical viability of merging agriculture and solar power on the same holding. Awarded by the Indian Agricultural Research Institute (IARI), the project is innovative not only in technology but is also an example of climate-smart agriculture and decentralized RE.

Figure 7: Agri-PV Plant in Sagar, Madhya Pradesh

Source: The Better India and ETV Bharat

Infrastructure and Technicalities

Agri-PV plant is constructed on Reinforced Concrete Cement (RCC) based raised structures, 3-4 meters above ground level, having solar panels with a spacing of approximately 8 meters between them (column to column). The structure has bifacial solar panels installed with slots for allowing sunlight penetration and crop growth underneath. A broader 12-meter gap in the middle is also incorporated in the structure for optimum photosynthesis light supply. Shadow length is tracked and usually extends to 4 metres on the ground from each structural column, which helps in designing crop alignment and panel layout. This height provides maximum light distribution and allows easy movement of tractors and other agricultural machinery for ensuring regular agricultural operations continue unhampered. To accommodate effective irrigation of the crops, there is a newly installed underground piping system at depth of 3 feet with drip and sprinkler pipes under control of well-placed valves panel maintained by hand tankers and sprayers supplemented at times by natural rains. During cleansing operations, utmost care is taken not to create any disturbance to the crop beds to preserve the integrity of the farming activities in the Agri-PV systems.

Agricultural Experience and Crop Trials

The farmer has been cultivating herbs, medicinal plants for more than three decades. He started his career in agriculture in 1994, growing medicinal and herbal crops like *safed muesli*, (a root booster of the immune system) and stevia rebaudiana (a sun plant due to its natural sweetness). Under the Agri-PV scheme, he tried cultivating 16 crops. Out of which, wheat, broccoli, lettuce, strawberry, tomato, and watermelon have given good yield. Some of the crops such as muskmelon, cauliflower and cabbage have been sub-optimal. Crops such as stevia, which are shade sensitive as well, also grew sub-optimally under the panels. In such types of crops, it was felt that light availability was not the sole factor, but intensity of light and ambient temperature was equally deciding factors on the growth and the yield. The farmer has reported there was a higher incidence of insect attack, possibly because the microclimatic conditions had been disturbed due to night light. To avoid this, partial net house has also been installed to understand the behaviour of plant when there is no pest/ insect attack. There has been a debate that wheat as a crop does not yield high productivity but as per experience of farmer, wheat has potential under Agri-PV shade, given sunlight is provided in sufficient quantity. One method is to withdraw panels tactfully from certain rows to maximize direct sunlight penetration during peak periods when growth rates are enhanced, enhancing productivity.[2]

[2] Agricultural productivity data is yet to be developed, as the farmer is currently experimenting, with the plant having begun operations earlier this year.

Energy Generation and Business Model

Agri-PV plant is connected to the grid seamlessly under a valid Power Purchasing Agreement (PPA) promising long-term revenue stability. It is maintained and serviced by a professional technician in charge for day-to-day panel washing, system checks and general site control, While the system has worked well, the small technical problems concerning earthing and lubrication of the system have been reported and are being rectified as part of regular maintenance. To enhance operational efficiency the project developers are planning to introduce robotic cleaning systems in future minimising water use and manual cleaning using tankers and sprayers supplemented by occasional rainfall. The energy generation performance has been promising with the system capable of generating up to 20 percent more than the baseline requirement specified in the PPA. With a total installed capacity of 4.5 MW DC, the plant generates about 80 lakh kWh of power per year. The power is supplied to the grid at a levelized tariff of INR 3.07/kWh with a 25-year PPA term and return guarantee.

Economic Feasibility of the Plant

To determine if the planned 4.5 MW Agri-PV system at Sagar is economically feasible, a thorough techno-economic modelling exercise was undertaken. The plant has been installed with a project life of 25 years, and the entire Capital Expenditure (CapEx) stands at INR 18.5 crore. The debt structure is 63:37 debt-to-equity ratio, of which the debt component is INR 11.65 crore and the equity amount stands at INR 6.84 crore. The project's discount rate for evaluating present value cash flows and internal rate of return (IRR) is assumed to be 11.46 percent, reflecting the opportunity cost of capital and sectoral risk factors. The debt is structured over a loan tenure of 15 years at an annual interest rate of 9.85 percent. Considering the above, the farmer's equated monthly instalment (EMI) commitment per annum is a sum of INR 1.48 crore comprising principal repayment and interest payment. The need for working capital is estimated to be 3 percent of the capital cost, i.e., INR 55.5 lakh, for which the farmer's interest commitment per annum at an interest rate of 11.95 percent would be INR 6.63 lakh.

On the operational front, the upfront Operations and Maintenance (O&M) cost has been benchmarked at INR 10 lakhs in the first year, growing at 5 percent per annum, included in the model to cover for inflation and rise in cost of services. The plant is spread on 15 acres of land, which shall also be devoted to simultaneous agricultural activity, creating the foundation of the dual-use character of the Agri-PV model. From an energy production perspective, the plant will run every month of the year (8,760 hours/year) at the capacity utilization factor (CUF) of 21 percent, in line with performance levels of comparable solar PV plants in the region. The gross annual production is estimated to be 80 lakh kWh, which is equivalent to a specific yield of 1,778 kWh/kWp/year. Subtracting 0.75 percent auxiliary consumption, the net total annual energy production is 79.4 lakh kWh.

With the revenue from energy, revenue from the farm will also play a major role in making the project feasible. With the yield of INR 4 lakh per acre annually growing high value crops like strawberry, the 15-acre land is guaranteed to produce INR 60 lakh worth of farm revenue annually. This double revenue source energy sales and farm output is the crux of the Agri-PV business model, making the economic feasibility of the project stronger. These inputs are the starting point for computing key financial metrics such as payback period, IRR, and net present value (NPV) and, collectively, illustrate the potential of Agri-PV as a sustainable, farmer-inclusive model for clean energy deployment.

Economic Feasibility Results for the 4.5 MW Agri-PV Plant (Sagar, Madhya Pradesh)

Table 2: Economic Feasibility with Agricultural Income

Total Profitability (INR/acre/year)	8,87,266
Payback Period (Years)	5.8
IRR (in %) for 25 Years	17%

Source: Authors' Analysis from the Data Collected on Field

The economic feasibility of the 4.5 MW Agri-PV farm in Sagar, Madhya Pradesh, provides some interesting observations regarding the prospects of integrating solar energy production alongside agriculture on the same land. The analysis considers two possibilities: one which only accounts for revenue from power generation, and another which includes agricultural income combined with energy generations

In Madhya Pradesh's agri-PV plant the high agricultural income is substantially improving economic viability of the project, capturing the dual-purpose nature of the Agri-PV system. In this case, the plant is generating the sale of electricity and farming activity performed below or in between the solar panels. With agriculture factored in, NPV stands at INR 1.33 crore that captures an even more robust financial support. The payback period falls to 5.8 years. This indicates that agriculture assists in the energy aspect and makes the whole system more economically viable. The IRR also increases to 17 percent and indicates that with the combination of solar and agriculture, the profitability of the project increases.

The net profitability per acre in this scenario is likely to be INR 8.87 lakh per annum, which is a notable source of additional income for farmers over conventional practices. This is significant for farmers who are not keen to allocate their land only for solar installations. Using the Agri-PV method, they can cultivate their land and have extra recurring income from energy produced by solar means.

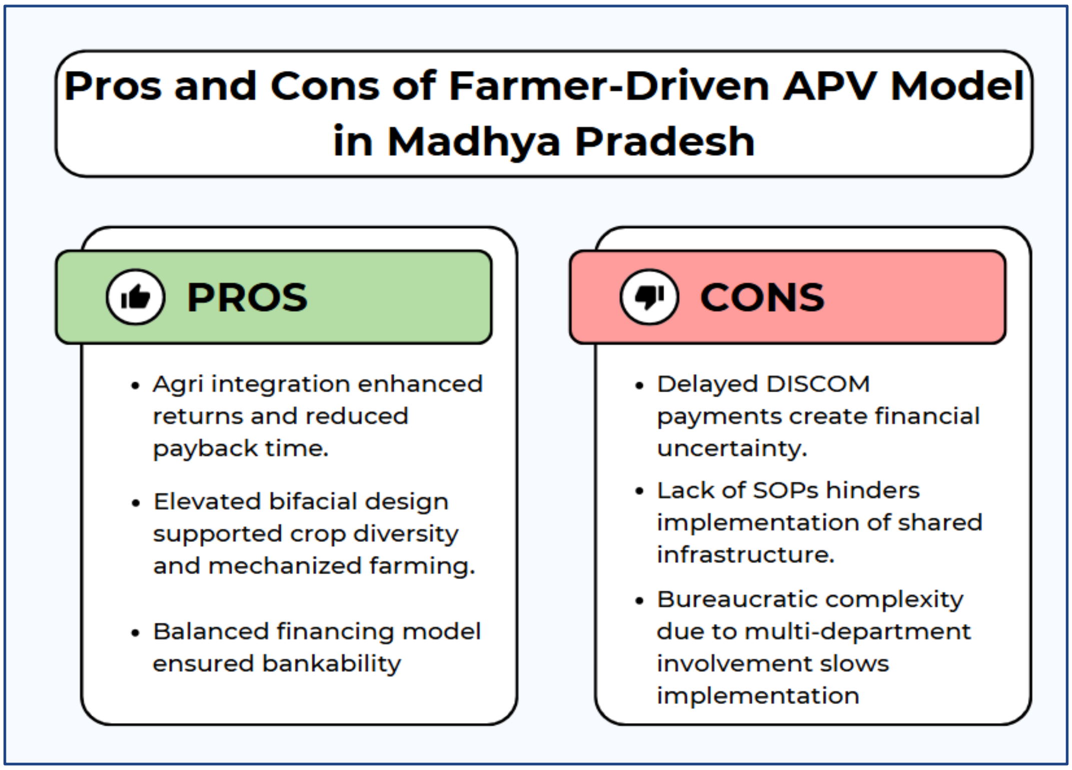
The findings validate Agri-PV as a viable investment model under PM-KUSUM Component A, particularly when agriculture remains central to project design, as demonstrated by Anand Jain's model. High-value crops such as strawberries significantly enhance farm incomes, while enabling farmers to participate in the renewable energy economy as active stakeholders rather than passive land lessors. The results strengthen the case for scaling Agri-PV in India as an integrated pathway for improving land-use efficiency, farmer incomes, and clean energy generation. They also highlight the importance of supportive policies and timely DISCOM payments for the long-term success of farmer-owned Agri-PV systems.

2.4.3 Challenges

The execution of PM-KUSUM in MP involves coordination between three different state departments including Madhya Pradesh Urja Vikas Nigam Limited (MUPVNL), Madhya Pradesh Power Generating Company Limited (MPPCL) and Madhya Pradesh

Poorv Kshetra Vidyut Vitaran Co. Ltd (MPPKVCL). This multi-department involvement led to bureaucratic complexity resulting in lags and other discrepancies in ground-level implementation. Payment delays are the biggest operational issues and although electricity is supplied to the grid regularly, payment from the sale of electricity is credited after a delay. Since the last couple of months, the farmer has not received the revenue. This lag leads to financial stress for the farmer. Despite existing clauses in the PPA that mandate timely disbursal, DISCOMs are not adhering to these. DISCOMs in Madhya Pradesh are resisting implementation of High Tension (HT) connection line sharing clause supported under the PM-KUSUM guidelines. In this case the two farmer- brothers; jointly own the Agri-PV setup, this HT connection resistance has posed an additional hurdle. The distance between their plant and the nearest grid substation is 4.9 km. To avoid the high cost of setting up two separate transmission lines, they opted to share one line. However, absence of official Standard Operating Procedures (SOPs) and institutional support, this has faced resistance from the utility. This hints at broader policy gap, especially the lack of a centralised monitoring and grievance redressal mechanism at the state level. The farmer emphasizes that large-scale deployment of distributed solar by initiatives such as PM-KUSUM can bring Madhya Pradesh to energy self-sufficiency. However, the weakness in infrastructure remains a cause for concern. Failure of transformers due to overloading is seen in a few cases that underscores the need for upgrading rural grid infrastructure in parallel with scaling solar generation.

Figure 8: Pros and Cons of Farmer- Driven Agri-PV Model in Madhya Pradesh



Source: Authors' Analysis

2.4.4 Bottomline for Case Study 1

There is a need to develop a strong centralised monitoring system for Agri-PV projects. It would ensure strong adherence to national PM-KUSUM guidelines, facilitate coordination among different state departments, and address DISCOM level bottlenecks on connectivity, payment, and support for operation. In states such as Madhya Pradesh, where there are several agencies involved in operation, the lack of unified systems will lead to delays and inefficiencies that deter farmers' participation in Agri-PV system installation. To enhance the viability of Agri-PV systems, there is a strong case for unlocking interstate electricity trade. At present, policy restrictions limit solar power sales within state boundaries and reduces market access and impacts financial returns. Enabling interstate sale of electricity generated through Agri-PV would open new revenue streams, promote resource efficiency, and support grid balancing at a national level. From a financial perspective, it is recommended revisiting the current debt-equity structure under PM-KUSUM A. Boosting the debt component to at least 85 percent, would reduce the initial capital burden on farmers. Such a revision would make solar adoption more affordable and enable the mass deployment of Agri-PV systems in rural India.

2.4.5 PM-KUSUM Agri-PV Model in Jaipur, Rajasthan

While the ambition of Agri-PV under PM-KUSUM carries immense national promise, its on-ground execution remains limited. Till now, only the state of Madhya Pradesh has successfully deployed an Agri-PV plant under the scheme. This clear disparity between vision and delivery poses a hurdle and a possibility. In response, ICRIER is testing a novel model in Rajasthan to enable individual farmer to become solar energy producers under Component A of PM-KUSUM.

Rajasthan was selected deliberately. As the leading state under Component A of PM-KUSUM, it offers a strong platform to pilot Agri-PV. At the same time, the rapid expansion of solar plants on agricultural land in the state is gradually displaced farming for long periods, typically up to 25 years. This makes Rajasthan a suitable setting to test a more balanced, farmer-first Agri-PV model that integrates solar generation while preserving agricultural use.

The ICRIER pilot showcases the technical and financial viability of dual land use where farmers will continue growing crops and produce clean energy and earn a secure and long-term income through energy export to the grid. This integrated approach offers a scalable pathway to boost farmers' incomes, strengthen energy security, and promote India's renewable energy and climate resilience goals.

Location: Kundanpura Village, Bassi Block, Jaipur District, Rajasthan
Scheme: PM-KUSUM Component A
Stakeholders: Smallholder Farmer, Jaipur Vidyut Vitaran Nigam Limited (JVVNL) and State Bank of India, Bhaskar Jyoti Private Limited as an EPC.

Pilot Location

ICRIER's demonstration initiative will be in Kundanpura Village in Bassi block of Jaipur district. This is primarily a dryland zone, characterized by hot and dry climatic conditions with blazing summers and mild cold spells. It receives an average precipitation of 536 mm per year, clustered over about 68.5 wet days during the monsoons. The high variability of rainfall in this region necessitates effective irrigation strategies to maintain agricultural activity all year round. While the monsoon months fulfil the water needs for crop growth, the associated cloud cover will diminish the solar power output. On the other hand, the pre-monsoon period from May to June experiences the most intense solar radiation, representing optimal conditions for PV power generation. Since temperatures during summers frequently surpass 40°C, crop planning in Bassi must incorporate temperature-tolerant crops, while the comparatively milder winters need to allow room for more diverse crop selection. From an economic standpoint, the inhabitants of Bassi are dependent on the nearby markets of Dausa and Jaipur which are major hubs for selling produce and purchasing farm inputs.

Background

As India advances towards its renewable energy targets and seeks to increase farmers' incomes, Agri-PV, the joint use of solar panels and farming provides a promising route. Component A of the PM-KUSUM scheme permits the farmers to either lease or utilize their land to establish grid-connected solar installations, supplying power to the local DISCOM. Conventional ground-mounted systems come with the downside of displacing agriculture, leading to a binary choice between food and energy. In Kundanpura village, a farmer has installed a ground mounted 600 kWp solar project under the PM-KUSUM Component A, however it will be interesting to see how this model can be replicated to an Agri-PV setup. This case study explores two technical design models with a total of three scenarios ranging from a conventional ground-mounted system to a dual-use elevated structure having scenarios of providing and not providing Viability Gap Funding (VGF) to assess trade-offs in design, capital needs, and income generation.

Condition 1: Ground-Mounted Solar PV (Energy-Only Model)

In this baseline configuration, a standard ground-mounted 600 kWp PV installation spanning around 2.96 acres is in existence. This is monetized by funding mechanism where 70 percent of the investment is secured through commercial bank loans at an interest rate of 10.25 percent and the remaining 30 percent is termed as the owner's contribution. The electricity produced is supplied to the regional DISCOM, JVVNL, at a tariff of INR 3.14/kWh.

Figure 9: Ground Mounted Solar PV Plant in Kundanpura, Rajasthan

Source: Captured by the Authors during field visit to Kundanpura, Rajasthan

The system has been structured with a service duration of 25 years, with a total CapEx of INR 2 crores. The project's discount rate, applied to estimate present value, cash flows and IRR, is taken as 11.46 percent, capturing the cost of capital as mentioned in Central Electricity Regulatory Commission (CERC) tariff orders. The debt is organized over a 15-year loan duration at an annual interest rate of 10.25 percent, equivalent to a monthly interest rate of 0.90 percent. Based on this, the EMI burden for the borrower amounts to INR 19.20 lakhs, covering both principal and interest dues. Further, the working capital demand is assessed at 3 percent of the investment, i.e., INR 6 lakhs, for which the yearly interest payment at a rate of 11.95 percent is calculated at INR 71.7 thousand. From an operational perspective, the initial O&M expenditure for the ground-mounted PV plant is set at INR 1 lakh for the first year, with a yearly increase of 5 percent included to reflect inflation and higher service charges. The plant is spread across 2.96 acres of land. In terms of energy output, the plant function continuously (8,760 hours annually) at a CUF of 18 percent. The total gross yearly energy generation is estimated at roughly 9.46 lakh kWh, which corresponds to a specific yield of 1577 kWh/kWp/year. After deducting auxiliary usage of 0.75 percent, the net energy yearly output stands at 9.38 lakhs kWh.[3]

These parameters serve as the basis for deriving major financial metrics such as payback period, IRR, and NPV.

Table 3: Economic Feasibility Results of Ground Mounted Solar PV plant, Kundanpura, Rajasthan

Solar Profitability (INR/acre/year)	3,81,175
Payback Period (Years)	8.3
IRR (in %) for 25 Years	14%

Source: Authors' Analysis

The findings suggest that over a 25-year project duration, the NPV which represents the present-day valuation worth of the plant's future cash flows amounts to approximately INR 11.28 lakhs. This implies that after accounting for all upfront and recurring expenditures, the plant is projected to yield a positive return throughout its operational span. The payback period is about 8.3 years. The IRR is estimated at 14 percent.

In addition, the solar income per acre stands at INR 3.81 lakhs per acre per year. However, this value can increase significantly under Agri-PV conditions due to an additional income stream from agricultural produce. This will be a more practical alternative.

To investigate the viability of Agri-PV in this structure, a revised system was modelled using PVsyst, a prominent tool for evaluating PV system performance. Key aspects examined included tilt angle, phi angle, module and inverter count,

[3] The total gross yearly energy generation might lie in range from 8.5 lakh KWh to 9.5 KWh depending upon the sunshine hours and CUF.

field dimensions, structure height, system and specific production, performance ratio, and various system losses. The objective of this assessment is to understand how Agri-PV could maximize land utility while enhancing overall energy generation performance.

Condition 2: Elevated Agri-PV System (Energy + Agriculture Model)

In this condition, the existing plant is being modified into an Agri-PV pilot where the farmer selects a 4-metre tall and 7.5 metre gap between each row and column in an elevated Agri-PV structure, which facilitates dual land use by allowing ample sunlight to reach the crops cultivated beneath the solar panels. In comparison to the reference ground-mounted condition, this one includes agricultural operations below the panels with farming income assumed at INR 1 lakh per acre.

Figure 10: Retrofitted Elevated Agri-PV System (Energy +Agriculture) in Kundanpura, Rajasthan

Source: Captured by the Authors during field visit to Kundanpura, Rajasthan

Like the earlier condition, this configuration covers 2.96 acres, with 70 percent of the capital obtained through commercial bank financing at an interest rate of 10.25

percent, and the remaining 30 percent contributed as equity. The energy generated is transmitted to the regional DISCOM, JVVNL, at a tariff of INR 3.14/kWh. The plant is designed for a 25-year operational duration. The working capital requirement is evaluated at 3 percent of the total project cost. On the operational front, the initial O&M expense has been estimated at INR 1.5 lakh for the first year, with a 5 percent annual increase incorporated into the model to reflect inflation and rising service charges. The plant remains situated over 2.96 acres. Regarding energy generation, the system functions year-round (8,760 hours per annum) with a CUF of 18 percent. The gross annual output is projected at approximately 9.46 lakh kWh, which translates to a specific yield of 1577 kWh/kWp/year. After adjusting for auxiliary usage of 0.75 percent, the net annual electricity output reaches 9.38 lakh kWh. These parameters are used for computing key financial metrics such as payback period, IRR, and NPV, and collectively highlight the relevance of Agri-PV as a long term, farmer-centred approach for clean energy expansion.

Within this condition, two scenarios are examined under the broader category of Agri-PV configurations. The first scenario is excluding VGF and the second scenario, including the required VGF support. These scenarios are developed to analyse how capital subsidies influence the long-term financial outlook of Agri-PV projects. VGF provided, as upfront capital aid, can significantly reduce the initial investment burden, making these solutions more accessible to farmers.

Scenario 1: Agri-PV Plant with VGF

In this scenario, along with the previously mentioned parameters, the CapEx is valued at INR 2.35 crores with 35.3 lakh VGF/capital subsidy, provided by ICRIER INR 1.40 crores secured through debt and INR 60 lakhs invested as equity. The return on equity amounts to INR 9.88 lakhs, while the annual equated EMI stands at INR 19.20 lakhs. The yearly interest on working capital is computed at INR 717000. The table below presents the financial feasibility results in this scenario.

Table 4: Economic Feasibility Results of Agri-PV Plant (With VGF)

Total Profitability (INR/acre/year)	4,48,927
Payback Period (Years)	6.1
IRR (in %) for 25 Years	18%

Source: Authors' Analysis

The findings suggest that over a 25-year project life, the NPV which represents the present-day equivalent of the plant's future financial returns totals approximately INR 13.28 lakhs. This indicates that after covering all upfront and ongoing expenses, the plant is anticipated to deliver a net positive return across its lifecycle. The payback period reflects the time required to recover the initial outlay, which is around 6.1 years. The IRR, a standard benchmark of long-term investment viability, is estimated at 18 percent. Additionally, the total profitability per acre stands at INR 4.48 lakhs per acre per year. This rise in numbers is because of the Agri-PV setup instead of a plain ground mounted solar plant which shows higher returns and profitability in a shorter time span in presence of VGF of INR 35.3 lakhs and agriculture income of INR 1 lakh/acre being integrated in the cash flow.

Scenario 2: Agri-PV Plant Without VGF

In this scenario, building on the previously outlined data, the CapEx is INR 2.35 crores, accounting for an additional INR 35.3 lakhs incurred by the farmer for incorporating the mounting structure in the absence of VGF. The debt amounts to INR 1.64 crores, while equity contributes to INR 70.5 lakhs. The return on equity is calculated at INR 11.62 lakhs with the annual EMI at INR 22.14 lakhs. The yearly interest on working capital is assessed at INR 84,355.

The table below illustrates the economic viability findings under this scenario.

Table 5: Economic Feasibility Results of Agri-PV Plant (Without VGF)

Total Profitability (INR/acre/year)	3,76,564
Payback Period (Years)	11.8
IRR (in %) for 25 Years	12%

Source: Authors' Analysis

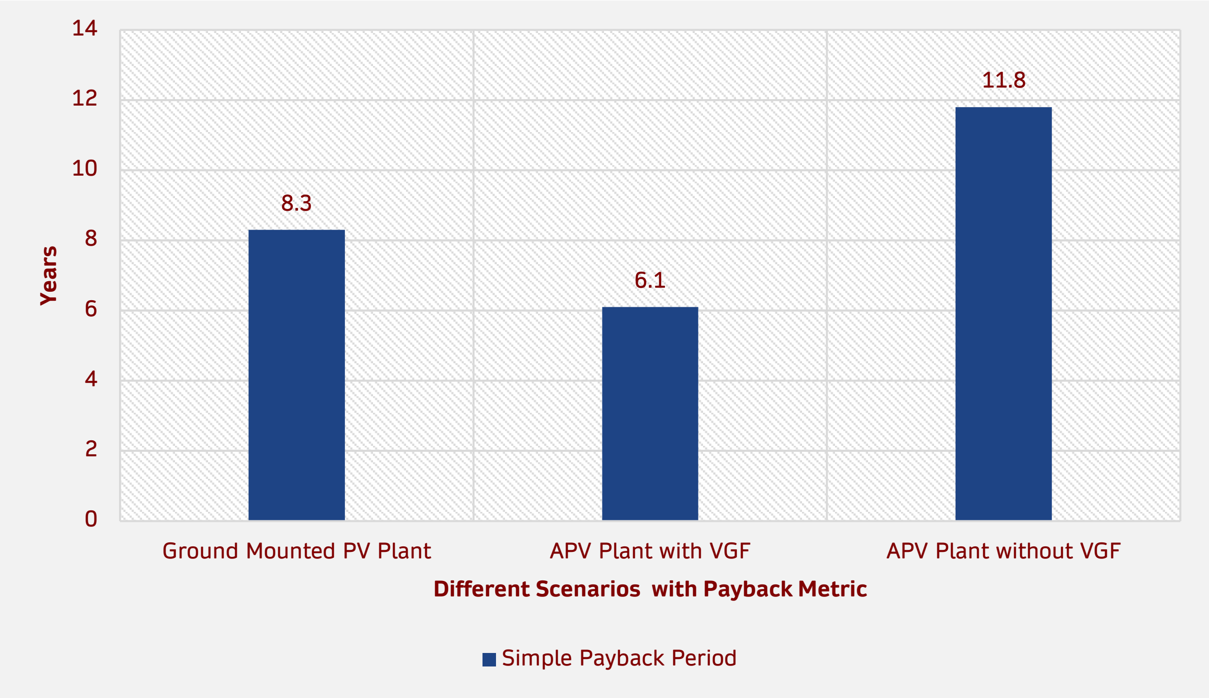
The outcomes suggest that over a 25-year project horizon, the NPV which represents the present-day value of the plant's projected cash flow amounts to approximately INR 11.14 lakhs. This implies that after factoring in all initial and ongoing expenses, the plant is anticipated to yield a net positive return throughout its operational life. The payback period, which denotes the time needed to recover the upfront investment, is roughly 11.8 years. The IRR, a widely used metric for evaluating long-term project profitability is estimated at 12 percent. The total annual profitability per acre stands at INR 3.76 lakhs per acre per year.

Comparing from the existing structure, the Agri-PV setup can have a better economic viability. By increasing the height of the ground-mounted solar PV plant, the farmer can earn extra from the crops grown beneath the panels.

The technical design created on PV Syst for this Agri-PV plant was carefully modelled considering the full utilization of the solar panels so that there are no shading losses and the energy generation can be maximized. The design creation and simulation computed on the software provided the data on normalized and specific production of both the conditions.

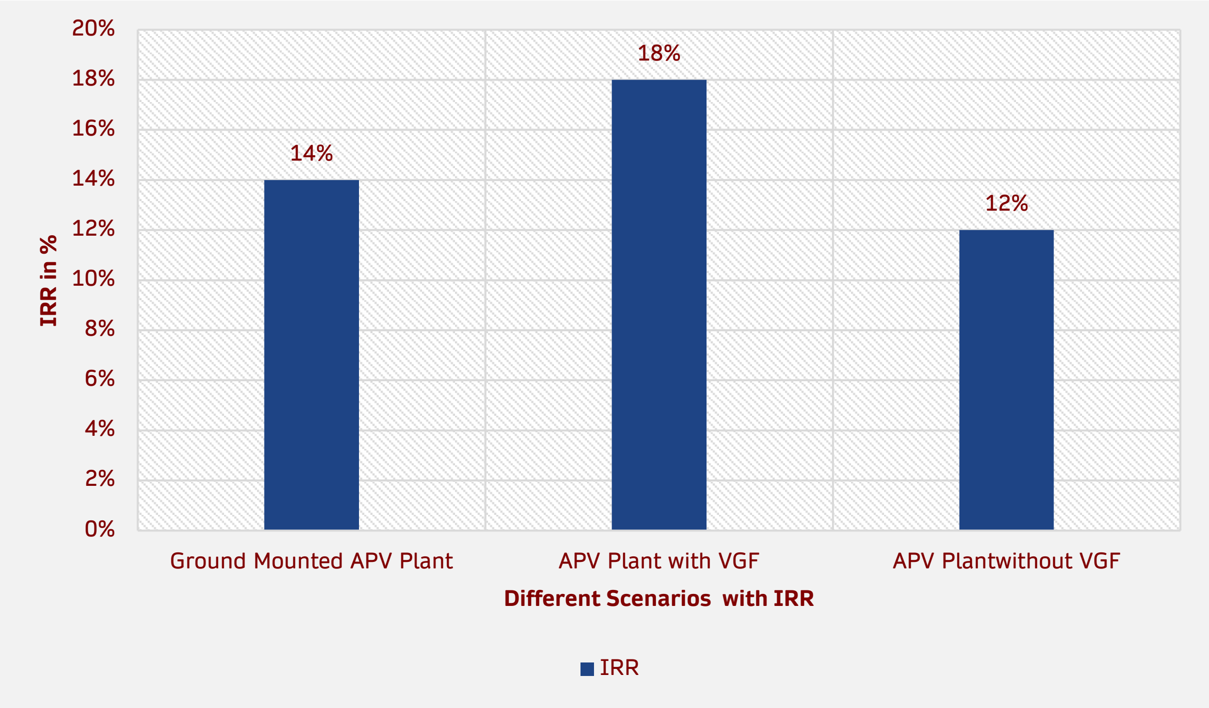
On the financial viability front, all the 3 scenarios analysed resulted in a simple payback period to showcase the practicality of the models.

Figure 11: Comparison of Payback Period of Different Scenarios for Kundanpura, Rajasthan



Source: Authors' Analysis

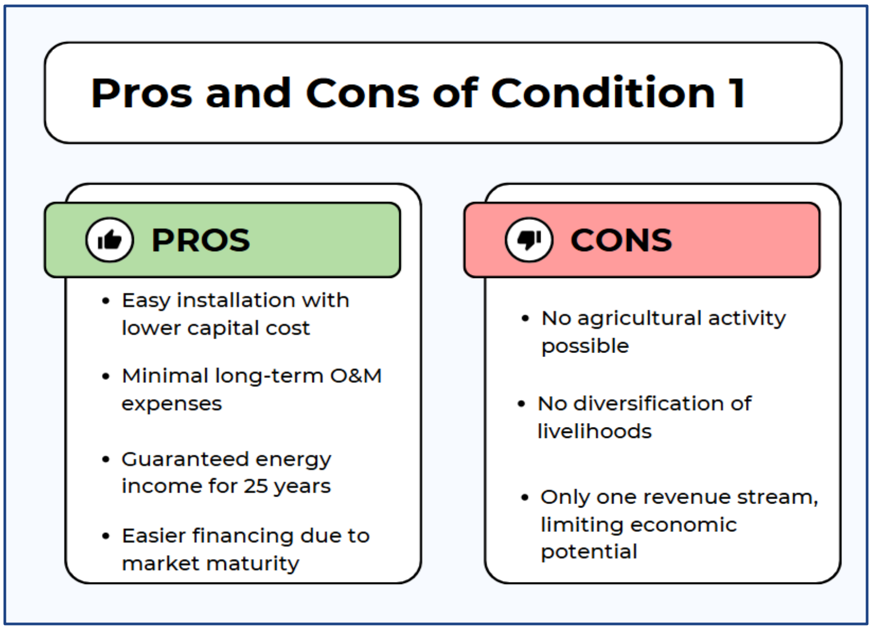
Figure 12: Comparison of IRR of Different Scenarios for Kundanpura, Rajasthan



Source: Authors' Analysis

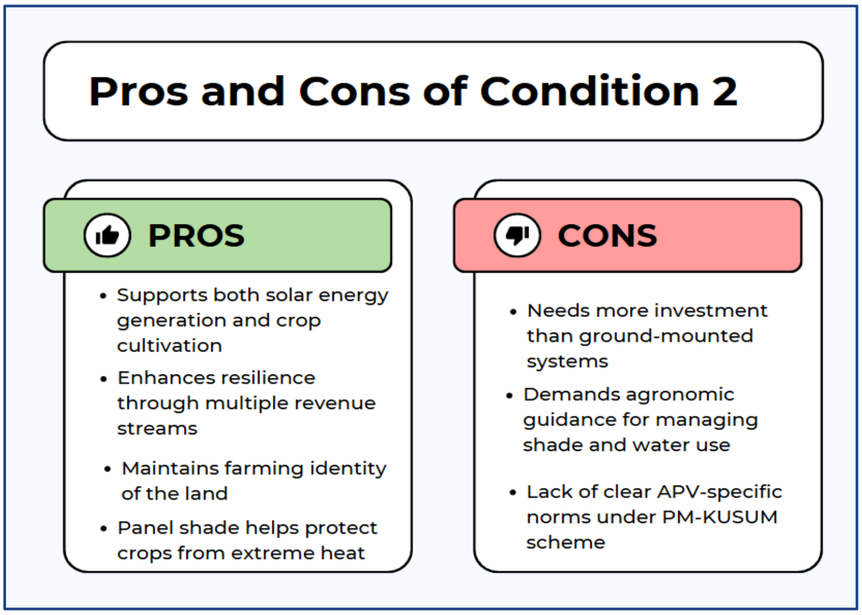
The Agri-PV setup without any external support (VGF) to farmers exhibits the longest payback timelines among all conditions, signalling slower capital recovery and reduced financial appeal. Agri-PV systems backed by VGF perform well, with moderately shorter payback periods, indicating that policy assistance greatly improves project feasibility even without advanced technology.

Figure 13: Pros and Cons of Condition 1



Source: Author's Analysis

Figure 14: Pros and Cons of Condition 2



Source: Author's Analysis

The Bottomline for Case Study 2

The Kundanpura, Rajasthan case study highlights the potential of multiple approaches to deploying Agri-PV under PM-KUSUM Component A, with the objective of maximising land use efficiency and enhancing farmers' incomes. The standard ground-mounted solar system (Condition 1) provides a stable revenue stream from energy generation with relatively lower capital investment. However, it eliminates the possibility of continued agricultural activity, thereby limiting livelihood diversification.

In contrast, elevated Agri-PV configurations demonstrate how dual land use can enable simultaneous crop cultivation and solar power generation. Such systems improve overall land productivity and increase the total income potential for farmers. However, these models require higher upfront investment. To support their scale-up, financial instruments such as viability gap funding (VGF) could play a critical role. An overhead stilted Agri-PV system typically costs 15–20 percent more than a conventional ground-mounted PV installation, and VGF could help bridge this cost differential.

The Agri-PV models explored in the Rajasthan case offer a resilient pathway for scaling agrivoltaics in India, aligning renewable energy expansion with agricultural sustainability and rural livelihood enhancement.

To realize the full potential of integrated solutions as discussed in both case studies, cohesive and targeted policy framework is essential. The next section provides the policy recommendations that can support the sustained development and mainstreaming of the concept of Agri-PV in India.

2.5 Need for Policy Ecosystem

To move beyond pilots and make Agri-PV scalable, there are certain policy ecosystems needed.

2.5.1 Establish a Centralised Monitoring and Grievance Redressal Mechanism

While the PM-KUSUM A is running since 2019 ever since the policy came into action, at present there is no centralised monitoring or grievance redressal cell. The absence of a centralised monitoring system to oversee the implementation of PM-KUSUM A leads to bureaucratic delays. For example, in MP the farmer has reported that payment delay for energy sale receipts from DISCOMs end and in the absence of a monitoring unit, he is unsure of whom to reach out to during such a crisis. The presence of multiple state departments without a single point of coordination impedes the smooth implementation of the project.

To address this, the Ministry of New and Renewable Energy (MNRE) should establish a centralised Agri-PV monitoring portal. This mechanism should:

- Track project commissioning, energy export status, and payment timelines.
- Serve as a grievance redressal platform for farmer-developers.
- Enable real-time coordination between DISCOMs, State Nodal Agencies, and implementation partners regarding any bottlenecks during implementation.

This system would increase transparency, ensure timely compliance with PM-KUSUM guidelines, and build confidence among stakeholders, particularly the investors including farmers or other financial institutions like commercial banks.

2.5.2 Revise the Financial Architecture of PM-KUSUM to Improve Affordability

For smallholder participants, mobilising equity financing remains a critical bottleneck. Based on the consultation with farmers, many have reported consideration for increasing the debt component to 85 percent so that they can leverage the support from banks to meet the high capital expenditure associated with such Agri-PV plants. Providing farmers with stronger support of financial institutions is critical for such innovations to scale up in the country. Apart from increasing the debt component, loans should be provided at concessional interest rate to farmers. While PM-KUSUM A had been included in priority sector lending by

RBI yet farmers have reported having to pay high interest rate within the range of 9 percent-11 percent. Revising the financial architecture of PM-KUSUM to accommodate and accelerate the deployment of Agri-PV is crucial. Alongside the introduction of interest subventions schemes, providing farmers with partial risk guarantee could make such agri-solar projects more attractive for investors. NABARD's credit guarantee fund could be explored in this regard. Such financial restructuring could be expected to encourage broader participation and improve the bankability of small-scale Agri-PV projects.

2.5.3 Institutionalise Model Contracts for Lease and Revenue-Sharing

In India one of the business models that has gained considerable traction in recent years is the developer owned Agri-PV model. As discussed earlier in this report, in such a model the developer leases land from the farmer and earns income through energy and agriculture sales. However, without standardised legal frameworks of model lease and revenue sharing agreements, there is a risk of farmers particularly those with limited literacy and bargaining power entering contracts with undervalued leases terms for 25 years. Most of the private developers entering the Agri-PV ecosystem have strong prior knowledge of the solar sector but not as much of the agriculture. In the absence of standardised frameworks, energy generation and management could gain precedence over agriculture production, compromising the agriculture component within Agri-PV.

To ensure fair participation, the government could consider introducing model lease and revenue-sharing agreements for Agri-PV that:

- Include inflation-indexed rent escalation clauses.
- Provide options for mid-term contract renegotiation or exit.
- Guarantee a share of both energy and agricultural returns to landowners.

Government and community institutions like KVK and local panchayats could raise awareness on these issues and support farmers with the required knowledge to build a stronger negotiation capacity among farmers.

2.5.4 Introduce Feed-in Tariff Premiums for Inclusive Agri-PV Models

One of the key factors determining the economic viability of any solar project is the feed-in tariff (FiT) offered to farmers or developers by DISCOMs or other procuring entities. Under the current framework of PM-KUSUM Component A, there is no tariff differentiation between conventional ground-mounted solar plants and Agri-PV systems. Both are offered the same FiT, despite the fact that Agri-PV installations typically entail 15-20 percent higher capital costs due to elevated mounting structures and design modifications required to enable continued agricultural activity. While the additional costs of Agri-PV systems can be partially recovered through high-value crop cultivation under the panels, the absence of a differentiated and remunerative tariff lengthens the payback period and may discourage adoption. Introducing a FiT above Rs 3.5/kWh for Agri-PV systems could play an important role in improving their financial viability and incentivising dual land-use models (Gulati et al., 2026).

To catalyse inclusive and farmer-centred Agri-PV models, policy must reward designs that actively involve local communities. One effective approach could be to provide a modest FiT premium to projects that meet inclusive design criteria such as local land ownership, revenue-sharing mechanisms, or employment generation for rural youth. States such as Gujarat and Maharashtra have experimented with differential tariffs for rooftop and decentralised solar, while countries like Japan have successfully implemented a feed-in-premium model. Adopting a similar structure for scaling Agri-PV in India could create strong incentives for developers to collaborate with FPOs and cooperatives, encourage farmers to retain productive control over their land, and promote institutional models where local benefits are formalised and transparently distributed.

2.5.5 Strengthen Research and Development for Agri-Technical Optimisation

There is strong momentum among different stakeholders surrounding Agri-PV in the country in recent years. However, in India the research on Agri-PV is operating at a nascent stage.

Scaling Agri-PV in India will require innovation in technology, agronomy, and system design. This calls for enhanced investment in applied R&D to:

- Identify crop varieties suitable under different shading conditions.
- Develop panel mounting structures optimised for diverse agro-climatic zones.
- Integrate Artificial Intelligence (AI) and sensors for real-time monitoring of energy and crop performance.
- Evaluate microclimatic impacts of Agri-PV on soil health and biodiversity.

These research efforts should be decentralised and supported through agricultural universities, ICAR centres, and pilot programs in collaboration with private players. Dissemination of findings in farmer-accessible formats is crucial to improve adoption.

2.5.6 Integrate Agri-PV Explicitly into PM-KUSUM Guidelines

In India, there is a policy platform for solarisation of agriculture in the form of PM-KUSUM. However, while the objectives of Agri-PV align with that of the policy, it continues to remain an implicit element under Component A. The scheme in its current form lacks explicit mandates or incentives to prioritise co-location of agriculture and solar energy generation.

To mainstream Agri-PV, PM-KUSUM should be revised to include Agri-PV as a formal sub-component, with:

- Design flexibility allowing elevated structures and crop-friendly layouts.
- Inclusion of crop yield monitoring as a project outcome.
- Incentives for models that demonstrate dual-income generation.

This will allow India to accelerate Agri-PV adoption using an existing scheme rather than designing new policy instruments from scratch. If PM-KUSUM 2.0 comes into existence and is rolled out, then it is imperative for inclusion of Agri-PV within the mandate and delivery system of the policy.

2.5.7 Conclusion

As India charts a path toward a net-zero future, agrivoltaics (Agri-PV) emerges as a strategic solution to achieve energy transition while revitalizing the agricultural economy. This report underscores that Agri-PV is not a singular technology, but a dynamic system of co-location that can generate dual income for farmers through both crop production and solar energy sales if designed with inclusivity, viability, and regional realities in mind. The case studies examined under the PM-KUSUM A scheme illustrate both the promise and pain points of Agri-PV in practice. While the Madhya Pradesh case exemplifies how farmer-owned Agri-PV models can achieve commercial-scale viability, it also reveals the critical need for interdepartmental coordination and streamlined energy evacuation infrastructure. These ground realities reinforce that successful Agri-PV deployment requires not just technological readiness but an enabling policy ecosystem that supports farmers, developers, and institutions alike.

To that end, the report identifies six key policy interventions. First, the establishment of a centralized monitoring and grievance redressal mechanism under MNRE is essential to ensure project oversight, transparency, and resolution of issues such as payment delays and bureaucratic bottlenecks. Second, the current financial architecture of PM-KUSUM-A must be restructured to improve affordability, especially for smallholder farmers. Enhancing the debt-equity ratio in favour of concessional debt (e.g., 85:15), introducing interest subventions, and exploring credit guarantees through NABARD can significantly improve the bankability and inclusiveness of Agri-PV projects. Third, institutionalizing model lease and revenue-sharing contracts is critical in protecting farmers particularly those with limited legal awareness. This will enable farmers to avoid exploitative lease terms and in ensuring that agriculture is not side-lined within the solar infrastructure and energy management. Standardized contracts with clauses for inflation indexing, renegotiation, and shared returns can be considered for fair and transparent partnerships between developers and landowners.

Fourth, the report calls for the introduction of feed-in-tariff (FiT) premiums to make Agri-PV economically viable, especially since system costs are higher due to elevated structures and dual-use designs. Such premiums should be linked to inclusive Agri-PV practices like local land ownership, participation of Farmer Producer Organizations (FPOs), or rural employment generation to incentivize models that balance energy production with equitable development.

Fifth, and perhaps most crucially, the report highlights the urgent need to strengthen research and development (R&D) efforts to optimize Agri-PV for Indian agro-climatic diversity. Applied research must focus on crop varieties suited to varying shade conditions, region-specific panel mounting designs, integration of AI and sensors for real-time monitoring, and evaluation of Agri-PV's impact on soil health, biodiversity, and microclimate. Decentralized R&D through ICAR institutions, agricultural universities, and public-private pilot projects can ensure that innovation is responsive to farmers' needs and accessible to all stakeholders. Dissemination of these findings in locally relevant languages and formats is vital to ensure last-mile adoption.

Finally, to institutionalize these recommendations, the report proposes integrating Agri-PV explicitly into the mandate of PM-KUSUM. While the scheme currently allows Agri-PV as an implicit possibility under Component A, there is a need for clear guidelines that prioritize dual-use system designs, monitor crop performance, and incentivize farmer-led and community-owned deployments. With PM-KUSUM already established as India's flagship policy for solarizing agriculture, its next phase PM-KUSUM 2.0 offers an ideal platform to embed Agri-PV as a formal sub-component and scale its adoption without reinventing the policy wheel.

In sum, Agri-PV holds transformative potential not just as a clean energy solution, but as a pathway to more resilient, diversified, and dignified rural livelihoods. For this promise to materialize, India must foster a supportive ecosystem that combines enabling policies, targeted finance, technical innovation, and farmer-first implementation. This report targets towards contributing to that effort by offering a practical and policy-relevant roadmap for making Agri-PV scalable, inclusive, and impactful in the Indian context.

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ANNEXURE

Annex 1: Inputs and Assumptions for Sunmaster Agri-PV, Najafgarh, Delhi

	Variable	Value
Project Finance	Project Size (MW)	2.5
	Useful Life (Years)	25
	Total Capital Cost (INR)	₹11,25,00,000
	Debt Ratio	70%
	Equity Ratio	30%
	Debt Amount (INR)	₹7,87,50,000
	Equity Amount (INR)	₹3,37,50,000
	Discount Rate (%)	11.46%
Loan Terms	Loan Tenure (Years)	7
	Interest Rate (%)	8.50%
	Monthly Interest Rate (%)	0.71%
	Monthly EMI (INR)	₹12,47,915.39
	Annual EMI (INR)	₹1,49,74,985
Depreciation	Depreciation Rate (Years 1-15) (%)	4.67%
	Salvage Value (%)	10%

	Depreciation (1st 15 years) (INR)	₹52,53,750
	Depreciation Rate (Years 16-25) (%)	2%
	Depreciation (16th Year to 25th Year) (INR)	₹22,50,000
	Debt % Of Depreciation (INR) (1-15 Years)	₹36,77,625
	Debt % Of Depreciation (INR) (16-25 Years)	₹15,75,000
	Salvage Value (INR)	₹1,12,50,000
	Total Depreciable (INR)	₹10,12,50,000
	Total Depreciable (1st 15 years) (INR)	₹3,67,76,250
	Total Depreciable (Last 10 years) (INR)	₹6,44,73,750
	Depreciation (Last 10 years) (INR)	₹64,47,375
	Debt % Of Depreciation (INR) (16-25 Years)	₹45,13,162.50
Working Capital	**Working Capital (% of Capital Cost)**	3%
	Working Capital (INR)	₹33,75,000
	Working Capital Interest Rate (%)	11.95%
	Annual Interest on Working Capital (INR)	₹4,03,313
Variable Cost	**Initial O&M Expense (INR)**	₹3,75,000
	O&M Escalation (%)	1.00%
	Total Land (Acre)	4.5
Generation	**Annual Runtime (Hours)**	8760
	CUF (%)	19%

	Gross Annual Energy Generation (kWh)	41,61,000
	kWh/kWp/year	1,664
	Auxiliary Consumption (%)	0.75%
	Net Generation (%)	99.25%
	Net Annual Energy Generation (kWh)	41,29,793
Agricultural Income	**INR/ha**	₹3,70,650
	INR/acre	₹1,50,000
	Total Agricultural Income for this Plant	₹6,75,000

Annex 2: Inputs and Assumptions for Agri-PV Plant, Sagar, Madhya Pradesh (With Agricultural Income)

	Variable	Value
Project Finance	Project Size (MW)	4.5
	Useful Life (Years)	25
	Total Capital Cost (INR)	₹18,50,00,000
	Debt Ratio	63%
	Equity Ratio	37%
	Debt Amount (INR)	₹11,65,50,000
	Equity Amount (INR)	₹6,84,50,000
	Discount Rate (%)	11.46%
Loan Terms	Loan Tenure (Years)	15
	Interest Rate (%)	9.85%
	Monthly Interest Rate (%)	0.82%
	Monthly EMI (INR)	₹14,00,000
	Annual EMI (INR)	₹1,68,00,000
Depreciation	Depreciation Rate (Years 1-15) (%)	4.67%
	Salvage Value (%)	10%
	Depreciation (1st 15 years) (INR)	₹86,39,500
	Depreciation Rate (Years 16-25) (%)	2%
	Depreciation (16th Year to 25th Year) (INR)	₹37,00,000

	Debt % Of Depreciation (INR) (1-15 Years)	₹54,42,885
	Debt % Of Depreciation (INR) (16-25 Years)	₹23,31,000
	Salvage Value (INR)	₹1,85,00,000
	Total Depreciable (INR)	₹16,65,00,000
	Total Depreciable (1st 15 years) (INR)	₹12,95,92,500
	Total Depreciable (Last 10 years) (INR)	₹3,69,07,500
	Depreciation (Last 10 years) (INR)	₹36,90,750
	Debt % Of Depreciation (INR) (16-25 Years)	₹23,25,172.50
Working Capital	**Working Capital (% of Capital Cost)**	3%
	Working Capital (INR)	₹55,50,000
	Working Capital Interest Rate (%)	11.95%
	Annual Interest on Working Capital (INR)	₹6,63,225
Variable Cost	**Initial O&M Expense (INR)**	₹10,00,000
	O&M Escalation (%)	5.00%
	Total Land (Acre)	15
Generation	**Annual Runtime (Hours)**	8760
	CUF (%)	21%
	Gross Annual Energy Generation (kWh)	80,00,000
	kWh/kWp/year	1,778

	Auxiliary Consumption (%)	0.75%
	Net Generation (%)	99.25%
	Net Annual Energy Generation (kWh)	79,40,000
Agricultural Income	**INR/ha**	₹9,88,400
	INR/acre	₹4,00,000
	Total Agricultural Income for this Plant	₹60,00,000

Annex 3: Inputs and Assumptions for Ground-Mounted Solar PV Plant, Kundanpura, Rajasthan

	Variable	Value
Project Finance	Project Size (MW)	0.6
	Useful Life (Years)	25
	Total Capital Cost (INR)	₹2,00,00,000
	Debt Ratio	70%
	Equity Ratio	30%
	Debt Amount (INR)	₹1,40,00,000
	Equity Amount (INR)	₹60,00,000
	Discount Rate (%)	11.46%
Loan Terms	Loan Tenure (Years)	14
	Interest Rate (%)	10.25%
	Monthly Interest Rate (%)	0.85%
	Monthly EMI (INR)	₹1,60,000
	Annual EMI (INR)	₹19,20,000
Depreciation	Depreciation Rate (Years 1-15) (%)	4.67%
	Salvage Value (%)	10%
	Depreciation (1st 15 years) (INR)	₹9,34,000
	Depreciation Rate (Years 16-25) (%)	2%
	Depreciation (16th Year to 25th Year) (INR)	₹4,00,000

	Debt % Of Depreciation (INR) (1-15 Years)	₹6,53,800
	Debt % Of Depreciation (INR) (16-25 Years)	₹2,80,000
	Salvage Value (INR)	₹20,00,000
	Total Depreciable (INR)	₹1,80,00,000
	Total Depreciable (1st 15 years) (INR)	₹1,30,76,000
	Total Depreciable (Last 10 years) (INR)	₹49,24,000
	Depreciation (Last 10 years) (INR)	₹4,92,400
	Debt % Of Depreciation (INR) (16-25 Years)	₹3,44,680.00
Working Capital	**Working Capital (% of Capital Cost)**	3%
	Working Capital (INR)	₹6,00,000
	Working Capital Interest Rate (%)	11.95%
	Annual Interest on Working Capital (INR)	₹71,700
Variable Cost	**Initial O&M Expense (INR)**	₹1,00,000
	O&M Escalation (%)	5.00%
	Total Land (Acre)	2.96
Generation	**Annual Runtime (Hours)**	8760
	CUF (%)	18%
	Gross Annual Energy Generation (kWh)	9,46,080
	kWh/kWp/year	1577

	Auxiliary Consumption (%)	0.75%
	Net Generation (%)	99.25%
	Net Annual Energy Generation (kWh)	9,38,984
Agricultural Income	**INR/ha**	₹0
	INR/acre	₹0
	Total Agricultural Income for this Plant	₹0

Annex 4: Inputs and Assumptions for Agri-PV Plant (With VGF), Kundanpura, Rajasthan

	Variable	Value
Project Finance	**Project Size (MW)**	0.6
	Useful Life (Years)	25
	Total Capital Cost (INR)	₹2,00,00,000
	Debt Ratio	70%
	Equity Ratio	30%
	Debt Amount (INR)	₹1,40,00,000
	Equity Amount (INR)	₹60,00,000
	Discount Rate (%)	11.46%
Loan Terms	**Loan Tenure (Years)**	14
	Interest Rate (%)	10.25%
	Monthly Interest Rate (%)	0.85%
	Monthly EMI (INR)	₹1,60,000
	Annual EMI (INR)	₹19,20,000
Depreciation	**Depreciation Rate (Years 1-15) (%)**	4.67%
	Salvage Value (%)	10%
	Depreciation (1st 15 years) (INR)	₹9,34,000
	Depreciation Rate (Years 16-25) (%)	2%
	Depreciation (16th Year to 25th Year) (INR)	₹4,00,000

	Debt % Of Depreciation (INR) (1-15 Years)	₹6,53,800
	Debt % Of Depreciation (INR) (16-25 Years)	₹2,80,000
	Salvage Value (INR)	₹20,00,000
	Total Depreciable (INR)	₹1,80,00,000
	Total Depreciable (1st 15 years) (INR)	₹1,30,76,000
	Total Depreciable (Last 10 years) (INR)	₹49,24,000
	Depreciation (Last 10 years) (INR)	₹4,92,400
	Debt % Of Depreciation (INR) (16-25 Years)	₹3,44,680.00
Working Capital	**Working Capital (% of Capital Cost)**	3%
	Working Capital (INR)	₹6,00,000
	Working Capital Interest Rate (%)	11.95%
	Annual Interest on Working Capital (INR)	₹71,700
Variable Cost	**Initial O&M Expense (INR)**	₹1,50,000
	O&M Escalation (%)	5.00%
	Total Land (Acre)	2.96
Generation	**Annual Runtime (Hours)**	8760
	CUF (%)	18%
	Gross Annual Energy Generation (kWh)	9,46,080
	kWh/kWp/year	1577

	Auxiliary Consumption (%)	0.75%
	Net Generation (%)	99.25%
	Net Annual Energy Generation (kWh)	9,38,984
Agricultural Income	**INR/ha**	₹2,47,100
	INR/acre	₹1,00,000
	Total Agricultural Income for this Plant	₹2,96,000

Annex 5: Inputs and Assumptions for Agri-PV Plant (Without VGF), Kundanpura, Rajasthan

	Variable	Value
Project Finance	Project Size (MW)	0.6
	Useful Life (Years)	25
	Total Capital Cost (INR)	₹2,35,30,000
	Debt Ratio	70%
	Equity Ratio	30%
	Debt Amount (INR)	₹1,64,71,000
	Equity Amount (INR)	₹70,59,000
	Discount Rate (%)	11.46%
Loan Terms	Loan Tenure (Years)	14
	Interest Rate (%)	10.25%
	Monthly Interest Rate (%)	0.85%
	Monthly EMI (INR)	₹1,84,516
	Annual EMI (INR)	₹22,14,193
Depreciation	Depreciation Rate (Years 1-15) (%)	4.67%
	Salvage Value (%)	10%
	Depreciation (1st 15 years) (INR)	₹10,98,851
	Depreciation Rate (Years 16-25) (%)	2%
	Depreciation (16th Year to 25th Year) (INR)	₹4,70,000

	Debt % Of Depreciation (INR) (1-15 Years)	₹7,69,196
	Debt % Of Depreciation (INR) (16-25 Years)	₹3,29,420
	Salvage Value (INR)	₹23,53,000
	Total Depreciable (INR)	₹2,11,77,000
	Total Depreciable (1st 15 years) (INR)	₹1,53,83,914
	Total Depreciable (Last 10 years) (INR)	₹57,93,086
	Depreciation (Last 10 years) (INR)	₹5,79,309
	Debt % Of Depreciation (INR) (16-25 Years)	₹4,05,516.02
Working Capital	**Working Capital (% of Capital Cost)**	3%
	Working Capital (INR)	₹7,05,900
	Working Capital Interest Rate (%)	11.95%
	Annual Interest on Working Capital (INR)	₹84,355
Variable Cost	**Initial O&M Expense (INR)**	₹1,50,000
	O&M Escalation (%)	5.00%
	Total Land (Acre)	2.96
Generation	**Annual Runtime (Hours)**	8760
	CUF (%)	18%
	Gross Annual Energy Generation (kWh)	9,46,080
	kWh/kWp/year	1577

	Auxiliary Consumption (%)	0.75%
	Net Generation (%)	99.25%
	Net Annual Energy Generation (kWh)	9,38,984
Agricultural Income	**INR/ha**	₹2,47,100
	INR/acre	₹1,00,000
	Total Agricultural Income for this Plant	₹2,96,000

GLIMPSES FROM THE FIELD

Image 1: Photos Captured During Field Visit to Agri-PV Plant in Sagar, Madhya Pradesh


Image 2: Glimpses from the Field: Pre-Implementation Stage



Image 3: Glimpses from the Field: Progress of our Work in Jaipur, Rajasthan During Implementation Phase

Image 4: Glimpses from the Field: Post-Implementation Stage




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