Tapping the Potential of Agriphotovoltaics in India

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CLIMATE POLICY INITIATIVE

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DISCLAIMER

The views & opinions expressed in this report are based on the information shared by developer & other reliable sources. However, the same has not been independently verified. While every effort has been made to ensure accuracy & competency, PFI or CPI assumes no responsibility or liability for errors, omissions or the accuracy of information contained herein. Readers are advised to exercise their own judgment before making decisions based on this report.

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We express our sincere appreciation to **Shri Surinder Ahuja**, Director, SunMaster, for facilitating the site visit to their Agriphotovoltaic installation and sharing critical perspectives from both developer and farmer viewpoints. We also express our sincere appreciation to **Shri Rajul Agarwal** (Chief Business Officer, BSES Rajdhani Power Limited) for facilitating the site visit to the substation where power from the above Agriphotovoltaic installation is injected. Their contributions were instrumental in shaping the practical understanding and recommendations presented in this study.

"By enabling the dual use of land, Agriphotovoltaics presents a sustainable solution to address land-use challenges while fostering inclusive growth in the renewable energy sector. This study provides valuable insights for policymakers to accelerate its adoption through well-designed tariff mechanisms and supportive policy interventions." — **Shri Anshuman Srivastava, Executive Director, Power Foundation of India**

"Agriphotovoltaics exemplifies the synergy between clean energy generation and agricultural productivity. Establishing a clear policy definition and recognising it as a renewable energy source will be pivotal in unlocking its vast potential to enhance rural livelihoods while contributing to India's renewable energy targets." — **Shri Sambit Basu, Head – Research, Power Foundation of India**

"Agriphotovoltaics is emerging as an important tool for India in balancing its clean energy commitment and food security. Agriphotovoltaics also enhances water efficiency, strengthens climate resilience, and provides "Annadata" with a stable, diversified source of income." — **Shri Saarthak Khurana, Senior Manager, Climate Policy Initiative**

"Agriphotovoltaics follows the principles of just and inclusive energy transition, ensuring the direct participation of farmers in the nation's growth story. It enhances rural income in line with the government's commitment while turning farmers into equal stakeholders in the clean energy revolution." — **Shri Debal Mitra, Senior Manager, Climate Policy Initiative**

FOREWORD

Dr. Srikant Nagulapalli, IAS
Director General
Power Foundation of India

India has set an ambitious target of achieving 500 GW of non-fossil fuel-based power capacity by 2030, reaffirming its commitment to a cleaner and more sustainable energy future. As the pace of renewable energy deployment accelerates, new challenges have emerged such as the grid stability due to geographical concentration of projects, limited land availability, and constraints in developing evacuation infrastructure.

In this context, Distributed Renewable Energy (DRE) presents a promising pathway to achieve balanced growth while improving energy access and system resilience. The Government of India has launched several initiatives to promote DRE generation, most notably the Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM) scheme.

Among the various DRE models, Agriphotovoltaics stands out as an innovative solution that enables the dual use of agricultural land for both solar power generation and crop cultivation. This approach not only enhances energy security but also supports farmer income diversification, efficient land utilisation, and climate-resilient agricultural practices.

This report, jointly prepared by the Power Foundation of India (PFI) and the Climate Policy Initiative (CPI), provides a comprehensive assessment of the opportunities, challenges, and policy measures necessary to scale up Agriphotovoltaics in India. The insights and recommendations presented here will serve as valuable guidance for policymakers, developers, and stakeholders. This initiative also aligns with the country's vision of Viksit Bharat@2047.

Vivek Sen
Director - India
Climate Policy Initiative

India stands at a pivotal moment in its clean energy and agricultural transformation. While the country has made remarkable progress in expanding renewable energy capacity, primarily through large-scale solar installations, emerging challenges related to land availability, grid integration, and climate risks highlight the need for innovative and locally adaptive solutions. In this context, Agriphotovoltaics presents a compelling opportunity—enabling the dual use of agricultural land for solar power generation and crop cultivation. This integrated approach strengthens energy security, diversifies farmer incomes, and promotes sustainable land and resource use.

This report, *"Tapping the Potential of Agriphotovoltaics in India,"* jointly developed by the Power Foundation of India (PFI) and Climate Policy Initiative (CPI), offers a comprehensive assessment of India's emerging Agriphotovoltaics landscape. It draws on field evidence and analytical insights to highlight the opportunities, challenges, and enabling policy and financial mechanisms required to scale this promising solution.

By linking clean energy generation with agricultural resilience, Agriphotovoltaics aligns with India's broader vision for sustainable development, rural empowerment, and climate resilience. The findings and recommendations presented herein will be valuable to policymakers, investors, and practitioners working to integrate renewable energy within India's agricultural ecosystems.

I commend the collaborative efforts of PFI and CPI in advancing research and dialogue on Agriphotovoltaics, and in contributing meaningfully to India's journey toward a sustainable and inclusive energy future.

EXECUTIVE SUMMARY

India's commitment to achieving its renewable energy targets marks a defining milestone in the country's clean energy transition. While renewable energy deployment has accelerated over the last decade, the growth remains geographically concentrated in a few states which leads to to improper price signals. In addition, issues related to land availability and evacuation infrastructure continue to pose challenges to large-scale renewable energy projects.

In this context, Agriphotovoltaics (Agriphotovoltaics), the co-location of solar power generation and agricultural activity, emerges as a promising solution that not only ensures balanced regional development but also optimises land use and strengthens rural economies. Agriphotovoltaics systems offer dual benefits by enabling solar power generation alongside agriculture, thereby ensuring diversification of income for farmers. A study by GIZ (2024) estimates that India's technical potential for Agriphotovoltaics ranges between 3,156 GW and 13,803 GW. With nearly 43% of India's land area under agriculture, the potential for Agriphotovoltaics deployment is immense.

This study by the Power Foundation of India (PFI), a registered society under the aegis of the Ministry of Power, GoI and the Climate Policy Initiative (CPI) provides an in-depth assessment of the regulatory, policy and financial landscape for Agriphotovoltaics in India. It is the first-of-its-kind study to model Feed-in Tariffs at varying Capacity Utilisation Factors (CUFs), taking into account the costs associated with elevated structures, land lease, and benefits to farmers. The modelled tariffs (based on CERC Renewable Energy Tariff Regulations, 2024), ranging between INR 3.67/kWh and INR 5.49/kWh, indicate that Agriphotovoltaics projects are economically viable Distributed Renewable Energy (DRE) systems.

The analysis further reveals that Agriphotovoltaics (DRE) projects offer lower levelized tariffs compared to non-DRE grid-connected projects, even after factoring in additional farmer benefits (INR 0.60/kWh). The impact of Transmission loss and Transmission Infrastructure in non-DRE is around INR 1.42/kWh, which gets avoided in Agriphotovoltaics projects. When compared with Rooftop Solar (RTS), prima facie Agriphotovoltaics appears costlier if farmer benefit is included, which is actually an economic benefit that may result in higher economic internal rate of return compared to financial internal rate of return comparison between projects. However, excluding this component, Agriphotovoltaics tariffs (INR 4.14/kWh + INR 0.75/kWh) are at par with RTS (INR 5.08/kWh). Agriphotovoltaics offers greater scalability, especially in dense urban areas, Group Housing Societies where rooftop potential is limited and shading issues arise.

The study recommends a multi-stakeholder approach for scaling up Agriphotovoltaics in India. Key recommendations include:

- **Ministry of Power:** Mandate the compulsory purchase of Agriphotovoltaics power under the Renewable Purchase Obligation (RPO) framework.
- **Ministry of New and Renewable Energy:** Define Agriphotovoltaics to facilitate eligibility for subsidies and streamlined approvals.
- **State Electricity Regulatory Commissions**: Adopt a feed-in tariff framework that includes elevated structure costs, land lease payments, and free power to farmers other than the Base Tariff, while mandating tripartite agreements between developers, farmers, and DISCOMs.

- **Ministry of Agriculture & Farmers Welfare**: Notify minimum agricultural yield thresholds, promote capacity building among farmers, and support pilot projects to identify shade-tolerant crops.
- **State Governments**: Amend land-use policies to allow Agriphotovoltaics installation on agricultural land without requiring land reclassification, or recognise it as a mixed land-use category.
- **Financial Institutions**: Structure loans based on PPA cash flows rather than land collateral.
- **Developers**: Align land lease tenure with PPA duration (25 years) and ensure transparent and equitable farmer compensation.
- **Farmers**: Engage in training and awareness programmes to strengthen local participation.

Agriphotovoltaics represents a win-win opportunity to enhance India's renewable energy capacity, augment farmer incomes, and promote a more inclusive and sustainable energy transition. It aligns closely with national priorities such as affordable and clean energy, land-use optimisation, rural development, and the Viksit Bharat @2047 vision.

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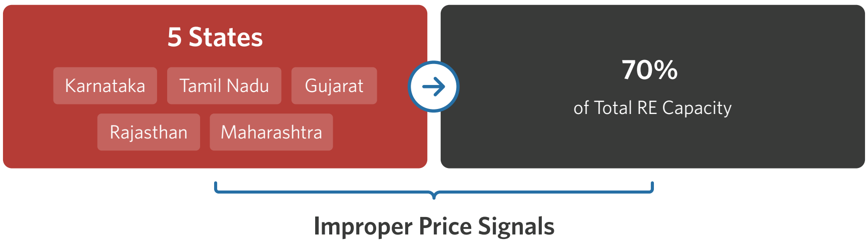
1. INTRODUCTION

India has committed to achieving 500 gigawatts (GW) of non-fossil fuel-based electricity capacity by 2030. As of September 2025, the country has already crossed the 250 GW milestone, marking significant progress towards this target. However, renewable energy growth remains unevenly distributed across states. Just five states (Gujarat, Rajasthan, Maharashtra, Karnataka, and Tamil Nadu) together account for nearly 70% of the total renewable energy installed capacity.

This geographic concentration reflects the absence of effective and uniform price signals across states. If left unaddressed, it could lead to challenges in grid balancing, regional equity, and investment diversification within the power sector. A more balanced distribution of renewable energy generation, aligned with state-level demand and infrastructure, is therefore essential to ensure a sustainable and inclusive energy transition.



A. Renewable Energy Cost Competitiveness and Locational Dynamics

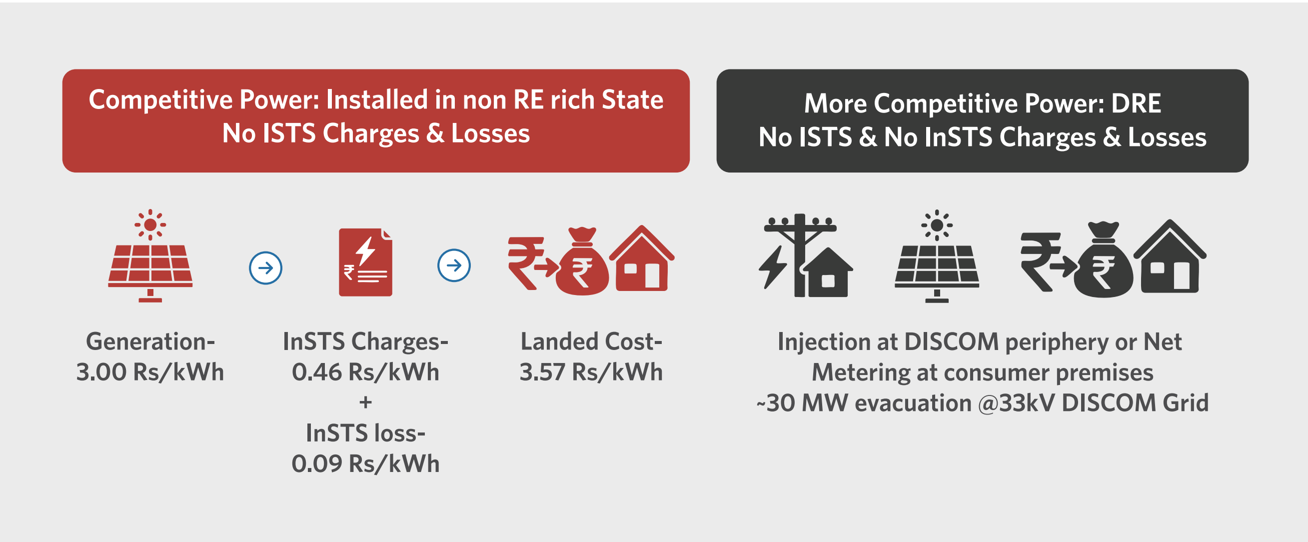
An analysis of the Landed Cost of Renewable Energy (RE) at the DISCOM periphery (refer Table 1) underscores this imbalance. For a reference solar project installed in an RE-rich state and withdrawn by another state, the landed cost is INR 3.02/kWh when ISTS charges are waived, and INR 3.71/kWh when such charges are included. These figures indicate that the competitiveness of RE projects is currently supported by policy-driven waivers and the ‘must-run’ status of these plants.

By contrast, a solar project installed in a non–RE-rich state for state-level consumption (hence, lower CUF and no ISTS charges and losses) has a landed cost of around INR 3.57/kWh, demonstrating that local generation can be cost-competitive even in a non–RE-rich state. This suggests that promoting state-level renewable development could mitigate geographic concentration and provide clear price signals. Even more favourable economics can be achieved through Distributed Renewable Energy (DRE) projects, which entirely avoid ISTS and InSTS charges and losses.

Table 1: Landed Cost of Renewable Energy at the DISCOM periphery

Particulars	Capacity	Gen. Inj.	DISCOM Drawl	Gen. Cost + 7p/kWh Trading Margin	CUF / PLF	Gen. (ex-bus)	ISTS Chg	ISTS Chg.	ISTS Chg. (with UF)	ISTS Loss	ISTS Loss	In-STS Charges	In-STS Charges	In-STS Losses	In-STS Losses	Load Des. Ch (Reg + State)	Load Des. Ch (Reg + State)	Landed cost with no waiver of ISTS Charges	Landed cost with Waiver of ISTS Charges
	MW	State	State	INR/kWh	%	MU	INR Cr.	INR/kWh	INR/kWh	MU	INR/kWh	INR Cr.	INR/kWh	MU	INR/kWh	INR Cr.	INR/kWh	INR/kWh	INR/kWh
				A					B		C		D		E		F	A+B+C+D+E+F	A+C+D+E+F
Solar Power Plant	300	Bihar	Bihar	**3.00**	**16%**	**424**	Not Applicable					57	**0.46**	13	**0.09**	0.68	**0.02**	**3.57**	
	300	Raj.	Bihar	**2.44**	**20%**	**526**	103	**2.09**	**0.70**	19	**0.09**	57	**0.38**	15	**0.08**	1.21	**0.02**	**3.71**	**3.02**

Source: Authors' construct



B. Stranded Renewable Energy Projects

While India's RE capacity has expanded rapidly, a growing share of it remains stranded. Nearly 50 GW of awarded projects have yet to be commissioned, a figure that has more than doubled within nine months. The main causes are the prolonged legal disputes over land acquisition and evacuation, which delay project execution.

These systemic challenges strengthen the case for Agriphotovoltaics (Agriphotovoltaics) — a model that enables dual use of land by integrating agricultural production with solar power generation on the same land. Agriphotovoltaics can help mitigate land-related bottlenecks, facilitate renewable deployment within state, and enhance local participation in the clean energy transition.

C. Agriculture and the Need for Integrated Solutions

India sits at the intersection of its energy transition and rural development agendas. Agriculture supports over 42.3% of India's population (Economic Survey 2022–23[1]) and occupies 141 million hectares, around 43% of the nation's total land area (Land Use Statistics at a Glance: 2022–23[2]). However, the sector faces mounting challenges, including water scarcity, erratic monsoons, climate variability, and declining productivity, all of which threaten rural livelihoods.

Over time, India's per capita availability of arable land has declined sharply from 0.35 hectares in 1961 to 0.11 hectares in 2021 due to the conversion of cultivable land for industrial and infrastructural use[3]. Meanwhile, India's economy is steadily transitioning from an agrarian base towards manufacturing and services (Indian Express, 2024), reducing agriculture's share in the national GDP.

Adding to these economic shifts is rural energy poverty. Agriculture accounts for nearly 19% of India's electricity consumption (PFI Energy Dashboard[4]), yet many farmers continue to rely on diesel pumpsets[5] due to unreliable grid supply and distortions created by cross-subsidies and tariff structures.

D. Land-Use Pressure and the Potential of Agriphotovoltaics

India's growing energy demand is placing increasing pressure on its finite land resources. The competition between land for food production and energy generation underscores the urgency of developing integrated land-use solutions. In this context, decentralised renewable energy models offer a promising pathway that supports both energy access and sustainable rural development.

Agriphotovoltaics, the co-location of solar installations with agricultural activity, offers a win-win solution. It promotes dual land use, enhances farmer incomes, and contributes to decentralised electrification (IISD 2023; GIZ 2024). Although the concept is still nascent in India, with an installed capacity of about 24 MW[6], initial pilots have demonstrated encouraging results.

A Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH Study[7] estimates India's technical potential for Agriphotovoltaics at 3,156 GW to 13,803 GW, depending on crop type, technology, and climatic conditions, highlighting its vast untapped opportunity.

1 https://pib.gov.in/PressReleasePage.aspx?PRID=2034943
2 https://desagri.gov.in/wp-content/uploads/2024/09/Final-file-of-LUS-2022-23-for-uploading.pdf
3 Taken from: Arable land (hectares per person) - India | Data
4 https://www.powerfoundation.org.in/electricity-consumption-connected-load.php
5 https://desagri.gov.in/wp-content/uploads/2024/04/2018-19-Solarisation-of-Agricultural-Water-Pumps-in-Rajasthan.pdf
6 https://www.Agriphotovoltaics.in/agripv-map-of-india (Accessed on May 31, 2025)
7 https://0c91be0b-3282-49b8-b0cf-5701e6b03914.usrfiles.com/ugd/0c91be_10fd5e5de18c4608b2f0314eb4a457bd.pdf

2. OBJECTIVE AND SCOPE OF THE STUDY

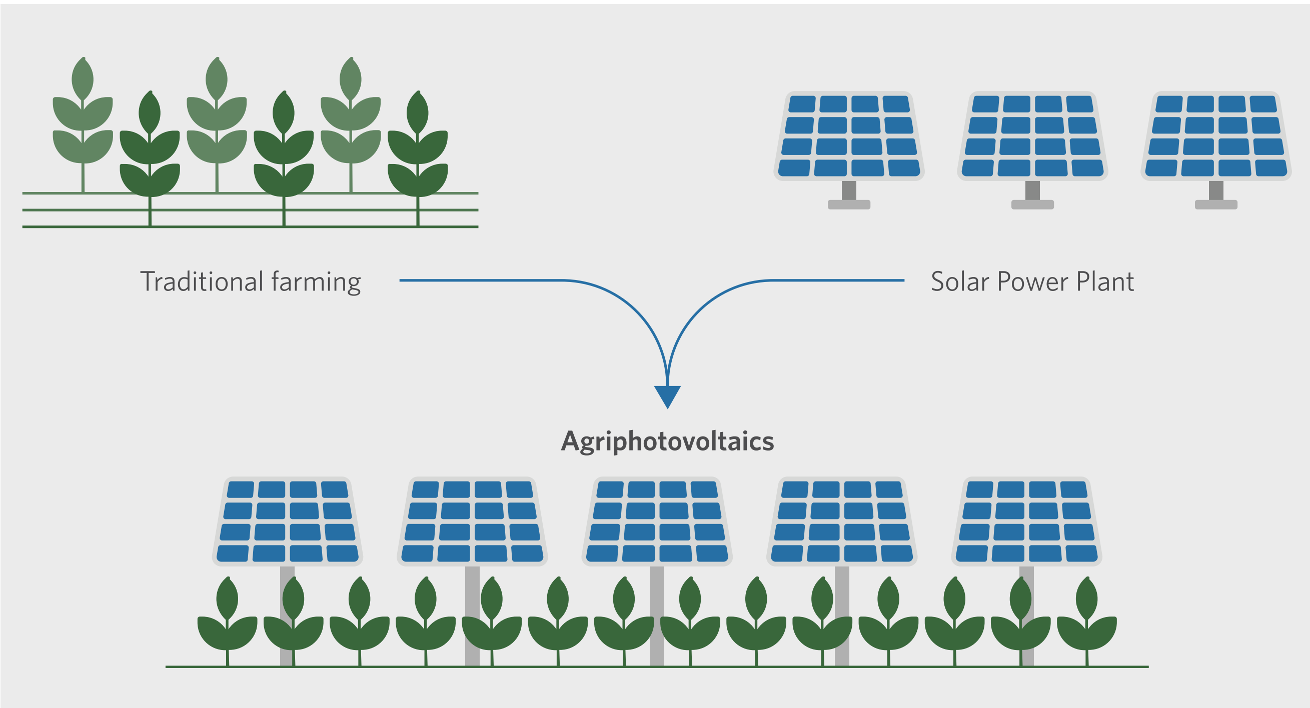
This report, jointly prepared by the Power Foundation of India (PFI) and the Climate Policy Initiative (CPI), evaluates Agriphotovoltaics as a scalable and economically viable solution capable of delivering dual benefits.

The report:

- Studies the existing landscape in India to identify key policy, regulatory, and financial barriers affecting Agriphotovoltaics deployment;
- Proposes measures such as feed-in tariffs, regulatory incentives, and concessional financing to unlock its potential;
- Analyses the implications for the power sector, particularly for Distribution Companies (DISCOMs); and
- Draws on insights from field visit to a pilot Agriphotovoltaics project, highlighting on-ground challenges faced by developers.

Overall, the report positions Agriphotovoltaics as a practical and forward-looking solution to advance land-use optimisation, increase rural income and provide proper price signal with reduction in transmission losses and infrastructure, and promote decentralised electrification.

Agriphotovoltaics as a concept



3. CLASSIFICATION OF AGRIPHOTOVOLTAICS

Agriphotovoltaics systems can be broadly classified into three main configurations based on the structural design of solar installations. These include:

1. **Overhead PV Systems** – Solar panels are mounted on elevated structures, allowing conventional agricultural operations to continue beneath them.
2. **Interspace PV Systems** – Ground-mounted panels are arranged in rows with adequate spacing to enable cultivation or other agricultural activities in the inter-row areas.
3. **Vertical PV Systems** – Panels are installed vertically, often in an east–west orientation, with open spaces between rows to permit crop cultivation or fodder growth.

Each configuration presents distinct advantages and limitations in terms of land-use efficiency, crop compatibility, irrigation requirements, ease of farming, and cost. While overhead systems maximise land-use efficiency and allow continuation of traditional farming, they entail higher capital costs due to elevated mounting structures. Interspace systems, on the other hand, are more cost-effective and simpler to deploy but may experience reduced crop yield due to partial shading. Vertical systems strike a balance, offering ease of operation and moderate costs, though with relatively lower energy yield per unit of land area.

Table 2: Comparison of Agriphotovoltaics Configurations

Feature	Overhead Agriphotovoltaics	Interspace Agriphotovoltaics	Vertical Agriphotovoltaics
Design	PV panels mounted on elevated structures with crop cultivation beneath	Ground-mounted or low-mounted panels with cultivation between rows	PV panels installed vertically (often east-west orientation) with open space between rows
Land Use	Shared land for crops and solar; full overlap of functions	Crops/livestock in spaces between rows; partial overlap	Significant open space between rows; suitable for row crops and fodder
Height/ Orientation	Height depends on crop type, light needs, and equipment movement	Rows of tilted panels, spaced for adequate sunlight penetration	Vertical panels, usually east-west oriented
Land Use Efficiency	High (same land fully used for energy + crops)	Lower (part of land exclusively under panels)	Moderate (panel spacing reduces density, but farming space remains usable)
Capital Cost	High, due to the elevated structure	Lower than overhead systems	Moderate; lower than overhead but higher than standard ground-mount
Crop Compatibility	Limited to shade-tolerant crops	Wider range of crops; supports grazing and aquaculture	Suitable for row crops, fodder, and pasture; minimal shading impact
Operational Advantages	Allows the use of agricultural equipment under panels	Supports mixed uses (grazing, aquaculture)	Easier mechanised farming; panels act as partial windbreaks
Energy Yield	High, due to optimal tilt and density	Comparable to conventional ground-mount	Lower per-unit land area compared to overhead/ interspace systems

Source: Authors' Construct

4. GLOBAL OVERVIEW OF AGRIPHOTOVOLTAICS

Agriphotovoltaics has emerged globally as a promising innovation at the intersection of agriculture and renewable energy. Between 2012 and 2021, global Agriphotovoltaics capacity has grown significantly from just 5 MW to over 14 GW [Gorjian et al., 2022; Fraunhofer ISE, 2022[8]]. The concept has gained momentum across several countries, including Germany, Japan, China, Italy, and France, where it is being integrated into national renewable energy and rural development strategies.

Table 3 provides an overview of the Agriphotovoltaics landscape in key countries, highlighting their policy landscape and deployment status.

Table 3: Agriphotovoltaics Landscape in Other Countries

Country	Policy / Regulation / Guideline	Installed Capacity
China	National policies such as Administrative Measures for Poverty Alleviation with PV Power Plants (2017) promote Agriphotovoltaics for poverty alleviation.	~12 GW (2020)
Italy	Decree no. 1/2012 introduced the concept of Agriphotovoltaics. Legislative Decree no. 199/2021 regulates the identification of suitable areas and design criteria. The Ministry of Ecological Transition provide details about technical requirements. New regulations mandate a minimum panel height of 1.3 meters and **limit yield reduction to 30%**.	593 MW
Japan[9]	Agricultural Promotion Bureau of the Ministry of Agriculture, Forestry and Fisheries (MAFF) permits Agriphotovoltaics installations on all categories of farmland. The Feed-in Tariff Act, under the Ministry of Economy, Trade and Industry (METI), provides preferential treatment for small-scale Agriphotovoltaics systems. **Crop yield loss must not exceed 20%.**	~200 MW
Germany[10]	German Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz (EEG)) regards Agriphotovoltaics as "special plants" and receives a higher remuneration for electricity fed into the grid. Must achieve **at least 66% of the agricultural reference yield** and keep land losses due to mounting structure below 10% for Category I and 15% for Category II.	~82 MW (2023)[11]
France	Decree No. 2024-318 defines the modalities for the development and regulation of Agriphotovoltaics. It should preserve the agricultural use of the land, and **cap yield loss to 10%.**	Data not available

Sources: Hu Z (2024), EMBER (2024), JRC (2023)

8 https://www.thegef.org/sites/default/files/documents/2024-01/EN_GEF.STAP_.C.66.Inf_.04_Agriphotovoltaics.pdf
9 Source: https://www.xmwintop.com/japan-releases-new-Agriphotovoltaics-guidelines_n19
10 Source: https://www.wind-energie.de/english/policy/rea
11 http://bit.ly/43CdZ6l

5. PREVALENT BUSINESS MODELS

The large-scale deployment of Agriphotovoltaics hinges on the viability of business models that are both financially attractive and operationally feasible. Broadly, three models have emerged, differentiated by ownership and investment responsibility. These include:

A. Farmer or FPO-owned

Under this model, individual farmers or Farmer Producer Organisations (FPOs) take ownership of the Agriphotovoltaics installation. Capital is mobilised through a mix of equity contributions and loans from financial institutions. FPOs and farmer collectives can play a pivotal role in pooling resources and enhancing access to credit.

Power generated can be used for captive consumption, with any surplus sold to distribution companies (DISCOMs) via net metering or power purchase agreements (PPAs). This model empowers farmers by providing an additional and sustainable source of income and promoting rural self-sufficiency. It reduces the government's subsidy burden on agricultural electricity. DISCOMs also benefit because the revenue received from selling electricity to agricultural consumers is typically lower than their average cost of supply.

However, the adoption of this model can be constrained by high upfront costs, limited access to affordable finance, insufficient technical knowledge for the operation and maintenance (O&M) of solar plants, and a lack of awareness about electricity sales processes, particularly among small and marginal farmers.

B. State Government-owned

In this business model, a Special Purpose Vehicle (SPV) is established by the state's Finance and Energy Departments to implement and operate the Agriphotovoltaics project. The State Power Development Corporation typically acts as the implementing agency, responsible for capital investment, installation, and O&M.

Farmers are compensated through land lease payments, which may also include additional remuneration for any loss in agricultural productivity. Compensation frameworks generally account for crop type, annual income, and prevailing market prices. Farmers may also receive free electricity from the project for agricultural use. This model ensures professional management of the solar installations, provides stable income to farmers, and helps the state reduce subsidy burdens.

However, project viability may be impacted by bureaucratic delays, poorly defined compensation mechanisms, and dependence on state budget allocations. Transparent, legally enforceable compensation frameworks and timely disbursement mechanisms are crucial to enhance replicability and investor confidence.

C. Developer-owned

In this model, a private entity finances, installs, operates, and maintains the Agriphotovoltaics system on agricultural land leased from farmers. Electricity generated is sold either through PPAs or net metering, allowing the developer to recover costs.

The Land Lease Agreement with the farmer includes fixed lease payments and, where applicable, compensation clauses for potential crop yield losses. This arrangement provides farmers with a stable income while relieving them of technical (O&M of solar plant) and financial (involvement with DISCOM for sale of power) management.

The model's success depends heavily on the financial stability and long-term commitment of the developer. Any financial or legal distress faced by the developer can affect project operations and disrupt farmer income. Therefore, legally binding contracts with clearly defined responsibilities, risk-sharing, and grievance redressal mechanisms are essential to safeguard farmers' interests.

6. BENEFITS OF AGRIPHOTOVOLTAICS SYSTEMS

Agriphotovoltaics systems — by enabling the simultaneous use of land for both agriculture and solar power generation — offer various economic, environmental, and systemic benefits. These support India's twin goals of agricultural resilience and clean energy transition. These systems are particularly valuable in states that are rich in agriculture but face land scarcity issues in deploying renewable energy projects. One of the key measures of Agriphotovoltaics's land-use efficiency is the Land Equivalent Ratio (LER), which exceeds one (LER > 1) in many studies. This indicates that combined outputs (crop yield and electricity) from Agriphotovoltaics systems on the same parcel of land surpass those from separate land uses (Guerin, 2019; Kostik et al., 2020; Trommsdorff, Gruber et al., 2022). Agriphotovoltaics systems enhance climate resilience and lead to rural income diversification, thus reducing sole dependence on agriculture. It will enhance rural energy access by providing reliable daytime power for irrigation and reduce carbon emissions by supporting renewable energy deployment.

The key advantages of Agriphotovoltaics for three major stakeholders, including Farmers, DISCOMs, and Developers, are elaborated below:

1. Farmers

- **Increased Income:**
    - **Farmer-Owned Model:** Diversifies and increases income for farmers by providing additional revenue from the generation and sale of electricity, under different routes such as net metering and PPA.
    - **Developer-Owned Model:** Farmers receive fixed lease payments for land and revenue sharing of agricultural output, creating a dual-income stream. This enhances financial stability for farmers. (As elaborated later in Case Study of SunMaster's Agriphotovoltaics plant, the farmers' annual agricultural income was approximately INR 60,000 per acre per year before the installation of the Agriphotovoltaics system. However, after Agriphotovoltaics, they earned INR 1.05 lakh per acre per year, which included their share in agriculture, land lease payments, and rent of agricultural equipment, nearly doubling their income from the same land.)
- **Improved Crop Yield and Soil Health:** The partial shading provided by elevated solar panels creates a microclimate that can be especially beneficial for crops like leafy greens, root vegetables, spices, and herbs. It shields crops from extreme weather events such as heatwaves, hailstorms, and heavy rain. Other benefits include moderating temperature extremes, reduced wind exposure, conserved soil moisture, and enhanced soil fertility due to moderated exposure. These changes can improve crop yields and minimise water loss (elaborated in case study later), thereby reducing irrigation costs. According to some literature, as temperatures rise over time, agriculture stands to benefit from Agriphotovoltaics in many scenarios, particularly in hot and arid regions.

2. DISCOMs

- **Reduced Cross-Subsidy Burden:**
  - Agriphotovoltaics systems reduce electricity demand from the agriculture sector by enabling farmers to meet a significant portion of their in-house energy needs through on-site solar generation, previously supplied by DISCOMs.
  - It reduces DISCOMs' burden of supplying subsidised electricity to agricultural consumers. This frees up supply capacity for high-paying commercial and industrial (C&I) consumers, improving the DISCOMs' revenue mix and financial health.
- **Better compliance with RPO Targets:**
  - Agriphotovoltaics projects can support DISCOMs in meeting their Renewable Purchase Obligations (RPOs) more effectively within the state through intra-state generation, thereby reducing dependence on renewable energy procurement from other states. Projects under PPA arrangements contribute to 'Other Renewable Energy' RPO targets, while deployment under net metering, gross metering, virtual net metering, group net metering, or behind-the-meter installations help fulfil 'Distributed Renewable Energy (DRE)' RPO targets.
  - In addition to RPO compliance, Agriphotovoltaics deployments address key implementation challenges typically associated with large-scale renewable energy projects like land acquisition and resettlement issues, as the projects are installed on existing agricultural land.
- **Reduced Transmission Losses Through Localised Generation:**
  - Agriphotovoltaics foster decentralised generation, especially in non-RE-rich states, thus reducing reliance on interstate power transmission from RE-rich states. Localised solar generation results in lower transmission and distribution (T&D) losses.
  - As per the 20th Electric Power Survey (EPS) of India conducted by the Central Electricity Authority (CEA), annual electricity consumption for irrigation is projected to reach approximately 390 Billion Units (BUs) by FY 2031-32. According to the Power Finance Corporation's (PFC) Report on the Performance of Power Utilities, the average cost of supply in FY 2023–24 stood at INR 7 per unit, whereas Agriphotovoltaics projects have the potential to generate electricity at a significantly lower cost of INR 4.5–5 per unit (substantiated later as Feed-in-Tariff). By installing Agriphotovoltaics, DISCOMs can benefit over time from avoided capital expenditure on T&D infrastructure, reduced T&D losses, and lower procurement costs for meeting agricultural demand.
  - If we assume that even 10% of the total projected agricultural electricity demand is met through Agriphotovoltaics, T&D losses of around INR 4,356 crores can be avoided. (Gross input requirement = 39/(1-0.1376) = 45.22 BUs; T&D loss = 45.22-39 = 6.22 BUs; Financial cost of T&D losses = 6.22 BUs x INR 7=INR 4,356 crore per annum; assuming T&D loss of approximately 13.76%[12] (FY 2031-32)

12 https://cea.nic.in/wp-content/uploads/irp/2023/05/NEP_2022_32_FINAL_GAZETTE-1.pdf

3. Developers

- **Revenue from Sale of Electricity:** Private developers operating Agriphotovoltaics plants under long-term PPAs, or net metering arrangements benefit from steady revenue through the sale of electricity.
- **Reduced Land Acquisition Risks:** The dual-use nature of the land and engaging farmers as land-leasers also enhances land acquisition feasibility, promotes community acceptance and reduces project opposition from local communities, which is often a bottleneck for utility-scale solar projects.

7. LANDSCAPE OF AGRIPHOTOVOLTAICS IN INDIA

India receives over 300 days of sunshine annually, with average daily solar insolation ranging between 4 and 7 kWh per square meter (IREDA). This abundant solar potential, combined with India's diverse agricultural landscape, makes Agriphotovoltaics a compelling approach for simultaneously advancing clean energy generation and ensuring food security. This section provides an overview of the policy, financial, regulatory, and legal landscape surrounding Agriphotovoltaics in India and assesses how these frameworks shape its deployment and growth.

7.1. Policy Landscape

The PM KUSUM scheme, launched in 2019, is a flagship central government scheme aimed at enhancing farmers' income through solar-based decentralised energy generation, reducing dependence on diesel pumps in agriculture, and promoting rural energy security. The scheme, designed as demand-driven, allocates capacities based on proposals received from States and Union Territories. It targets the addition of 34,800 MW of solar capacity by March 2026. The Scheme has three components:

- Component-A: Installation of 10,000 MW of decentralised ground-mounted or stilt-mounted grid-connected solar or other renewable energy power plants (0.5 MW to 2 MW capacity) on barren/ fallow/marshy/ pasture or cultivable lands (cultivated land if panel height permits continued agricultural use). The local DISCOM will purchase the power generated at a pre-fixed tariff.
- Component-B: Installation of 14 lakh stand-alone solar agriculture pumps.
- Component-C: Solarisation of 35 lakh grid-connected agriculture pumps, including feeder-level solarisation.

For Component-A, eligible entities include individual farmers, groups of farmers, cooperatives, panchayats, FPOs, and Water User Associations. In cases where farmers lack the ability to finance the installation, they can opt for implementation via developers or DISCOMs.

The estimated income for farmers leasing land under Component-A ranges from INR 25,000 to INR 65,000 per acre annually[13], depending on the ownership model and whether a loan is availed.

Initial implementation challenges included delays caused by the COVID-19 pandemic, supply chain disruptions, unavailability of low-cost finance, collateral requirements by banks, and land-related hurdles. In response, the government, in September 2024, included all components of PM-KUSUM under the Agriculture Infrastructure Fund (AIF), ensuring access to low-cost capital. The Reserve Bank of India (RBI) designated Component-A as eligible for priority sector lending, enabling banks to extend loans on favourable terms. In January 2024, the Ministry issued revised and simplified guidelines to address concerns related to land, state share, and other technical challenges.

13 https://static.pib.gov.in/WriteReadData/specificdocs/documents/2023/may/doc202351191401.pdf

State-Level Initiatives

In addition to central schemes, several state governments have initiated programs to promote renewable energy use in agriculture. Some of the notable efforts are summarised below:

Table 4: Key state-led programs integrating solar energy with farming practices

State	Program and Key Features
Gujarat	**Suryashakti Kisan Yojana (SKY)**[14] • Launched in 2018; enables farmers to install solar power panels on their agricultural land, allowing them to use the generated electricity for irrigation and sell surplus energy to the grid. • Offers a 60% subsidy from both State and Central Governments; a low-interest loan covering 35% of the project cost at interest rates between 4.5% and 6%; and the remaining 5% as the farmer's contribution. • Scheme duration: 25 years; farmers earn INR 7 per unit in the initial 7 years (split between INR 3.5 from GUVNL and INR 3.5 from the State), followed by INR 3.5 per unit for the subsequent 18 years. • As of 31st March 2022, the scheme has commissioned 93 solar feeders generating 101.7 MW of electricity and benefitting 4445 farmers.[15]
Maharashtra	**Mukhyamantri Saur Krushi Vahini Yojana (MSKVY)**[16] • Launched in June 2017, to address the electricity needs of about 45 lakh agricultural consumers, accounting for 22% of the state's electricity demand. • Provides reliable daytime electricity to farmers through decentralised solar projects ranging from 2 MW to 10 MW, located near substations. • Revised in 2021, the MSKVY 2.0 aims to solarise 30% of agricultural feeders by 2025 and targets 7,000 MW of decentralised solar projects.
Delhi	**Mukhyamantri Kisan Aay Badhotary Yojna**[17] • Uses raised solar panel structures (minimum 3.5 meters high) on agricultural land, using one-third of the area for solar panels while the rest remains available for cultivation. • Farmers earn INR 8,333 per acre per month in the first year, with a 6% annual increase, reaching INR 33,741 by the 25th year. They also receive up to 6,000 electricity units free per MW annually. • Implemented under the RESCO model, with no upfront cost to farmers.

Source: Authors' Construct

While schemes like PM-KUSUM and these state-led programs are steps in the right direction in promoting solar adoption in agriculture, their implementation has faced significant hurdles. Risk aversion, capital constraints, and regional disparities in participation highlight the need for localised approaches and creating awareness amongst the farmers. This necessitates a dedicated policy framework for Agriphotovoltaics.

7.2. Financing Landscape

Agriphotovoltaics systems are inherently capital-intensive, primarily due to the cost of elevated structures. The estimated installation cost of an overhead Agriphotovoltaics system is INR 4.30 crore per MW, significantly higher than the INR 3.50 crore per MW required for conventional ground-mounted solar PV systems. This cost differential stems from the need for elevated mounting structures, stronger foundations, and modified layouts that allow agricultural activity underneath.

14 https://www.gprd.in/Training/JBUSKY.pdf
15 https://www.nabard.org/auth/writereaddata/tender/pub_040723062434599.pdf
16 https://www.mahadiscom.in/solar-mskvy/index.php
17 https://eerem.delhi.gov.in/sites/default/files/eerem/important-news/mukhya_mantri_kisaan_aay_badhotary_yojana.pdf

Given these higher capital requirements, their successful deployment necessitates long-term coordination among multiple stakeholders, including farmers, developers, financial institutions, and government agencies. The financial viability of these projects depends on well-aligned business models, ownership structures, and policy incentives. Achieving large-scale commercialisation will therefore require a blend of public and private financing, tailored to the scale and nature of each project.

Globally, clean energy projects, including Agriphotovoltaics, are promoted through budgetary allocations, concessional financing, and targeted incentive schemes to address high upfront costs and structural barriers. The financial support mechanisms for Agriphotovoltaics can be broadly classified into three categories:

1. **Capital Support:** These measures aim to reduce the high initial capital cost of installation, thereby enhancing the financial viability of the project. These include direct subsidies, low-interest loans and tax incentives that enable farmers and developers to access affordable finance. For instance, in September 2024, the government included all components of the PM-KUSUM scheme under the Agriculture Infrastructure Fund (AIF), enabling access to low-cost capital.

2. **Revenue Support:** These mechanisms ensure consistent cash flows post operationalisation of Agriphotovoltaics projects, encouraging long-term private sector participation. Instruments such as Feed-in Tariffs and Generation Based Incentives (GBI) provide predictable income streams and enhance investor confidence. For instance, a Pre-fixed tariff is available under Component A of the PM-KUSUM scheme.

3. **Risk Mitigation Instruments:** Instruments like credit guarantees, insurance coverage, and refinancing support are essential to reduce perceived risks. These tools improve project bankability by safeguarding investors and lenders against uncertainties related to agricultural yield, power generation variability, or policy changes.

Such support mechanisms are currently unavailable for Agriphotovoltaics. Financing Agriphotovoltaics projects remains complex due to the unique challenges of integrating energy generation with agricultural practices. Many farmers lack sufficient collateral or credit history to secure institutional finance. In such cases, provision of GBI, free electricity, or Viability Gap Funding can serve as a critical enabler for scaling Agriphotovoltaics deployment.

7.3. Legal & Regulatory Landscape

The legal and regulatory environment in India poses significant challenges to the adoption of Agriphotovoltaics. Existing frameworks often treat land, power, and water usage through sector-specific lenses, creating fragmentation that hampers integrated projects like Agriphotovoltaics.

1. Regulatory Complexity and Legal Overlaps

Agriphotovoltaics projects in India must navigate a web of central and state regulations/laws:

- **Electricity:** As a concurrent subject, the generation, transmission, and distribution of electricity (including renewables) are governed by both central and state governments under the *Electricity Act, 2003*[18].

18 https://cercind.gov.in/Act-with-amendment.pdf

- **Land Acquisition and Use:** The *Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013*[19] governs land acquisition, while land-use conversion is a state subject with widely varying rules.
- **Environmental Compliance:** Projects may require approvals under the *Environmental Impact Assessment (EIA) Notification, 2006*[20], especially for large-scale installations.
- **Water and Irrigation Laws:** Compliance with local irrigation and groundwater usage regulations adds another layer of complexity.

2. State-Level Disparities in Land Use

Agriphotovoltaics occupies a regulatory grey area, as it does not fall squarely under either 'agricultural' or 'non-agricultural' land-use categories. This often necessitates special exemptions or case-by-case approvals, creating procedural hurdles.

Land-use laws vary significantly across Indian states:

- Some states have comparatively supportive frameworks that recognise mixed land-use models, facilitating Agriphotovoltaics deployment, e.g. Delhi.
- In contrast, states like Uttar Pradesh, Punjab, and Haryana have strict land-use conversion norms that restrict the use of agricultural land for commercial purposes, thereby complicating the implementation of Agriphotovoltaics projects. In these states, farmers frequently encounter problems such as complex land-leasing procedures, delays in obtaining permits for land conversion, and conflicts between farming activities and solar development, particularly in areas where cultivable land is scarce (CEEW, 2021)[21].

This lack of regulatory uniformity creates uncertainty for developers and investors, impeding scalability. The absence of a dedicated policy framework for Agriphotovoltaics underscores the urgent need for harmonised land-use regulations that formally recognise dual-use models and promote compatible agricultural practices beneath solar installations.

3. Tariff Challenges and Delay in Evacuation

Agriphotovoltaics often struggle to compete commercially with conventional ground-mounted solar projects, except in specific contexts like areas with high land rent. There is a need to develop a separate tariff category for Agriphotovoltaics that better accommodates its unique characteristics, including the higher capital cost of elevated structures and land lease payments. Moreover, delays in grid connectivity, PPA approvals, and a lack of evacuation infrastructure further undermine project viability. Hence, there is a need to streamline power tie-ups with DISCOMs, including timely clearances and adequate evacuation infrastructure to integrate power generated by Agriphotovoltaics into the grid efficiently.

19 https://bhoomirashi.gov.in/auth/revamp/la_act.pdf
20 http://www.environmentwb.gov.in/pdf/EIA%20Notification,%202006.pdf
21 https://www.ceew.in/sites/default/files/ceew-study-on-pm-kusum-scheme-for-solar-based-power-plants-and-grid-pumps-india.pdf

4. Absence of a regulatory framework

Currently, India lacks a dedicated regulatory framework for Agriphotovoltaics. Without clear demarcation, most pilot projects are implemented under broader renewable energy schemes (such as PM-KUSUM) and are limited to states that allow mixed land use.

However, unlike conventional solar applications, Agriphotovoltaics projects require integrated planning to align solar energy generation with continued agricultural productivity, rural employment, and optimal land use. Hence, there is a need to define Agriphotovoltaics and incentivise its adoption through mechanisms such as Renewable Purchase Obligation (RPO).

There is also no mechanism to standardise revenue-sharing models, e.g., crop-sharing or co-ownership arrangements between farmers and developers. This lack of clarity affects transparency, financial viability, and investor confidence.

Moreover, the Ministry of Agriculture and Farmers Welfare has not prescribed minimum agricultural yield thresholds under Agriphotovoltaics projects, ensuring that agricultural activity remains a primary function of the land —a requirement already instituted in several other countries.

There is also ambiguity regarding the continuation of agricultural benefits after the installation of Agriphotovoltaics projects, such as eligibility for tax exemptions for farm income and crop insurance coverage. Additionally, land lease agreements require greater regulatory clarity regarding scope, inclusions and exclusions, and duration.

5. International Experience and Lessons for India

Globally, several countries have adopted enabling frameworks for Agriphotovoltaics:

- **Germany:** Germany mandates that at least 85% of the land remains available for agricultural purposes, and the agricultural yield should be at least 66% of the reference yield.
- **Japan:** Japan mandates at least 80% of the original agricultural yield post solar installation.
- **Italy:** Italy requires at least 70% of the area for agricultural activity, in compliance with Good Agricultural Practices.
- **France:** In France, the Agriphotovoltaics system must demonstrate a direct contribution to the agricultural production, maintain or improve yields within acceptable limits and maintain or increase the farmers' income. It caps yield loss to 10%.

These international experiences raise key questions for India: a) Should India define Agriphotovoltaics as a distinct category? b) Would this require amendments to land-use and electricity laws across jurisdictions? c) Should specific policy, regulatory and financial incentives be developed? d) Should ongoing programs (like projects under PM-KUSUM and state-led schemes) be adapted to support Agriphotovoltaics more directly?

Unlocking the potential of Agriphotovoltaics in India requires: A clear demarcation of Agriphotovoltaics as a dual-use category; uniform land-use policies across states or model guidelines for mixed land use; dedicated support programs, including feed-in tariffs and standard revenue-sharing models; streamlined approvals for grid connectivity; and incorporation into existing schemes like PM-KUSUM with specific provisions for Agriphotovoltaics (probably under PM KUSUM 2.0). A cohesive policy, financial, legal and regulatory framework, informed by global best practices and tailored to India's unique landscape, is essential for scaling Agriphotovoltaics.

8. CASE STUDY

SunMaster's 2.5 MWp Agriphotovoltaics Plant at Issapur, Najafgarh, Delhi

About the Agriphotovoltaics plant

The 2.5 MWp Agriphotovoltaics plant set up by SunMaster in the village of Issapur, Najafgarh, Delhi, was commissioned on March 26, 2021. Spread across 3.4 acres of land, the project operates on a developer-owned model and integrates an overhead solar power plant with sustainable agriculture underneath. This project also reduces space requirement for putting up solar panels as compared to conventional ground mounted projects. PFI and CPI officials conducted a site visit to the Agriphotovoltaics plant to gather information on the on-ground challenges faced by the various stakeholders.

System Configuration and Investment

The plant works on monocrystalline solar panels (390 Wp and 485 Wp module sizes), mounted at an elevation of 4.3 meters to allow sufficient space for crop cultivation below. The total capital expenditure was approximately INR 12 crore, funded entirely through equity. Key cost components include solar panels, followed by high mounting structures (costing around INR 80 lakh per MW), string inverters and overhead cables for internal evacuation and connectivity to the nearest transformer. No significant expenditure was incurred on land development, site studies or regulatory clearances.

Solar Plant Operations and Maintenance (O&M)

A total of 12 personnel are deployed to handle O&M of the plant. Panels are cleaned weekly, and panel upkeep costs around 40 paisa per Watt. This ensures efficient generation with minimal downtime.

Energy Generation and Supply

The plant operates at a capacity utilisation factor (CUF) of 18.4%. It sells electricity to BSES Rajdhani Power Limited (BRPL) at the average power purchase cost (APPC) under a Group Net Metering (GNM) arrangement. Power generated at the Najafgarh site is fed into the grid and credited against the consumption of a nearby hospital with a 707 kW load located in Dwarka Sector 10.

Agricultural Productivity and Farmer Income

Underneath the solar panels, the land is used to cultivate high-value crops such as vegetables and spices [Cherry tomatoes, Turmeric (annual yield ~1.5 tonnes, sold dried), Eggplant, cabbage, broccoli, onions, potatoes, green chillies]. The agriculture is entirely supported by organic fertiliser, utilising cattle manure from an on-site shelter. Because of elevated solar panels, the rate of evaporation has declined by 50%.

The farmers' annual agricultural income was approximately INR 60,000 per acre per year before the installation of the Agriphotovoltaics system. However, after Agriphotovoltaics, they earned INR 1.05 lakh per acre per year, which included their share in agriculture, land lease payments and rent of agricultural equipment, nearly doubling their income from the same land.

Key Challenges

- **Procedural Delays:**
  Delhi allows mixed land use, which enables smooth land approvals. However, delays occurred because the timely provision of evacuation infrastructure was lacking, hindering commissioning.
- **Financial Barriers:**
  The project was developed entirely through developer equity, without any government subsidy. The absence of concessional financing or support mechanisms can pose significant entry barrier and limit replicability at scale.

Opportunities for Government Intervention

This project exemplifies the potential of Agriphotovoltaics in the Indian context, while also exposing the key barriers and bottlenecks that need to be addressed to enable wider adoption. A critical enabling factor in this case was Delhi's policy permitting mixed land use, which eliminated the challenges associated with land acquisition. The project also underscores the ability of the private sector to mobilise capital and technical expertise. Formalising policies on Group Net Metering/ Virtual Net Metering and streamlining approval processes for providing evacuation are imperatives to mitigate delays and ensure seamless implementation. Further, dedicated programs to educate farmers, panchayats, and local institutions on the benefits and operational requirements of Agriphotovoltaics are necessary. This includes training, awareness campaigns, and capacity building.

From the Desk of Shri Surinder Ahuja, Director, SunMaster

"At SunMaster, we are committed to transforming agriculture through innovative solar solutions. Our Agriphotovoltaics technology embodies the vision of ***Harvesting sunlight to empower farmers and boost productivity.*** By integrating solar energy directly into farming practices, we help farmers reduce their dependence on conventional power sources, lower costs, and increase crop yields.

We believe in creating a brighter, sustainable future for farmers, where clean energy and agriculture go hand in hand. SunMaster's Agriphotovoltaics is more than just a technological advancement; it is a step towards empowering farmers, fostering ecological balance, and building resilient rural communities.

Together, let's harness the power of the sun for a prosperous and sustainable tomorrow."

Pictures sourced from SunMaster

9. BARRIERS TO ADOPTION OF AGRIPHOTOVOLTAICS IN INDIA

While Agriphotovoltaics offers a promising solution to land-use by simultaneously generating solar energy and producing agriculture, its adoption in India is hindered by several financial, regulatory, legal and policy challenges.

1. Renewable Energy Source

Agriphotovoltaics has not been defined in India. Agriphotovoltaics systems must be recognised as a renewable energy source under national policy frameworks.

2. High Capital Costs

Agriphotovoltaics systems are significantly more expensive than conventional solar PV due to:

- Elevated mounting structures that require more material, which adds to construction costs.
- Need for stronger, wind-resistant materials due to greater risk of exposure to higher wind velocities, which are more expensive.
- Site-specific design requirements (e.g., crop compatibility, soil analysis and custom layout) increase planning and installation costs.

In international markets, Agriphotovoltaics systems are reported to cost 1.3 to 2 times more than conventional ground-mounted systems on a per kW basis (Horowitz et al., 2020; Trommsdorff, Dhal, et al., 2022), making the former less attractive financially. In India, the overhead mounting structure adds an incremental cost of around INR 80 lakh per MW as compared to conventional ground-mounted solar plants.

3. Regulatory and Land Use Constraints

- In India, land is categorised into 9 land-use categories, with strict land-use policies. Land is a state subject. Some states restrict agricultural land from being repurposed for non-agricultural purposes, such as solar generation.
- A lack of a dedicated land use category in India recognising Agriphotovoltaics as a legitimate land use category creates regulatory uncertainty and leads to delays.
- As per Land Use Statistics for 2022-23, around 43% of the country's land is agricultural land. This land cannot host solar panels without being re-designated in many states, which is often a lengthy and complex process. If mixed land use is allowed in all states, it would help in the installation of Agriphotovoltaics and aid India in achieving its clean energy goals while ensuring food security.
- Further, benefits such as crop insurance and agricultural subsidies can be denied if the land is converted from agricultural to commercial land. Similarly, there is no clarity whether the

revenue from Agriphotovoltaics to the farmer through either land rent or equity share can be categorised as agricultural income. Hence, these aspects should be adequately addressed through policies.

- Further, lease terms for agricultural land are inconsistent across states. For instance, it is a maximum of 5 years in Madhya Pradesh[22] and 30 years in Uttar Pradesh[23].

4. Technical and Infrastructure Barriers

- Rural substations often have limited evacuation capacity for additional solar power.
- Under PM-KUSUM, DISCOMs are mandated to notify the renewables energy generation capacity that can be injected into all the 33/11 kV, 66/11 kV or 110/11 kV substations in rural areas and place such information on their website for the information of all stakeholders. However, data is frequently missing or outdated.
- Project delays are further compounded by complex bureaucratic processes involved in securing approvals for grid connections.

5. Tariff and Policy Uncertainty

- There is currently no dedicated policy framework or standardised mechanism for tariff determination for Agriphotovoltaics projects.
- While several SERCs have determined tariffs under the PM-KUSUM scheme, Component A (decentralised solar power plants) and Component C (feeder-level solarisation), the process remains inconsistent.
- This policy inconsistency creates investment uncertainty, discourages private sector participation and limits scalability.
- Various power procurement routes like PPA with DISCOMs, Green Energy Open Access for direct sale to consumers, Virtual Net Metering, and Group Net Metering to enable collective consumption by multiple beneficiaries should be enabled to create an enabling ecosystem for Agriphotovoltaics.

6. Water Access and Environmental Regulations

- Water is essential for both the construction and regular cleaning of solar modules to maintain efficiency.
- Obtaining regulatory approvals for groundwater use meant for agriculture, for other such activities, involves high costs and complex procedures, particularly in over-exploited zones where additional requirements like artificial recharge are mandated.
- The Model Groundwater Bill does not explicitly account for Agriphotovoltaics or solar-powered irrigation systems, resulting in legal ambiguity and compliance uncertainty for such projects.

22 https://indiankanoon.org/doc/142764409
23 https://www.mercomindia.com/uttar-pradesh-agricultural-land-leased-solar

7. Financing and Institutional Challenges

- Despite the PM-KUSUM scheme's financial assistance to farmers for installing solar pumps and decentralised solar power plants on agricultural and fallow/barren land, many farmers continue to face high upfront costs, limited access to institutional credit due to lack of collateral or documentation, and low feed-in tariffs that affect project viability. Estimates suggest that the adoption of solar power under Component A of the PM-KUSUM scheme has been higher in states where farmers' contribution was less than 50% of the project cost.
- Limited awareness of Agriphotovoltaics models among financial institutions further restricts lending support.
- Addressing these issues requires higher subsidies or viability gap funding, higher feed-in-tariff, enhancing borrower credibility, securing repayments, standardising payment terms, and factoring in risks such as technology obsolescence to build investor confidence and ensure sustainable financing.

10. KEY RECOMMENDATIONS

Agriphotovoltaics systems are still at early stages of development in India compared to many other countries that have already made significant strides. The reason can mainly be attributed to regulatory and definitional ambiguities, rigid land-use policies, lack of financing avenues, and uncertainty regarding its commercial viability. For Agriphotovoltaics to grow from a niche idea into a widespread solution to promoting sustainable land use, these barriers must be addressed, and a supportive environment must be created that clarifies taxation issues for both agricultural and non-agricultural income.

The accelerated growth and large-scale adoption of Agriphotovoltaics will require coordinated and sustained collaboration among multiple stakeholders, spanning government agencies, financial institutions, private developers, and farmer collectives. To enable an enabling ecosystem for Agriphotovoltaics, targeted actions and role clarity across the value chain are essential. The key recommendations for various stakeholders involved in the development and implementation of Agriphotovoltaics are as follows:

1. Ministries and Electricity Regulatory Commissions

I. Ministry of Power (MoP), GoI

Renewable Purchase Obligation (RPO): It is important to view Agriphotovoltaics as a Solar PV plant with distinct co-benefits in Agriculture, and therefore, we need to have in place a framework which acknowledges the simultaneous use of land for agriculture and solar power through elevated or customised structures. The Ministry of Power, GoI, may mandate the Purchase of Power from Agriphotovoltaics projects. Renewable Purchase Obligation (RPO) notification dated 20th October 2023, may be suitably amended to carve out a separate category for Agriphotovoltaics.

As part of policy, we may promote Agriphotovoltaics on both large and small scales. In MoP RPO notification dated 20th October 2023[24], DRE is classified as capacities less than 10 MW, which may include Agriphotovoltaics at small-scale level. Capacities greater than 10 MW may be included in the Other RPO section.

To start with, we may have:

i. **20% of the DRE target to be met from Agriphotovoltaics RPO for FY 2026-27 with an annual escalation of 2% till FY 2029-30, as tabulated below. This will promote Agriphotovoltaics at the small-scale level, i.e., less than 10 MW levels.**

24 https://beeindia.gov.in/sites/default/files/Gazette%20notification%20dt%2020th%20Oct%202023%20on%20Non%20fossil%20obligation.pdf

Table 5: DRE RPO Trajectory for Agriphotovoltaics

Particulars	FY 2026-27	FY 2027-28	FY 2028-29	FY 2029-30
Consumption as per 20th EPS Report, CEA (MU)[25]	16,10,053	17,12,971	18,20,855	19,49,040
DRE Target (%)	2.70%	3.30%	3.90%	4.50%
DRE Target (MU)	43,471	56,528	71,013	87,707
Small Scale AgroPV target (<10 MW) %	**20%**	**22%**	**24%**	**26%**
Small Scale AgroPV target (<10 MW) MU	8,694	12,436	17,043	22,804
CUF	20%	20%	20%	20%
Small Scale AgroPV target MW	**4,962**	**7,098**	**9,728**	**13,016**

ii. **1% of Other RPO target to be met from Agriphotovoltaics for FY 2026-27 with an annual escalation of 0.5% till FY 2029-30. This will promote Agriphotovoltaics on a large scale, exceeding 10 MW.**

Table 6: Other RPO Trajectory for Agriphotovoltaics

Particulars	FY 2026-27	FY 2027-28	FY 2028-29	FY 2029-30
Consumption as per 20th EPS Report, CEA (MU)	16,10,053	17,12,971	18,20,855	19,49,040
Other RPO Target (%), which includes Solar	29.94%	31.64%	33.10%	34.02%
Other RPO Target (MU)	4,82,050	5,41,984	6,02,703	6,63,063
Large Scale AgroPV target (> 10 MW) %	**1.0%**	**1.5%**	**2.0%**	**2.5%**
Large Scale AgroPV target (> 10 MW) MU	4,820	8,130	12,054	16,577
CUF	20%	20%	20%	20%
Large Scale AgroPV target (MW)	**2,751**	**4,640**	**6,880**	**9,462**

With the above tabulated approach, we may have around **13 GW + 9.5 GW, i.e., 22.5 GW** contribution from Agriphotovoltaics solar power projects in the 293 GW solar capacity target till

25 http://www.indiaenvironmentportal.org.in/files/file/report%20of%20the%20electric%20power%20survey%20of%20india.pdf

FY 2029-30. This electricity will be open to be sold to all, including C&I, unlike the PM KUSUM scheme, under which electricity can be sold only to DISCOMs at a pre-determined tariff.

II. Ministry of New and Renewable Energy (MNRE)

Currently, there is no definition and categorisation for Agriphotovoltaics in India. This often leaves scope for ambiguities and limited access to finance for such projects. Without a clear demarcation, most pilot projects rely on broader renewable energy programs. However, unlike conventional solar installations that focus solely on converting photons (light) into electricity, Agriphotovoltaics has an additionality related to agricultural production. Recognising this dual-use potential is essential for mainstreaming the technology. Notably, other technologies based on similar photovoltaic principles have already been defined in regulations, such as the 'Floating solar project', which is defined under the Central Electricity Regulatory Commission (CERC)'s Terms and Conditions for Tariff determination from Renewable Energy Sources Regulations, 2024.

In this context, the **Ministry of New and Renewable Energy,** under **the second phase of the PM-KUSUM scheme, may recognise Agriphotovoltaics as a Renewable Energy Source and may appropriately define Agriphotovoltaics as follows:**

> *"An Agriphotovoltaics project is a **solar photovoltaic power plant** where the arrays of photovoltaic panels are installed **on fertile agricultural land** in a manner that allows the **simultaneous usage of land for agricultural production** (as primary activity) **and electricity generation** (as secondary activity). This is achieved through **elevated mounting structures or other design configurations** that allow for **unhindered crop cultivation, irrigation, and farming operations** underneath or around the solar panels, such that the **agricultural yield is not compromised beyond a threshold level** defined by the relevant authority."*

A clear definition and formal recognition of Agriphotovoltaics would facilitate the extension of key benefits to such projects, including access to subsidies, concessional financing to farmers/ developers, and streamlined regulatory approvals. As the current Component-A of the PM-KUSUM scheme already supports grid-connected solar PV applications on barren or fallow land, expanding it to include well-defined Agriphotovoltaics systems on fertile land would align with broader goals of energy transition, land-use optimisation, and rural development.

III. State Electricity Regulatory Commissions (SERCs)

A. **Tariff:** The tariff determination framework for Agriphotovoltaics systems must adopt a cost-plus approach to reflect the unique cost components of such dual-use infrastructure. In particular, the following elements must be explicitly factored into the tariff calculation (as the case may be):

   i. **Base Tariff** – Costs associated with the design, development, and operation of the solar power plant;

   ii. **Overhead Structure Cost** – Additional capital expenditure incurred due to elevated mounting structures required to enable agricultural activity underneath in overhead Agriphotovoltaics configurations;

iii. **Land Lease Cost** – Lease payments made by the developer to the farmer, ensuring fair and consistent compensation for land use in developer-owned models.

iv. **Yearly 6,000 units of Free Electricity to farmers**.

Incorporating these components within the tariff determination methodology will ensure economic viability for developers while safeguarding farmers' interests. SERCs may consider issuing specific guidelines or incorporating Agriphotovoltaics-specific cost elements within the existing tariff regulations for renewable energy sources.

The electricity generated may be sold under the PPA route to DISCOM or through Net metering. For this, enabling provisions such as Virtual Net Metering (VNM) or Group Net Metering (GNM) may be permitted by SERCs, which enables the sale of surplus electricity to the grid at the **same Feed-in Tariff** (as given below), **or at the Average Power Purchase Cost (APPC) of the DISCOM.**

Feed-in Tariff: Under the PPA route, SERCs may allow Feed-in Tariff, which is in the range of INR 3.67/kWh to INR 5.49/kWh **(CUF ranging from 25% to 17%),** as worked out in this study, for the sale of electricity from an overhead Agriphotovoltaics project. This includes the cost of elevated structures, land lease payments, and 6,000 units of annual free electricity per MW to farmers, besides the Base Tariff.

The Base Tariff is in the range of INR 2.81/kWh to INR 4.14/kWh; overhead structure costs add another INR 0.51/kWh to INR 0.75/kWh; and land lease payments for developer-owned models add another INR 0.24/kWh to INR 0.34/kWh, and provision of 6000 units free annually per MW adds INR 0.11/kWh to INR 0.26/kWh. This tariff has been determined based on the following assumptions:

Table 7: Assumptions for Tariff Calculations

Particulars	Units	Values (based on CERC RE Tariff Regulations, 2024)
Number of days of Operation	Nos.	365
Plant Capacity	MW	1.00
Life of a Plant	Years	25
Capacity Utilisation Factor (CUF)	%	17 / 21 / 25
Auxiliary Energy Consumption	%	0.75
Financial Parameters		
Capital Cost of Solar Power Plant	INR Crore per MW	3.50
Capital Cost of Overhead Structure	INR Crore per MW	0.80
Debt: Equity ratio	Ratio	70: 30
Loan Amount	INR Crore per MW	3.01
Equity Amount	INR Crore per MW	1.29
Normative ROE (Return on Equity)	%	14.00

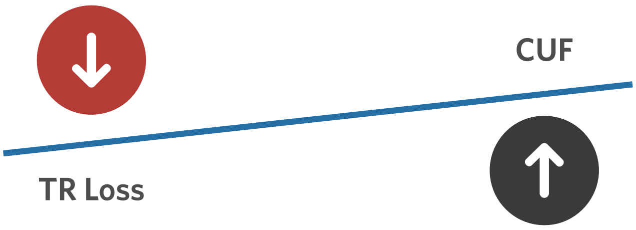
Particulars	Units	Values (based on CERC RE Tariff Regulations, 2024)
Minimum Alternate Tax (MAT)	%	16.69
Corporate Tax (CT)	%	25.00
ROE till 20 years (Grossed up with MAT)	%	16.81
ROE after 20 years (Grossed up with CT)	%	18.67
Loan repayment period	Years	15
Moratorium Period	Years	0
Rate of Interest on Loan	%	10.93
Salvage value of Assets	%	10.00
Rate of Depreciation for the first 15 years	%	4.67
Depreciation from the 16^{th} year	%	2.00
O&M Expenses	INR Lakh/MW	7.55
Increment in O&M Expenses	%	5.25
Lease rent payable to farmers in the first year	INR Lakh/MW	4
Escalation on the Lease rent (after every 2 years)	%	5.00
Discount Rate	%	9.94
Degradation Factor	%	0.50
Free units	Units per annum per MW	0.006
Working Capital Components		
O&M Cost	Months	1
Receivables	Months	1.5
Maintenance Spares as % of O&M Expenses	%	15.00
Rate of interest on working capital	%	12.18

Table 8: Cost-plus Tariff based on CERC RE Tariff Regulations, 2024 (INR/kWh)

Components	Rates & Source	17% CUF	21% CUF	25% CUF
Ground-mounted	Capex INR 3.50 Cr. per MW	4.14	3.35	2.81
Structure Cost	Rs 80 lakh per MW	0.75	0.61	0.51
Land Lease	Rs 1 lakh per acre per year for 25 yrs	0.34	0.27	0.24
Free units	6000 units annually per MW	0.26	0.17	0.11
Levelized Tariff		5.49	4.40	3.67

Source: Authors' Computation; For details, refer Annexure-I

B. **Tariff Comparison with other DRE and Non-DRE Projects:** The said tariff of Agriphotovoltaics has been compared with that of Rooftop Solar (RTS) and Non-DRE (Refer Table 9). Agriphotovoltaics (DRE) has been compared with non-DRE grid-connected projects, and the modelling indicates that Agriphotovoltaics offers a lower levelized tariff even with farmer benefits (60 p/kWh). The impact of Transmission loss and Transmission Infrastructure in non-DRE is around INR 1.42/kWh, which gets avoided in Agriphotovoltaics projects. Agriphotovoltaics has also been compared with RTS systems and prima facie, it appears expensive considering the farmer income, which is actually a societal benefit, but without considering the farmers' income, Agriphotovoltaics (INR 4.14/kWh + INR 0.75/kWh) is at par with RTS (INR 5.08/kWh, considering benchmark capital cost notified under Pradhan Mantri Surya Ghar: Muft Bijli Yojana (PMSGMBY)). Further, Agriphotovoltaics offers greater scalability, especially in dense urban areas, Group Housing Societies where rooftop potential is limited and shading issues arise.



Positive impact of higher CUF gets nearly nullified considering impact of inter state transmission system & intra state transmission system losses.

Table 9: Comparison of Cost-plus Tariff for Agriphotovoltaics, RTS and Non DRE projects (INR/kWh)

Components	Rates & Source	17% CUF			21% CUF		
		Agri-PV	RTS	Non-DRE	Agri-PV	RTS	Non-DRE
Ground-mounted	Capex 1. INR 3.50 Cr. per MW (Agriphotovoltaics and non-DRE, average of 3 plants) 2. INR 4.50 Cr. (RTS: as per Benchmark cost under PMSGMBY)	4.14	5.08	4.14	3.35	4.11	3.35
Structure Cost	Rs 80 lakh per MW	0.75	NA	NA	0.61	NA	NA
Transmission loss	ISTS+InSTS @ (3+3.5 =) 6.5%	NA	NA	0.29	NA	NA	0.24
Transmission Infrastructure	Capex	NA	NA	1.13	NA	NA	1.13
			Famer benefit				
Land Lease	Rs 1 lakh per acre per year for 25 yrs	0.34	NA	0.37	0.27	NA	0.30
Free units	6000 units annually per MW	0.26	NA	NA	0.17	NA	NA
Levelized Tariff		**5.49**	**5.08**	**5.93**	**4.40**	**4.11**	**5.02**

Source: Authors' Computation; For details, refer Annexure-II & III

Although both Agriphotovoltaics and RTS are forms of DRE, the former offers several other advantages that extend beyond electricity generation:

- Installation of a 1 kW rooftop solar system typically requires around 10 sqm. (approx.100 sq. ft.) of a shadow-free area. However, rooftop surfaces often contain parapets, water tanks, lift shafts, and antennas, reducing **usable roof area to only 20-50% of total rooftop space**. In contrast, Agriphotovoltaics systems are deployed on agricultural land with mounting structures designed to allow continued cultivation underneath, thereby **optimising land use efficiency**. This also facilitates **dual-use of land**.
- In dense urban areas, where rooftop space is constrained, access to solar power can be enabled through **Virtual Net Metering/Group Net Metering** frameworks. Group housing societies can source power from nearby Agriphotovoltaics projects rather than installing small, fragmented rooftop systems. For instance, a housing complex with 200 flats and an average connected load of 8 kW each (totalling ~1.6 MW load) may install around 800 kW of solar capacity (assuming 50% of the average load). This would require ~8,000 square metres of unobstructed rooftop space, which is often unavailable. Instead, the same can be procured through a nearby Agriphotovoltaics plant under Virtual Net Metering/ Group Net Metering arrangements, as done in Delhi by SunMaster, wherein the generation point is the Agriphotovoltaics plant at Nafajgarh and the withdrawal point is the nearby hospital in Dwarka.
- RTS systems are usually installed in distributed, small-capacity units (1-100 kW), making them harder to **aggregate for grid integration, financing, or bulk procurement benefits**. Agriphotovoltaics projects, by contrast, can be implemented over contiguous agricultural plots (ranging from 500 kW to several MW), which will allow for economies of scale, simplified maintenance, and more cost-effective evacuation of power through nearby substations or feeders.
- RTS adoption can be constrained by **ownership disputes, roof rights in shared buildings, and structural limitations** that restrict panel installation or maintenance access. Further, there can be shading issues in the installation of RTS, limiting its use by all households. Agriphotovoltaics implementation, on the other hand, can be relatively straightforward once farmer consent or land leasing arrangements are secured. Thus, Agriphotovoltaics can be more scalable.
- Agriphotovoltaics is also **beneficial for agriculture** as it provides shade, which reduces water evaporation, improves soil moisture, lowers irrigation requirements, protects crops from extreme weather, and can improve the yield of certain crops, besides promoting rural employment in construction, maintenance, and ancillary services. It promotes **Dual Income for Farmers** through crop cultivation, leasing land, or participating in revenue-sharing models for solar power generation.

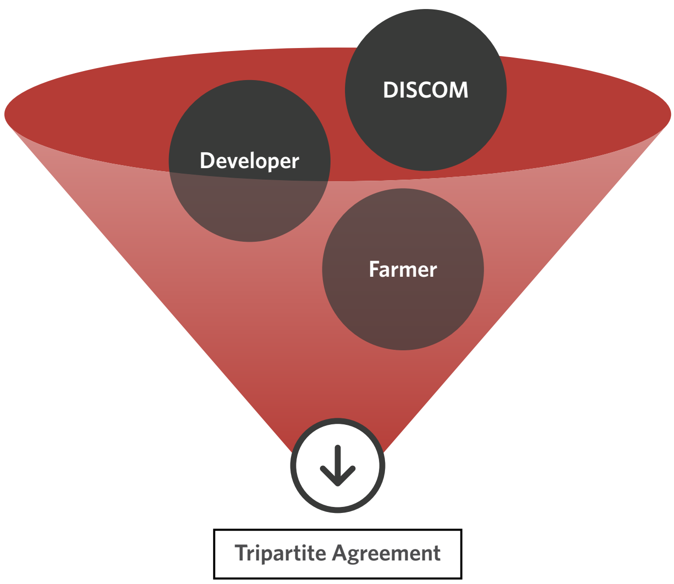
While RTS is a key component of India's DRE strategy, Agriphotovoltaics presents a more integrated approach by simultaneously advancing renewable energy expansion, sustainable agriculture, and rural livelihoods. Its deployment potential is especially relevant in semi-urban and rural areas where land availability, agricultural dependence, and grid connectivity create favourable conditions for scale-up of clean energy.

C. **Grid Integration:** Delays in evacuation infrastructure, as faced by the Delhi project, hinder timely project commissioning. Unlike large-scale solar parks, Agriphotovoltaics is often deployed in distributed, rural locations, where substation capacity and grid connectivity may be inadequate or require upgrades, or the evacuation may be delayed. **To resolve this, DISCOMs and State Transmission Utilities may be directed by SERCs to:**

- Mandate streamlined processes for grid connectivity
- Upgrade substations with dedicated capacity for decentralised solar generation
- Implement a single-window clearance system for grid connectivity, wheeling charges, and power evacuation approvals
- Enable the sale of electricity to nearby industrial clusters / MSMEs - Infrastructure to be provided by State DISCOM
- Ensure timely and transparent payment mechanisms for power injected into the grid
- Encourage installation of Battery Energy Storage System (BESS) by developers to manage excess generation and support non-solar hour supply.

However, DISCOMs may be reluctant to invest in infrastructure upgrades, especially when they add variability and potential grid management challenges. Therefore, it is essential to incentivise DISCOMs either through capital support under Centrally Sponsored Schemes or by granting RPO fulfilment credits for enabling Agriphotovoltaics integration.

D. **Tripartite Agreement:** To ensure long-term viability of the project, a **tripartite agreement among Farmer, Developer, and DISCOM may be mandated by SERCs.** This would formalise roles, responsibilities, and revenue flows, thereby reducing disputes and enhancing project bankability. A 25-year lock-in PPA period, as adopted under the PM-KUSUM scheme, will offer revenue certainty and investment confidence to the developer. While farmers may initially be hesitant to enter long-term agreements, targeted incentives and policy safeguards can facilitate adoption. These may include inflation-linked annual escalation in fixed land lease compensation and structured revenue-sharing models that ensure sustained and equitable farmer participation. Additionally, provisions to protect agricultural productivity, such as maintaining minimum yield thresholds, can help address concerns around their livelihoods based on agriculture.



IV. Ministry of Agriculture and Farmers Welfare, GoI and State

A. Notify Minimum Agricultural Yield Thresholds

The Ministry of Agriculture and Farmers Welfare, GoI, should **mandate and notify minimum agricultural yield thresholds** (in % of baseline yield) or **cap permissible yield loss across different regions. These thresholds must be maintained under Agriphotovoltaics systems to qualify as mixed land use and ensure the** continuation of agricultural benefits. These thresholds should be based on crop types (e.g., cereals, vegetables, horticulture), regions (e.g., rainfed vs. irrigated), and seasons (kharif vs. rabi).

This can be done by implementing more pilot Agriphotovoltaics projects across agro-climatic zones to assess yield impacts under different solar structure configurations. This data can be used to determine realistic yield expectations and define acceptable deviation from conventional farming.

The eligibility for incentives and benefits under government schemes, such as PM-KUSUM, Viability Gap Funding, mixed land use, and the continuation of agricultural benefits like tax-free income & crop insurance, can be made conditional on maintaining the prescribed yield thresholds. Penalties or cancellation of benefits can be introduced for non-compliance.

The Ministry of Agriculture and Farmers Welfare may recommend crop varieties that perform well under partial shade or altered microclimates induced by elevated solar structures through Krishi Vigyan Kendras (KVKs) and agricultural universities. The Ministry may mandate periodic agricultural audits through state agricultural departments or independent third-party evaluators.

B. Research & Development:

Continuous Research and Development is essential to identify optimal system configurations, crop compatibility, and system design adaptations suited to diverse agro-climatic zones. The reverse-engineering approach used in Madhya Pradesh by Khare Energy and the diverse cropping trials conducted in Delhi highlight the importance of tailored solutions. Hence, there is a need to establish demonstration pilot projects across diverse agro-climatic zones to generate region-specific empirical data on best practices (crop selection, ideal panel elevation/spacing, microclimate management). **Ministry of Agriculture and Farmers Welfare may establish such Pilots, and the findings should be compiled and disseminated in a user-friendly format that can be adapted by farmers, developers, and policy implementers.**

C. Spreading Awareness:

There is a need to develop gender- inclusive structured training programs in partnership with KVKs and agricultural universities to build capacity among farmers. **The farmers need to be educated and sensitised so that they understand their agricultural yield will not decline**. The information from various demonstration projects should be disseminated through farmer-facing communication tools such as printed manuals, videos, community radio, and mobile-based FAQs. These tools should highlight available government subsidies and loan schemes, project costs and financial returns, risk management strategies, success stories, and expected agricultural and energy yields. **The Ministry of Agriculture may support other agencies in disseminating the above information and may also establish KVKs and agricultural universities to build the capacity of farmers.**

V. State Department

A. Land-use policies

Restrictions on carrying out commercial activities (like the installation of solar panels) on agricultural land in certain states led to constraints in the installation of Agriphotovoltaics. While the Delhi-based pilot project of SunMaster benefited from a mixed land-use policy, the Madhya Pradesh project of Khare Energy faced significant delays due to the absence of such a policy. Hence, it is proposed that the **state governments, particularly in agrarian regions, may introduce or amend land-use policies** to allow for Agriphotovoltaics development without requiring land reclassification. Non-RE rich States can particularly benefit from mixed land-use as DISCOMs can meet their RPO targets of DRE/Other category within the state through such projects, without the need to purchase electricity from other states.

B. Taxation and Insurance Framework:

In the **farmer-owned Agriphotovoltaics model,** existing agricultural benefits such as **tax exemption on farm income and eligibility for crop insurance should be retained** to safeguard farmers' economic interests. The agricultural income derived from crop cultivation under Agriphotovoltaics systems should continue to be classified as agricultural income under Section 10(1) of the Income Tax Act, 1961, and remain tax-exempt.

In the **developer-owned model**, where the land is leased from the farmer, the **lease agreement should specify components such as a fixed annual lease payment for use of the land, and any revenue-sharing of agricultural production** (if applicable). The farmer's share of income derived from continuing agrarian activities, if actively involved, should continue to be treated as agricultural income and be tax-exempt. At the same time, the annual fixed fees may be taxed under current norms. Similarly, a developer's revenue from electricity sales (being a commercial activity) may be taxed as per applicable norms.

Crop insurance should remain available to farmers participating in Agriphotovoltaics projects under the Pradhan Mantri Fasal Bima Yojana or similar schemes, subject to compliance with eligibility conditions. The insurance coverage for the solar installation should be treated as a distinct commercial/ non-agricultural asset and should be obtained separately.

2. Financial Institutions

High capital cost, inadequate access to collateral, uncertain revenue streams, and a lack of established financial models deter lending institutions and private investors. To enable easy access to finance for Agriphotovoltaics projects, the following measures are recommended for Financing agencies:

- Loans should be structured based on long-term PPA cash flows rather than conventional land collateral.
- Establish a formal asset classification for Agriphotovoltaics with protocols for recovery mechanisms to address defaults and dismantling/resale concerns.
- Provide first charge to financing institution.

3. Agriphotovoltaics Projects Developers

The tenure of agricultural land lease for Agriphotovoltaics projects should be aligned with the duration of the PPA, typically 25 years, to ensure long-term land security for developers. Accordingly, the tripartite agreement between the farmer, developer, and DISCOM should be structured to remain valid for the full PPA period, ensuring continuity and confidence among all stakeholders throughout the project lifecycle.

4. Farmers

Farmers, with the support of the government, should undergo gender-inclusive structured training programs in partnership with KVKs and agricultural universities to build their capacity. Further, the farmers may educate and sensitise themselves about the benefits associated with the Agriphotovoltaics projects, which do not negatively impact their agricultural yield. Farmers may also attempt to integrate allied activities like cold storage, poultry, fishery, etc., to create additional revenue streams.

11. CONCLUSION

Agriphotovoltaics represents more than a convergence of energy and agriculture; it is a strategic imperative for India's sustainable development. Its potential to simultaneously deliver clean energy, enhance agricultural productivity, optimise land use, and strengthen rural economies makes it a cornerstone of integrated climate and development policy.

Realising this potential requires urgent, coordinated action. Therefore, the Ministry of Power, the Ministry of New and Renewable Energy, the Ministry of Agriculture and Farmers Welfare, and State Governments must work together. The Government must formally recognise Agriphotovoltaics as a renewable energy source, define it under PM-KUSUM 2.0, include under RPO mandates, and permit mixed land use with safeguards for minimum agricultural yield. A tariff framework, through PPA or virtual net metering/group net metering mechanisms, at feed-in tariff or average power purchase cost, is essential to attract investment (The tariff may range from INR 3.67/kWh to INR 5.49/kWh for CUF ranging from 25% to 17%, as worked out in this study). Equally critical are timely grid integration, DISCOMs' support to commission projects targeted financial support, and sustained investment in R&D and knowledge dissemination.

By acting decisively on these fronts, India can mainstream Agriphotovoltaics as a pillar of its low-carbon growth strategy, ensuring food security, empowering farmers, and accelerating a just and inclusive energy transition.

ANNEXURE-I

Tariff Calculations for Agriphotovoltaics

Parameters	Units	AgriPV	Sources
Number of days of Operation	Nos.	365	
Plant Capacity	MW	1	
Life of Plant	Years	25	CERC RE Tariff Reg 2024
Capacity Utilization Factor (CUF)	%	17%/21%/25%	Taken from orders & CEA RA Plan
Auxiliary Energy Consumption	%	0.75%	Maximum as per CERC RE Tariff Reg 2024
Financial Parameters			
Capital Cost excluding cost of land	Rs. Crore per MW	4.30	Average of 3 solar plants' capital cost considered by SERCs (incl. overhead structure cost)
Debt: Equity ratio	Ratio	70:30	CERC RE Tariff Reg 2024
Loan Amount	Rs. Crore per MW	3.01	Calculated
Equity Amount	Rs. Crore per MW	1.29	Calculated
Normative ROE (Return of Equity)	%	14%	CERC RE Tariff Reg 2024
Minimum Alternate Tax (MAT)	%	16.69%	
Corporate Tax (CT)	%	25.00%	
ROE till 20-years (Grossed up with MAT)	%	16.81%	CERC RE Tariff Reg 2024
ROE after 20-years (Grossed up with CT)	%	18.67%	CERC RE Tariff Reg 2024
Loan repayment period	Years	15	CERC RE Tariff Reg 2024
Moratorium Period	Years	-	
Rate of Interest on Loan	%	10.93%	CERC RE Tariff Reg 2024
Salvage value of Assets	%	10.00%	CERC RE Tariff Reg 2024
Rate of Depreciation for first 15 years	%	4.67%	CERC RE Tariff Reg 2024
Depreciation from 16th year	%	2.00%	CERC RE Tariff Reg 2024 - remaining depreciation shall be evenly spread during the remaining Useful Life of the project
O&M Expenses	Lakh/MW	7.55	Average of 3 solar plants' O&M expense considered earlier
Increment in O&M Expenses	%	5.25%	CERC RE Tariff Reg 2024
Lease rent payable to farmers per year	Lakh/MW	4.00	Rs 1 lakh paid per acre per year; Considering 4 acre land used for 1 MW plant
Escalation on Lease rent	%	5.00%	escalation after every 2 years
Discount rate	%	9.94%	CERC RE Tariff Reg 2024 - equivalent to the post-tax weighted average cost of capital
Working Capital Components			
O&M Cost	Months	1.00	CERC RE Tariff Reg 2024
Receivables	Months	1.50	CERC RE Tariff Reg 2024
Maintenance Spares as % of O&M Expenses	%	15.00%	CERC RE Tariff Reg 2024
Rate of interest on working capital	%	12.18%	325 basis points above the averageSBI MCLR (one year tenor) prevalent during the last available 6 months
Degradation factor	%	0.50%	
Free units	Units per annum per MW	0.006	Assumed

At 17% CUF

Tariff Calculations																									
Year+A81:Z81	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
Net Energy (MU)	1.48	1.47	1.46	1.46	1.45	1.44	1.43	1.43	1.42	1.41	1.41	1.40	1.39	1.38	1.38	1.37	1.36	1.36	1.35	1.34	1.34	1.33	1.32	1.32	1.31
Net Energy (after 6,000 free units annually)	1.47	1.46	1.46	1.45	1.44	1.44	1.43	1.42	1.41	1.41	1.40	1.39	1.39	1.38	1.37	1.36	1.36	1.35	1.34	1.34	1.33	1.32	1.32	1.31	1.30
Costs (Rs Crore)																									
O&M	0.08	0.08	0.08	0.09	0.09	0.10	0.10	0.11	0.11	0.12	0.13	0.13	0.14	0.15	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.26
Cost of free units	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Land lease	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07
Depreciation (SLM)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Interest on long-term loan	0.32	0.30	0.27	0.25	0.23	0.21	0.19	0.16	0.14	0.12	0.10	0.08	0.05	0.03	0.01	-	-	-	-	-	-	-	-	-	-
Interest on working capital	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
Return on Equity	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Total Cost (Rs Crore)	**0.90**	**0.88**	**0.87**	**0.85**	**0.83**	**0.82**	**0.80**	**0.78**	**0.77**	**0.75**	**0.74**	**0.72**	**0.71**	**0.70**	**0.68**	**0.56**	**0.57**	**0.58**	**0.60**	**0.61**	**0.62**	**0.63**	**0.65**	**0.66**	**0.68**
Per Unit Tariff (Rs/ kWh)	6.13	6.04	5.96	5.86	5.78	5.69	5.61	5.52	5.44	5.35	5.28	5.19	5.13	5.04	4.98	4.10	4.21	4.30	4.43	4.53	4.67	4.78	4.93	5.06	5.22
Discount Rate (%)	**9.94**	**9.94**	**9.94**	**9.94**	**9.94**	**9.94**	**9.94**	**9.94**	**9.94**	**9.94**	**9.94**	**9.94**	**9.94**	**9.94**	**9.94**	**9.94**	**9.94**	**9.94**	**9.94**	**9.94**	**9.94**	**9.94**	**9.94**	**9.94**	**9.94**
Discount Factor	1.00	0.91	0.83	0.75	0.68	0.62	0.57	0.52	0.47	0.43	0.39	0.35	0.32	0.29	0.27	0.24	0.22	0.20	0.18	0.17	0.15	0.14	0.12	0.11	0.10
Discounted Tariff	6.13	5.49	4.93	4.41	3.96	3.54	3.18	2.84	2.55	2.28	2.05	1.83	1.65	1.47	1.32	0.99	0.92	0.86	0.80	0.75	0.70	0.65	0.61	0.57	0.54
Levelized Tariff (Rs /kWh)													**5.49**												

At 21% CUF

Tariff Calculations																									
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
Net Energy (MU)	1.83	1.82	1.81	1.80	1.79	1.78	1.77	1.76	1.75	1.75	1.74	1.73	1.72	1.71	1.70	1.69	1.69	1.68	1.67	1.66	1.65	1.64	1.64	1.63	1.62
Net Energy (after 6,000 free units annually)	1.82	1.81	1.80	1.79	1.78	1.77	1.77	1.76	1.75	1.74	1.73	1.72	1.71	1.70	1.70	1.69	1.68	1.67	1.66	1.65	1.65	1.64	1.63	1.62	1.61
Costs (Rs Crore)																									
O&M	0.08	0.08	0.08	0.09	0.09	0.10	0.10	0.11	0.11	0.12	0.13	0.13	0.14	0.15	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.26
Cost of free units	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03
Land lease	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07
Depreciation (SLM)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Interest on long-term loan	0.32	0.30	0.27	0.25	0.23	0.21	0.19	0.16	0.14	0.12	0.10	0.08	0.05	0.03	0.01	-	-	-	-	-	-	-	-	-	-
Interest on working capital	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
Return on Equity	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Total Cost (Rs Crore)	**0.90**	**0.88**	**0.86**	**0.84**	**0.83**	**0.81**	**0.79**	**0.78**	**0.76**	**0.75**	**0.73**	**0.72**	**0.70**	**0.69**	**0.68**	**0.55**	**0.57**	**0.58**	**0.59**	**0.60**	**0.62**	**0.63**	**0.64**	**0.66**	**0.67**
Per Unit Tariff (Rs/kWh)	4.92	4.84	4.78	4.70	4.64	4.56	4.50	4.42	4.36	4.29	4.23	4.16	4.11	4.04	3.99	3.28	3.37	3.45	3.55	3.63	3.74	3.83	3.95	4.05	4.18
Discount Rate (%)	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**
Discount Factor	1.00	0.91	0.83	0.75	0.68	0.62	0.57	0.52	0.47	0.43	0.39	0.35	0.32	0.29	0.27	0.24	0.22	0.20	0.18	0.17	0.15	0.14	0.12	0.11	0.10
Discounted Tariff	4.92	4.41	3.95	3.54	3.17	2.84	2.55	2.28	2.05	1.83	1.64	1.47	1.32	1.18	1.06	0.79	0.74	0.69	0.64	0.60	0.56	0.52	0.49	0.46	0.43
Levelized Tariff (Rs /kWh)	**4.40**																								

At 25% CUF

Tariff Calculations																									
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Net Energy (MU)	2.17	2.16	2.15	2.14	2.13	2.12	2.11	2.10	2.09	2.08	2.07	2.06	2.05	2.04	2.03	2.02	2.01	2.00	1.99	1.98	1.97	1.96	1.95	1.94	1.93
Net Energy (after 6,000 free units annually)	2.17	2.16	2.15	2.14	2.12	2.11	2.10	2.09	2.08	2.07	2.06	2.05	2.04	2.03	2.02	2.01	2.00	1.99	1.98	1.97	1.96	1.95	1.94	1.93	1.92
Costs (Rs Crore)																									
O&M	0.08	0.08	0.08	0.09	0.09	0.1	0.1	0.11	0.11	0.12	0.13	0.13	0.14	0.15	0.15	0.16	0.17	0.18	0.19	0.2	0.21	0.22	0.23	0.24	0.26
Cost of free units	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Land lease	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07
Depreciation (SLM)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Interest on long-term loan	0.32	0.3	0.27	0.25	0.23	0.21	0.19	0.16	0.14	0.12	0.1	0.08	0.05	0.03	0.01	0	0	0	0	0	0	0	0	0	0
Interest on working capital	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
Return on Equity	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Total Cost (Rs Crore)	**0.89**	**0.87**	**0.86**	**0.84**	**0.82**	**0.8**	**0.79**	**0.77**	**0.76**	**0.74**	**0.73**	**0.71**	**0.7**	**0.69**	**0.67**	**0.55**	**0.56**	**0.57**	**0.59**	**0.6**	**0.61**	**0.62**	**0.64**	**0.65**	**0.67**
Per Unit Tariff (Rs/kWh)	4.11	4.04	3.99	3.92	3.87	3.81	3.75	3.69	3.64	3.58	3.53	3.48	3.43	3.37	3.33	2.74	2.82	2.88	2.96	3.03	3.12	3.2	3.3	3.38	3.49
Discount Rate (%)	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**
Discount Factor	1.00	0.91	0.83	0.75	0.68	0.62	0.57	0.52	0.47	0.43	0.39	0.35	0.32	0.29	0.27	0.24	0.22	0.20	0.18	0.17	0.15	0.14	0.12	0.11	0.10
Discounted Tariff	4.11	3.68	3.30	2.95	2.65	2.37	2.13	1.90	1.71	1.53	1.37	1.23	1.10	0.98	0.89	0.66	0.62	0.58	0.54	0.50	0.47	0.44	0.41	0.38	0.36
Levelized Tariff (Rs /kWh)	**3.67**																								

ANNEXURE-II

Tariff Calculations for RTS

Parameters	Units	AgroPV	Sources
Number of days of Operation	Nos.	365	
Plant Capacity	MW	1	
Life of Plant	Years	25	CERC RE Tariff Reg 2024
Capacity Utilization Factor (CUF)	%	17%/21%	Taken from orders & CEA RA Plan
Auxiliary Energy Consumption	%	0.75%	Maximum as per CERC RE Tariff Reg 2024
Financial Parameters			
Capital Cost excluding cost of land	Rs. Crore per MW	4.50	Benchmark capital cost in PMSG MBY
Debt: Equity ratio	Ratio	70:30	CERC RE Tariff Reg 2024
Loan Amount	Rs. Crore per MW	3.15	Calculated
Equity Amount	Rs. Crore per MW	1.35	Calculated
Normative ROE (Return of Equity)	%	14%	CERC RE Tariff Reg 2024
Minimum Alternate Tax (MAT)	%	16.69%	
Corporate Tax (CT)	%	25.00%	
ROE till 20-years (Grossed up with MAT)	%	16.81%	CERC RE Tariff Reg 2024
ROE after 20-years (Grossed up with CT)	%	18.67%	CERC RE Tariff Reg 2024
Loan repayment period	Years	15	CERC RE Tariff Reg 2024
Moratorium Period	Years	-	
Rate of Interest on Loan	%	10.93%	CERC RE Tariff Reg 2024
Salvage value of Assets	%	10.00%	CERC RE Tariff Reg 2024
Rate of Depreciation for first 15 years	%	4.67%	CERC RE Tariff Reg 2024
Depreciation from 16th year	%	2.00%	CERC RE Tariff Reg 2024
O&M Expenses	Lakh/MW	7.55	Average of 3 solar plants' considered earlier
Increment in O&M Expenses	%	5.25%	CERC RE Tariff Reg 2024
Discount rate	%	9.94%	CERC RE Tariff Reg 2024 - equivalent to the post-tax weighted average cost of capital
Working Capital Components			
O&M Cost	Months	1.00	CERC RE Tariff Reg 2024
Receivables	Months	1.50	CERC RE Tariff Reg 2024
Maintenance Spares as % of O&M Expenses	%	15.00%	CERC RE Tariff Reg 2024
Rate of interest on working capital	%	12.18%	325 basis points above the averageSBI MCLR (one year tenor) prevalent during the last available 6 months
Degradation factor	%	0.50%	

At 17% CUF

Tariff Calculations																									
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
Net Energy (MU)	1.48	1.47	1.46	1.46	1.45	1.44	1.43	1.43	1.42	1.41	1.41	1.40	1.39	1.38	1.38	1.37	1.36	1.36	1.35	1.34	1.34	1.33	1.32	1.32	1.31
Costs (Rs Crore)																									
O&M	0.08	0.08	0.08	0.09	0.09	0.10	0.10	0.11	0.11	0.12	0.13	0.13	0.14	0.15	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.26
Depreciation (SLM)	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Interest on long-term loan	0.33	0.31	0.29	0.26	0.24	0.22	0.20	0.17	0.15	0.13	0.10	0.08	0.06	0.03	0.01	-	-	-	-	-	-	-	-	-	-
Interest on working capital	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
Return on Equity	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
Total Cost (Rs Crore)	**0.86**	**0.84**	**0.82**	**0.80**	**0.78**	**0.77**	**0.75**	**0.73**	**0.71**	**0.70**	**0.68**	**0.66**	**0.65**	**0.63**	**0.62**	**0.49**	**0.50**	**0.51**	**0.52**	**0.53**	**0.54**	**0.55**	**0.56**	**0.58**	**0.59**
Per Unit Tariff (Rs/kWh)	5.82	5.72	5.62	5.52	5.42	5.32	5.22	5.12	5.03	4.93	4.84	4.74	4.65	4.56	4.47	3.59	3.67	3.76	3.85	3.95	4.05	4.15	4.27	4.38	4.51
Discount Rate (%)	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**
Discount Factor	1.00	0.91	0.83	0.75	0.68	0.62	0.57	0.52	0.47	0.43	0.39	0.35	0.32	0.29	0.27	0.24	0.22	0.20	0.18	0.17	0.15	0.14	0.12	0.11	0.10
Discounted Tariff	5.82	5.2	4.65	4.15	3.71	3.31	2.96	2.64	2.36	2.1	1.88	1.67	1.49	1.33	1.19	0.87	0.81	0.75	0.7	0.65	0.61	0.57	0.53	0.5	0.46
Levelized Tariff (Rs /kWh)													**5.08**												

At 21% CUF

Tariff Calculations																									
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
Net Energy (MU)	1.83	1.82	1.81	1.80	1.79	1.78	1.77	1.76	1.75	1.75	1.74	1.73	1.72	1.71	1.70	1.69	1.69	1.68	1.67	1.66	1.65	1.64	1.64	1.63	1.62
Costs (Rs Crore)																									
O&M	0.08	0.08	0.08	0.09	0.09	0.10	0.10	0.11	0.11	0.12	0.13	0.13	0.14	0.15	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.26
Depreciation (SLM)	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Interest on long-term loan	0.33	0.31	0.29	0.26	0.24	0.22	0.20	0.17	0.15	0.13	0.10	0.08	0.06	0.03	0.01	-	-	-	-	-	-	-	-	-	-
Interest on working capital	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
Return on Equity	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
Total Cost (Rs Crore)	**0.86**	**0.84**	**0.82**	**0.80**	**0.78**	**0.77**	**0.75**	**0.73**	**0.71**	**0.70**	**0.68**	**0.66**	**0.65**	**0.63**	**0.62**	**0.49**	**0.50**	**0.51**	**0.52**	**0.53**	**0.54**	**0.55**	**0.56**	**0.58**	**0.59**
Per Unit Tariff (Rs/ kWh)	4.71	4.63	4.55	4.47	4.39	4.31	4.23	4.15	4.07	3.99	3.92	3.84	3.77	3.69	3.62	2.90	2.97	3.04	3.12	3.19	3.28	3.36	3.45	3.55	3.65
Discount Rate (%)	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**
Discount Factor	1.00	0.91	0.83	0.75	0.68	0.62	0.57	0.52	0.47	0.43	0.39	0.35	0.32	0.29	0.27	0.24	0.22	0.20	0.18	0.17	0.15	0.14	0.12	0.11	0.10
Discounted Tariff	4.71	4.21	3.76	3.36	3.00	2.68	2.39	2.14	1.91	1.70	1.52	1.35	1.21	1.08	0.96	0.70	0.65	0.61	0.57	0.53	0.49	0.46	0.43	0.40	0.38
Levelized Tariff (Rs /kWh)	**4.11**																								

ANNEXURE-III

Tariff Calculations for Non-DRE

Parameters	Units	AgroPV	Sources
Number of days of Operation	Nos.	365	
Plant Capacity	MW	1	
Life of Plant	Years	25	CERC RE Tariff Reg 2024
Capacity Utilization Factor (CUF)	%	17%/21%	Taken from orders & CEA RA Plan
Auxiliary Energy Consumption	%	0.75%	Maximum as per CERC RE Tariff Reg 2024
Financial Parameters			
Capital Cost excluding cost of land	Rs. Crore per MW	3.50	
Debt: Equity ratio	Ratio	70:30	CERC RE Tariff Reg 2024
Loan Amount	Rs. Crore per MW	2.45	Calculated
Equity Amount	Rs. Crore per MW	1.05	Calculated
Normative ROE (Return of Equity)	%	14%	CERC RE Tariff Reg 2024
Minimum Alternate Tax (MAT)	%	16.69%	
Corporate Tax (CT)	%	25.00%	
ROE till 20-years (Grossed up with MAT)	%	16.81%	CERC RE Tariff Reg 2024
ROE after 20-years (Grossed up with CT)	%	18.67%	CERC RE Tariff Reg 2024
Loan repayment period	Years	15	CERC RE Tariff Reg 2024
Moratorium Period	Years	-	
Rate of Interest on Loan	%	10.93%	CERC RE Tariff Reg 2024
Salvage value of Assets	%	10.00%	CERC RE Tariff Reg 2024
Rate of Depreciation for first 15 years	%	4.67%	CERC RE Tariff Reg 2024
Depreciation from 16th year	%	2.00%	CERC RE Tariff Reg 2024
O&M Expenses	Lakh/MW	7.55	
Increment in O&M Expenses	%	5.25%	CERC RE Tariff Reg 2024
Lease rent payable to farmers per year	Lakh/MW	4.00	Considering 4 acre land used for 1 MW plant
Escalation on Lease rent	%	5.00%	escalation after every 2 years
Discount rate	%	9.94%	CERC RE Tariff Reg 2024 - equivalent to the post-tax weighted average cost of capital
Working Capital Components			
O&M Cost	Months	1.00	CERC RE Tariff Reg 2024
Receivables	Months	1.50	CERC RE Tariff Reg 2024
Maintenance Spares as % of O&M Expenses	%	15.00%	CERC RE Tariff Reg 2024
Rate of interest on working capital	%	12.18%	325 basis points above the averageSBI MCLR (one year tenor) prevalent during the last available 6 months
Degradation factor	%	0.50%	
Transmission loss (ISTS+InSTS)	%	6.5%	

At 17% CUF

Tariff Calculations																									
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
Net Energy sold (MU)	1.38	1.37	1.37	1.36	1.35	1.35	1.34	1.33	1.33	1.32	1.31	1.31	1.3	1.29	1.29	1.28	1.27	1.27	1.26	1.26	1.25	1.24	1.24	1.23	1.22
Costs (Rs Crore)																									
O&M	0.08	0.08	0.08	0.09	0.09	0.10	0.10	0.11	0.11	0.12	0.13	0.13	0.14	0.15	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.26
Land lease	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07
Depreciation (SLM)	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Interest on long-term loan	0.26	0.24	0.22	0.21	0.19	0.17	0.15	0.13	0.12	0.10	0.08	0.06	0.04	0.03	0.01	-	-	-	-	-	-	-	-	-	-
Interest on working capital	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
Return on Equity	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Total Cost (Rs Crore)	**0.73**	**0.71**	**0.70**	**0.69**	**0.68**	**0.66**	**0.65**	**0.64**	**0.63**	**0.62**	**0.61**	**0.60**	**0.59**	**0.58**	**0.57**	**0.48**	**0.49**	**0.50**	**0.51**	**0.52**	**0.54**	**0.55**	**0.56**	**0.58**	**0.59**
Per Unit Tariff (Rs/ kWh)	5.26	5.19	5.13	5.06	5.00	4.93	4.87	4.80	4.75	4.69	4.64	4.58	4.54	4.48	4.45	3.72	3.84	3.93	4.05	4.15	4.29	4.40	4.55	4.67	4.84
Discount Rate (%)	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**
Discount Factor	1.00	0.91	0.83	0.75	0.68	0.62	0.57	0.52	0.47	0.43	0.39	0.35	0.32	0.29	0.27	0.24	0.22	0.20	0.18	0.17	0.15	0.14	0.12	0.11	0.10
Discounted Tariff	5.26	4.72	4.24	3.81	3.42	3.07	2.76	2.48	2.23	2.00	1.80	1.62	1.46	1.31	1.18	0.90	0.84	0.79	0.74	0.69	0.64	0.60	0.57	0.53	0.50
Levelized Tariff (Rs /kWh)	**4.80**																								

At 21% CUF

Tariff Calculations																									
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
Net Energy sold (MU)	1.71	1.70	1.69	1.68	1.67	1.66	1.66	1.65	1.64	1.63	1.62	1.61	1.61	1.60	1.59	1.58	1.57	1.57	1.56	1.55	1.54	1.54	1.53	1.52	1.51
Costs (Rs Crore)																									
O&M	0.08	0.08	0.08	0.09	0.09	0.10	0.10	0.11	0.11	0.12	0.13	0.13	0.14	0.15	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.26
Land lease	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07
Depreciation (SLM)	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Interest on long-term loan	0.26	0.24	0.22	0.21	0.19	0.17	0.15	0.13	0.12	0.10	0.08	0.06	0.04	0.03	0.01	-	-	-	-	-	-	-	-	-	-
Interest on working capital	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
Return on Equity	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Total Cost (Rs Crore)	**0.73**	**0.71**	**0.70**	**0.69**	**0.68**	**0.66**	**0.65**	**0.64**	**0.63**	**0.62**	**0.61**	**0.60**	**0.59**	**0.58**	**0.57**	**0.48**	**0.49**	**0.50**	**0.51**	**0.52**	**0.54**	**0.55**	**0.56**	**0.58**	**0.59**
Per Unit Tariff (Rs/kWh)	4.26	4.20	4.15	4.09	4.05	3.99	3.95	3.89	3.85	3.80	3.76	3.71	3.67	3.63	3.60	3.02	3.11	3.18	3.28	3.36	3.47	3.56	3.68	3.78	3.92
Discount Rate (%)	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**	**9.94%**
Discount Factor	1.00	0.91	0.83	0.75	0.68	0.62	0.57	0.52	0.47	0.43	0.39	0.35	0.32	0.29	0.27	0.24	0.22	0.20	0.18	0.17	0.15	0.14	0.12	0.11	0.10
Discounted Tariff	4.26	3.82	3.44	3.08	2.77	2.48	2.23	2.00	1.80	1.62	1.46	1.31	1.18	1.06	0.96	0.73	0.68	0.64	0.60	0.56	0.52	0.49	0.46	0.43	0.40
Levelized Tariff (Rs /kWh)	**3.89**																								

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