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Optimizing Decentralized Solar Adoption in Rajasthan: A Regional Strategy for PM-KUSUM Implementation using the Integrated Deployment Model (IPKDM)

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Abstract: The PM-KUSUM scheme aims to help farmers switch from diesel to solar energy while boosting their earnings. It offers a central subsidy of 30% to 50% for installing new solar pumps or converting current electric pumps to solar It also allows farmers to generate revenue by setting up solar power plants (up to 2MW) on fallow land and selling electricity to DISCOMs at state-determined rates. The prices for this power are fixed by the state regulator, and the scheme is managed by state government departments. The PM Kusum scheme got administrative approval in March 2019 and guidelines were prepared in July 2019. The scheme was launched by the Ministry of New and Renewable Energy (MNRE) (Choudhary, 2023)
Keyword: Solar Pump, PM KUSUM, Solar irrigation pump, Component of PM KUSUM, Installed Solar Capacity, Solar Power Trend.

I. INTRODUCTION

The PM-KUSUM scheme is a central government flagship scheme launched in 2019 by Ministry of New and Renewable Energy(MNRE) and its aim to help farmers switch to clean solar energy to run their irrigation pumps. This shift reduces their reliance on expensive diesel and allows them to earn money by selling extra power back to the grid. By setting up solar plants on unused or farm land, farmers gain access to a cheaper, more reliable, and eco-friendly energy source that boosts their income and protects the environment. Rajasthan is desert place and it has almost 320 sunny days so sun radiation directly falling down to surface .This paper is focused on the effect of PM KUSUM scheme to the farmers of Rajasthan State and benefit they gained after adoption of this scheme. The scheme is being implemented in Rajasthan by Rajasthan Renewable Energy Corporation Limited(RRECL). The first farm-based solar power plant under the Prime Minister's Kisan Urja Suraksha Evum Utthan Mahabhiyan (KUSUM) scheme has come up in Jaipur district's Kotputli tehsil with a provision for production of 17 lakh units of electricity every year [THE HINDU].

A. Component of PM Kusum Scheme

There are three component of PM Kusum Scheme-

- Component A
- Component B
- Component C

1) Component-A

Addition of 10,000 MW of solar capacity through installation of small solar power plants of capacity upto 2 MW Link.
Under this component, Renewable Power Generators—farmers, cooperatives, and various associations—may install energy plants ranging from 1000 kW to 2 MW. State authorities retain discretion for smaller capacities, while plants should nestle within a 5 km radius of substations—a strategic placement that slashes both transmission costs and losses.

Major beneficiary state
According to Press information Bureau, Government of India Ministry of New and Renewable Energy almost 57692 farmers of Rajasthan is benefited by this scheme (india, 2023).

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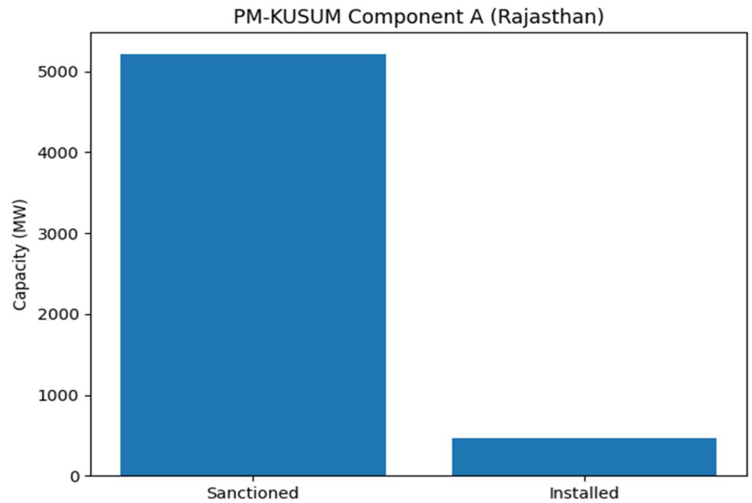
Component wise report of Rajasthan

Component	Total Sanctioned	Total Installed
Component A	5220 MW	466.75 MW
Component B	144752 Nos.	115584 Nos.
ComonentC (IPS)	2138 Nos.	2138 Nos.
Comonent C (LPS)	400000 Nos.	117840 Nos.



Comparison of sanctioned and installed solar capacity under PM-KUSUM Component A in Rajasthan.

Division wise installation under component A

DISCOM / Division	Approx. Installed Capacity (Component A)	Notes
Jodhpur DISCOM	Almost 990.50 MW highest in the state	Major contribution to Rajasthan's leading position in Component A. Link
Jaipur DISCOM	Almost 160 MW	Substantial but significantly less than Jodhpur. Link
Ajmer DISCOM	Almost 134 MW	Third among major DISCOM areas. Link

Jodhpur's doing really well in the PM-KUSUM Component-A because it has tons of sunshine 6-7kWh/m^2 in a day, smart government rules, and the electricity companies are doing a great job scince 33/11 kV substations already available putting it all together. fantastic solar energy potential, plenty of land that isn't good for farming, a solid power grid, and the government and developers are really on board. All these things together are creating a great way to set up solar power locally, which helps grow renewable energy and also gives farmers a better living.

2) Component-B

Installation of 20 lakh standalone solar powered agricultural pumps.

This component supports individual farmers in replacing existing diesel irrigation systems with standalone solar agriculture pumps (up to 7.5 HP) in off-grid areas where grid power is unavailable. While the installation of new pumps is permitted, it is prohibited in designated dark zone areas. Pumps with capacities higher than 7.5 HP are allowed, but the Central Financial Assistance (CFA) will be capped at the subsidy limit for a 7.5 HP pump.The scheme covers individual farmers, Water User Associations, and community-based irrigation systems, with priority given to small and marginal farmers. To promote water conservation, preference is granted to farmers utilizing or opting for micro-irrigation systems. The pump capacity will be determined based on the local water table, the size of the land, and specific irrigation water requirements.

Division wise installation under component B

Rajasthan Division	Implementation Status	Key Reasons
Jodhpur Division	Very High	Large off-grid rural areas, water scarcity, high diesel pump dependency, strong solar potential
Bikaner Division	Very High	Arid climate, remote villages, limited grid access, high irrigation need
Ajmer Division	High	Mixed grid availability, semi-arid agriculture, moderate pump demand
Jaipur Division	Moderate	Better grid coverage, preference shifting towards Component-C
Udaipur Division	High	Tribal and hilly regions with unreliable grid supply
Kota Division	Moderate to Low	Canal irrigation dominance, better power availability
Bharatpur Division	Low	Good grid penetration, less dependence on standalone pumps

3) Component-C

Solarisation of 15 lakh existing Grid-connected Agriculture Pumps (PM-KUSUM : A New Green Revolution)

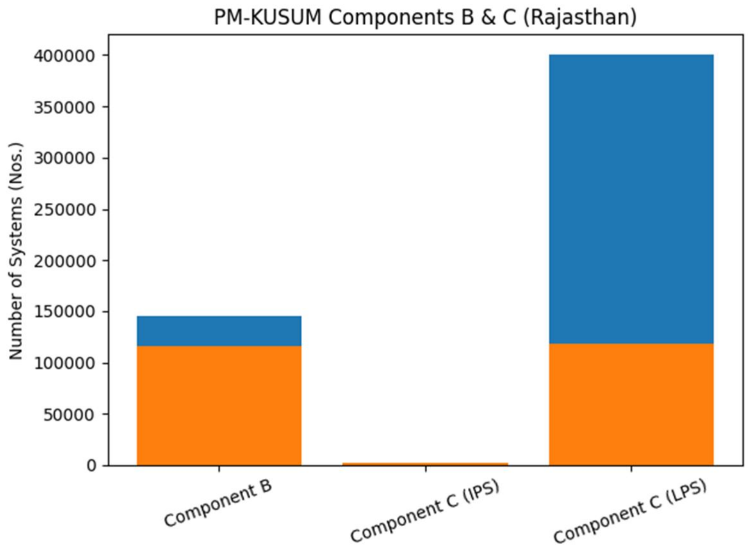
This component supports the solarization of existing grid-connected agriculture pumps for individual farmers. The scheme permits the installation of solar photovoltaic (PV) capacity up to two times the pump's capacity in kilowatts (kW). While States may specify a lower capacity limit, it must not be less than the pump's horsepower (HP); for instance, a 2 HP pump requires a minimum of 2 kW solar capacity. Farmers will utilize the generated solar power for irrigation and sell any surplus electricity to DISCOMs. Although the schemecovers Water User Associations and community irrigation systems, priority is granted to small and marginal farmers. Additionally, to promote water conservation, preference is given to farmers utilizing micro-irrigation systems or those willing to adopt them.

Division wise installation under component C

Rajasthan Division	Implementation Status	Key Reasons
Jaipur Division	Very High	Dense grid-connected pump network, strong feeder infrastructure, early adoption of feeder solarisation
Ajmer Division	High	Mixed agriculture, reliable grid access, DISCOM-led feeder projects
Kota Division	Very High	Canal-based irrigation, high concentration of grid-connected pumps, technical feasibility for feeder solarisation
Bharatpur Division	High	Assured grid supply, intensive agriculture, strong farmer participation
Udaipur Division	Moderate	Grid presence with terrain constraints, gradual transition from Component-B
Jodhpur Division	Moderate	Preference for Component-A and B due to land availability and off-grid areas

Trend Interpretation:

- Large gap between sanctioned (5220 MW) and installed capacity (466.75 MW).
- Indicates challenges related to land availability, grid connectivity, financing, and project approvals.



Comparison of sanctioned and installed solar pumps under PM-KUSUM Components B and C in Rajasthan.
Trend Interpretation:

- Component B shows strong adoption with moderate gaps.
- Component C (IPS) achieved 100% installation.
- Component C (LPS) shows significant shortfall due to DISCOM-level and technical challenges.

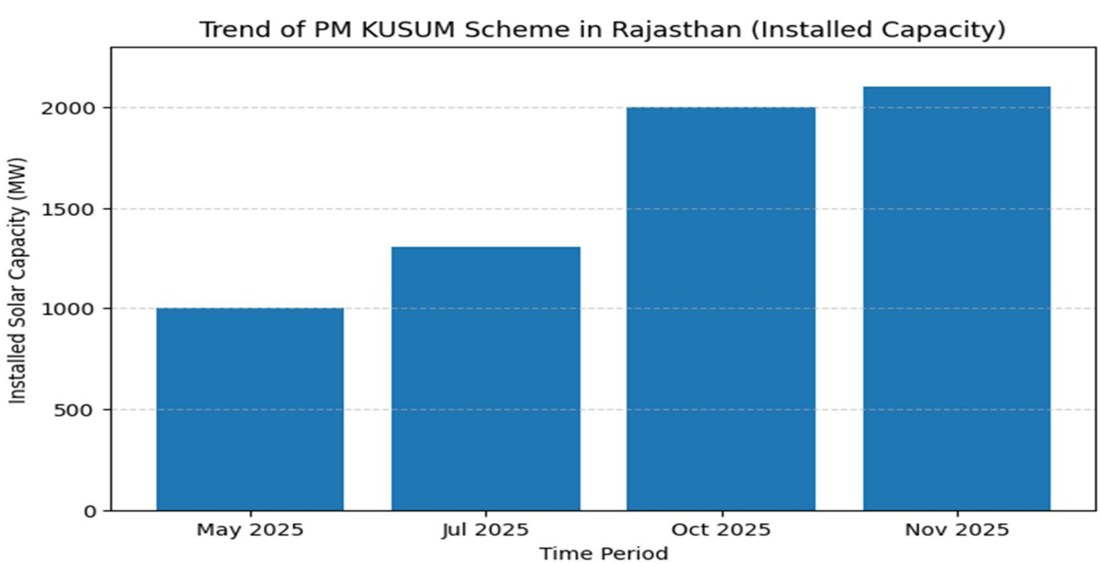
The Data taken from official Government of India PM KUSUM Website.Data Shows that Govt of India with Rajasthan Government continuously work on this Project and Farmers are benefited.

B. Key Achievements in Decentralised Solar

Rajasthan has total decentralised solar capacity installed in 684 plants is 1308MW in which 1190MW in 592 Plants came in year 2024-25. The report says that Rajasthan has become the top state among all state in component A which has installed capacity 467MW and In Component C Rajasthan got the rank third in all state.

C. Trend of PM KUSUM Scheme in Rajasthan

The trend shows that Rajasthan has actively worked on PM KUSUM Scheme in the year 2025.



D. *Challenges Under PM KUSUM Scheme*

There are some challenges faces by the farmers:

1) Environmental challenge- In area of Rajasthan like north east the ground water level falling upto 400feet and standard HP solar pumps effective up to 350feet making them un useful.
2) Financial Problem- Since Government provided subsidies up to 60% of the cost but still the 40% has burden to farmers. Another bank also hesitates to provide loan to farmer because it is not easily seized if they fall default link .
3) Maintenance Problem- Solar Pumps often used in a particular season and rest of the time it is useless so maintenance is also a problem arise to the farmers.

Drawing from the division-level assessment of PM-KUSUM (Components A, B, and C) and direct field insights in Rajasthan, the following strategic actions are proposed:

- Geographically Targeted Implementation: Solar strategies should align with regional characteristics. Arid western divisions (Jodhpur, Bikaner) should prioritize Component-A (solar plants) and Component-B (standalone pumps) due to vast available land and sparse grids. Conversely, eastern and south-eastern regions (Jaipur, Kota, Bharatpur) should focus on Component-C (feeder solarization) to leverage their established grid networks.
- Grid Modernization: To maximize the potential of Component-C, targeted funding is required for upgrading 33/11 kV substations and feeder lines, particularly in semi-arid zones where infrastructure currently limits power evacuation.
- Water Resource Stewardship: To prevent the depletion of aquifers, Component-B installations must be integrated with mandatory water-conservation measures, such as smart metering, drip irrigation, and incentives for low-water-intensity crops.
- Educational Outreach: State agencies should launch technical literacy programs for farmers, focusing on the maintenance of solar hardware, the mechanics of net-metering, and maximizing the financial returns of their assets.
- Open Data Initiatives: DISCOMs should maintain transparent, publicly accessible databases of district-wise capacity. This transparency is vital for independent research, progress monitoring, and data-driven governance.

II. FIELD METHODOLOGY AND FINDINGS

The author engaged in primary field research across diverse agro-climatic zones in Rajasthan to validate secondary data. The methodology included:

1) On-Site Inspections: Physical verification of decentralized plants, standalone pumps, and solarized feeders to assess operational health and land utilization.
2) Stakeholder Consultations: Qualitative interviews with end-user farmers, DISCOM technical staff, and local solar contractors to identify real-world challenges.
3) Empirical Observation: Analysis of how proximity to substations and local land-use patterns dictate the success of solar adoption.
4) Field Results: The investigation confirmed a distinct spatial trend: Component-A thrives in land-abundant arid regions, Component-B serves as a lifeline in off-grid pockets, and Component-C is most viable in regions with high-density electrical infrastructure.

III. THE INTEGRATED PM-KUSUM DEPLOYMENT MODEL (IPKDM)

To streamline the expansion of decentralized solar power, this study introduces the Integrated PM-KUSUM Deployment Model (IPKDM). This framework is designed to align scheme components with regional realities.

A. *Core Layers of the IPKDM*

1) Resource Assessment: Analyzing solar potential, land availability, and current grid health at the divisional level.
2) Strategic Mapping: Assigning components based on regional strengths (e.g., matching Component-A with land-rich zones and Component-C with grid-stable zones).
3) Governance Framework: Creating a collaborative ecosystem between DISCOMs, state renewable energy agencies, and local financial institutions.
4) Farmer Incentives: Ensuring economic viability through power purchase agreements (PPAs), subsidies, and secondary income streams from surplus energy.
5) Long-term Sustainability: Establishing oversight for groundwater levels and technical grid stability to ensure the scheme’s permanence.

B. Future Work In Rajasthan Under PM KUSUM Scheme

Rajasthan is the top state in India for the PM-KUSUM scheme, and its future plans are even more ambitious. The goal is simple: use solar energy to give farmers free electricity and extra income.In early 2026, Luminous Power Technologies is set to begin work on a massive 350 MW solar energy project in Rajasthan as part of the federal PM-KUSUM initiative(DECEMBER, 2025)LINK. This rollout marks a significant expansion into utility-scale renewable infrastructure for the company.The government has raised its goals significantly. They now want to install over 5,000 MW of small solar plants on barren land and provide solar power to 400,000 irrigation pumps(https://finance.rajasthan.gov.in/website/)LINK.

IV. CONCLUSION

The research indicates that PM-KUSUM's performance in Rajasthan is not uniform; rather, it is a product of regional variations in infrastructure and geography. While Jodhpur leads in decentralized power generation (Component-A), other regions show varied success based on their specific grid connectivity and irrigation needs. The field evidence confirms that a "one-size-fits-all" approach is insufficient. By adopting the proposed IPKDM framework, Rajasthan and other Indian states can better align renewable energy goals with rural economic development. Ultimately, PM-KUSUM serves as a critical bridge between India's clean energy transition and sustainable agricultural growth, provided that implementation remains flexible, data-driven, and region-specific. Under PM KUSUM Scheme Rajasthan is a leading state of total installed capacity in all three Components (Component A, Component B, Component C). The Trend shows gradually increasing installed solar capacity and crossed 2000MW of solar capacity. Few challenges faced by the farmers but technologies like Luminous Power Technologies is set to begin work on a massive 350 MW solar energy project in Rajasthan as part of the federal PM-KUSUM initiative.

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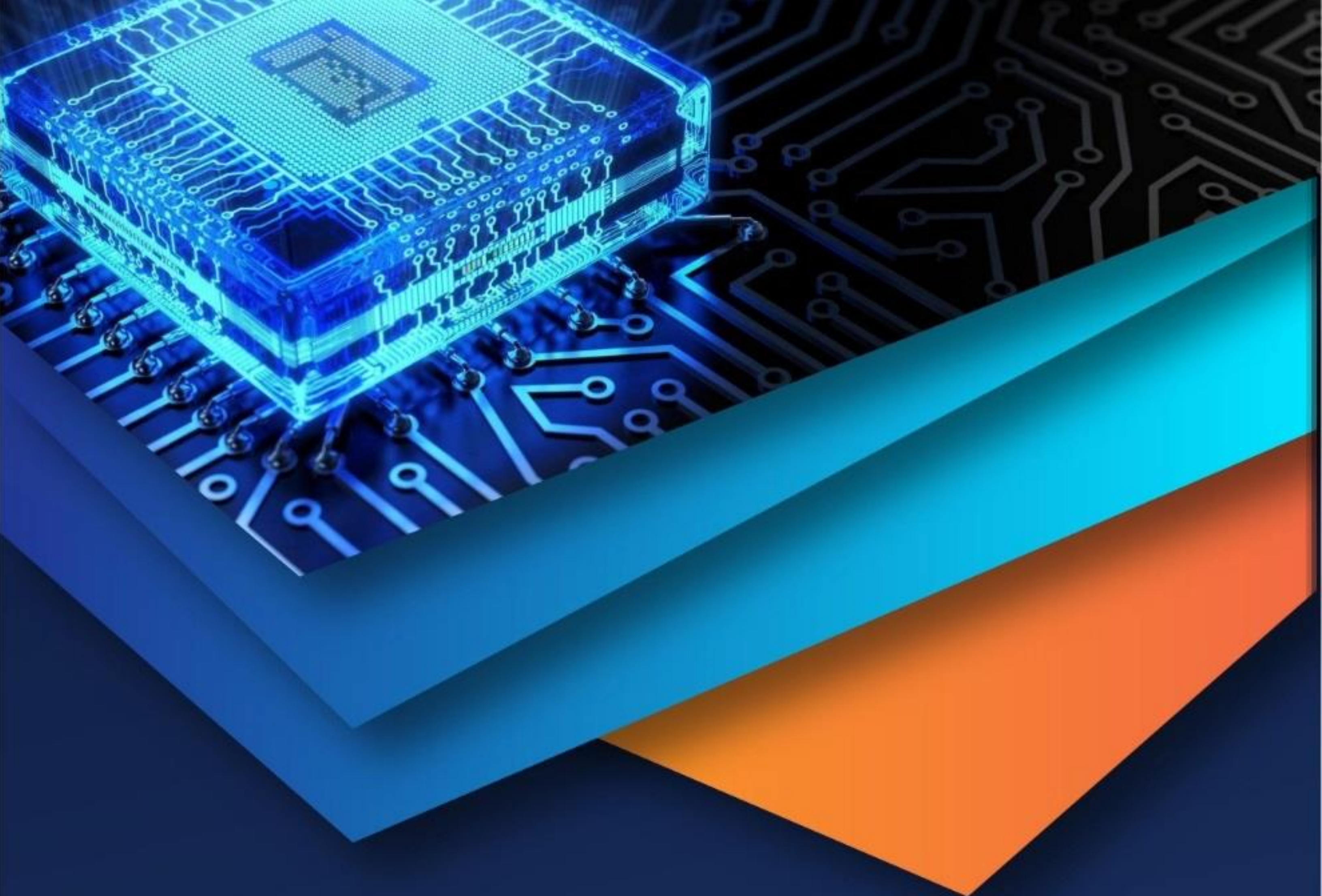

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