

Renewable Energy Progress, Policy Implementation, Challenges, and the Way Forward in Rajasthan, India

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ABSTRACT

Rajasthan endowed with abundant solar and wind resources, has emerged as a leading Indian state in renewable energy deployment. This paper critically reviews the progress made in renewable energy development in Rajasthan, examines the implementation of supportive policies, identifies persistent challenges, and suggests a roadmap for sustainable and inclusive energy transition. Despite remarkable growth in installed renewable capacity, issues related to policy execution, infrastructure, financing, and social acceptance continue to impede the sector's full potential. The paper concludes with recommendations for robust policy frameworks, technological upgrades, grid integration strategies, and participatory approaches to ensure equitable renewable energy growth in Rajasthan.

Keywords: Renewable Energy, Wind Resources, Infrastructure, Grid Integration Strategies, Policy Frameworks.

Introduction

Rajasthan, India's largest state by area, has emerged as a powerhouse in the country's renewable energy transition. With vast expanses of arid and semi-arid land, high solar insolation, and steady wind speeds, the state possesses immense potential for harnessing solar and wind energy. Over the past decade, it has leveraged these natural advantages through proactive policymaking, large-scale investments, and public-private partnerships. As India aims to achieve 500 GW of non-fossil fuel capacity by 2030, Rajasthan's contribution is expected to be pivotal, targeting over 125 GW of renewable energy (RE) capacity by the end of this decade.

Renewable Energy Progress in Rajasthan

- **Solar Energy**

Rajasthan ranks among the top Indian states in installed solar capacity, exceeding 18 GW as of 2025. Solar parks in Jodhpur, Bhadla, and Jaisalmer have contributed significantly to utility-scale solar generation. Rooftop solar, however, lags behind utility-scale adoption, with penetration still below national targets.

- **Wind Energy**

Rajasthan has an installed wind capacity of over 5 GW, with projects concentrated in Jaisalmer and Barmer districts. Repowering of aging wind turbines has begun but remains limited.

- **Hybrid Projects**

Hybrid solar-wind projects have been piloted to improve land utilization and grid stability. Storage-linked renewable projects are in their nascent stages.

Implementation of Renewable Energy Policies

- **Policy Framework**

Rajasthan Solar Energy Policy 2019 Rajasthan Wind and Hybrid Energy Policy 2019 Renewable Purchase Obligation (RPO) mandates Net metering policies for rooftop solar Incentives for solar parks under central schemes (e.g., PM-KUSUM for farmers)

- **Institutional Mechanisms**

Rajasthan Renewable Energy Corporation Limited (RRECL) coordinates planning and execution. Single-window clearance has been introduced to ease project approvals.

- **Financial Incentives**

Viability gap funding for solar parks Capital subsidies for rooftop solar Renewable energy certificates (RECs) for obligated entities

Challenges in Renewable Energy Development

- **Land Acquisition**

Scarcity of suitable land due to competing demands from agriculture and local communities. Land conflicts and lack of transparent acquisition processes.

- **Grid Integration**

Weak grid infrastructure and limited transmission corridors. Curtailment issues during peak generation periods.

- **Policy and Regulatory Uncertainty**

Frequent policy revisions and delays in payment from distribution companies (DISCOMs). Inconsistent net-metering frameworks discouraging rooftop adoption.

- **Financing and Investment Barriers**

High perceived risks among private investors. Limited credit access for small-scale renewable developers.

- **Social and Environmental Concerns**

Displacement of local communities Wildlife impacts, particularly in the Thar desert region

Installed Capacity & Recent Growth

Total RE capacity now exceeds 33 GW, with ~10.8 GW added in just the past 18 months. The state aims for 125 GW by 2030 (90 GW solar, 25 GW wind/hybrid, plus 10 GW storage)

Landmark projects include:

- **Bhadla Solar Park** (~2,245 MW): At ~2,245 MW, it is one of the largest operational solar parks in the world. Largest in India and among the world's biggest
- **Jaisalmer Wind Park** (~1,064 MW): Among the largest in India, with over 1,000 MW capacity.
- **PM-KUSUM Scheme**: Promotes solar-powered irrigation. Rajasthan has commissioned over 1,000 MW through standalone pumps and grid-connected agricultural feeders. >1,000 MW solar for agriculture, impacting 170k farmers

Policy Framework and Implementation Strategies

- **State Policy Support**

Rajasthan has introduced several policies to attract investment and simplify RE development:

- Rajasthan Solar Energy Policy 2019 : Provided a roadmap for achieving 30 GW of solar capacity by 2025, later revised under broader goals.
- Rajasthan Wind & Hybrid Energy Policy 2019 : Encouraged hybrid projects, particularly in wind-rich zones.
- Integrated Clean Energy Policy 2024 : A landmark step, consolidating solar, wind, storage, hydrogen, and green industry development under one umbrella.
- Key incentives include:
 - 100% exemption on land tax for seven years
 - Concessions on stamp duty, wheeling charges
 - Priority land allotment in designated Renewable Energy Zones (REZs)

- **PM-KUSUM Implementation**

The PM-KUSUM scheme is implemented at scale in Rajasthan:

- Component A: 1 GW solar for agriculture feeders

- Component B & C: 3–5 HP solar pumps for farmers
- Over *170,000 farmers* have benefitted, reducing diesel pump usage and increasing daytime agricultural productivity.
- **Investment and Public-Private Partnerships**
Rajasthan has signed *MoUs worth over ₹4.23 lakh crore*, with commitments for:
 - 66 GW in wind, solar, and hybrid energy
 - 20.5 GW in pumped hydro storage
 - 4 GWh in Battery Energy Storage Systems (BESS)**Key investors include:**
 - * *Adani Green Energy*: Targeting 100 GW pan-India, with a major share in Rajasthan
 - * *Tata Power, **JSW Energy, **ReNew Power, and **ACME Solar*

Infrastructure and Technological Backbone

- **Transmission and Grid Development**
As renewable energy generation grows, grid infrastructure is under massive expansion:
 - Rajasthan has built *44,500 circuit kilometers of transmission lines* and over *650 substations*.
 - The *Green Energy Corridor Project (GEC-II)* aims to enable 20 GW RE evacuation, with central assistance and World Bank funding.
 - Grid strengthening also includes real-time SCADA integration and AI-based forecasting tools.
- **Energy Storage Systems**
To address the intermittency of solar and wind, storage solutions are being scaled:
 - *Battery Energy Storage Systems (BESS): Central government allocated ₹720 crore to support 4 GWh storage under VGF (Viability Gap Funding).
 - *Pumped Storage Projects (PSPs): Over 20.5 GW capacity in the pipeline.
 - Hybrid projects (solar + wind + storage) are also being developed to ensure round-the-clock (RTC) supply.
- **Green Hydrogen and Emerging Technologies**
Rajasthan has immense potential for *green hydrogen* production:
 - Target: *2 million tonnes per annum by 2030*
 - ~5 GW electrolyser capacity planned in hydrogen hubs
 - Policy incentives for green ammonia and hydrogen-based industries to set up near RE parks

The Way Forward

- **Strengthen Policy Stability**
Ensure long-term policy consistency to build investor confidence. Streamline approvals with more digital and transparent systems.
- **Grid Modernization**
Invest in smart grids and storage systems to manage variable renewable energy. Expand transmission infrastructure to evacuate power from renewable-rich zones.
- **Community Engagement**
Integrate local communities in benefit-sharing models. Promote decentralized renewable systems (e.g., solar pumps, mini-grids).
- **Support Innovation**
Incentivize research on storage, hybrid systems, and floating solar. Encourage startups working on distributed renewable technologies.

- **Capacity Building**
Train the local workforce for installation, operation, and maintenance of renewable systems. Build institutional capabilities for better planning and monitoring.
- **Scale battery and pumped-storage infrastructure**
Leverage the ₹720 crore VGF package and MoUs to turn commitments into operational assets.
- **Push agrivoltaics rollout**
Combine land-use efficiency and farmer income, reducing land scarcity while enhancing rural resilience.
- **Promote green hydrogen hubs**
Use strong RE and industrial corridors to attract electrolyser investments.
- **Simplify approvals & monitor projects rigorously**
Monthly oversight by CM's office and dedicated nodal officers must ensure MoU deadlines and performance
- **Enhance rooftop & off-grid solar**
Kickstart microgrid and residential solar expansion—potential ~5 GW rooftop capacity still untapped.
- **Strengthen E-mobility ecosystem**
Expand EV charging networks and EV fleets in line with clean energy targets
(government.economictimes.indiatimes.com)

Social and Economic Impact

- **Employment Generation**
Renewable energy projects are labor-intensive during construction phases:
 - Estimated *3–4 jobs per MW* during setup
 - Local employment in maintenance, metering, panel cleaning, and community solar
- **Rural Electrification and Income Augmentation**
Solar projects under KUSUM have:
 - Enabled daytime electricity for farmers
 - Enhanced rural electrification and village energy security
 - Provided income opportunities by allowing farmers to sell surplus energy to discoms (under feeder-level solarization)

Conclusion

Rajasthan is a shining example of how geography, vision, and governance can align to create a sustainable energy future. With its unmatched potential in solar and wind energy, the state has already made significant strides and set a benchmark for others. However, the journey to achieving 125 GW of clean energy by 2030 requires not just capacity addition, but also smart grid integration, decentralized models, environmental sensitivity, and inclusive growth.

By addressing challenges head-on and focusing on innovation, Rajasthan can not only meet its targets but also become **a global leader in renewable energy** and a key contributor to India's net-zero journey.

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