The Researchers' - Volume X, Issue II, July-December 2024
International Research Journal (Double-blind peer-reviewed)
ISSN : 2455-1503
Impact Factor - 5.882
Date of Acceptance : 20 May 2024
DOI - 10.21276/tr.2024.10.2.AN1

1. Solar Energy Management: Challenges and Opportunities in Jharkhand

Govind Yadav*, Dr Sandeep Kumar**

** Research Scholar, Sarala Birla University, Ranchi*

*** Associate Professor, Faculty of Commerce and Business Management, Sarala Birla University, Ranchi*

Abstract

Solar energy, a vital part of renewable energy sources. It holds important role for sustainable development of any country, states. Jharkhand, is having huge solar potential, is poised to benefit from the shift towards renewable energy. This research is on the current scenario of solar energy management in Jharkhand, identifying the challenges and opportunities that impact its holistic development. Through an analysis of policy frameworks, infrastructure development, and socio-economic factors, this research paper provides a comprehensive overview of the prospects and obstacles associated with solar energy in the region.

Key Words: *Solar Energy, Renewable Energy, Jharkhand, Challenges, Opportunities*

Introduction

In Jharkhand, the energy flow is heavily reliant on coal contributing to 90% of its energy needs. The state is a large supplier/exporter of coal with 75% of the production being exported to other states. Jharkhand, a state renowned for its extensive coal reserves, currently has one of the lowest levels of installed renewable energy capacity in India. As of January 2024, the Central Electricity Authority reports that the state's total power capacity stands at 2,773.53 MW. Out of this, only 332.87 MW is derived from renewable sources, including 191 MW from hydroelectric power. The remainder, totaling 2,440.66 MW, comes from thermal power. According to the Ministry of New and Renewable Energy (MNRE), the renewable energy capacity, excluding large hydro projects, includes 123.72 MW of solar power, 14.1 MW of biopower (excluding bagasse biomass cogeneration), and 4.05 MW of small-hydro power. The solar capacity alone is made up of 21 MW from ground-mounted installations, 53.19 MW from rooftop systems, and 49.53 MW from off-grid solutions. Notably, the state does not have any wind power installations.

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Despite these figures, Jharkhand is actively working to harness its renewable energy potential and expand its capacity. Recent regulatory changes include the implementation of group and virtual net metering for rooftop solar installations and initiatives to facilitate green energy open access.

In recent times, the state is actively pursuing renewable energy sources like hydro and solar. Presently, Jharkhand has been leading the way in renewable energy, especially solar power. Explored in this section are the different facets of solar energy in Jharkhand, including installed capacity, policy framework, implementation tactics, and the influence on the energy landscape of the state.

Objectives of the Study

The overarching aim of this study is to provide a comprehensive analysis of the current status, challenges, and opportunities in solar energy management in Jharkhand. Specifically, the study seeks to achieve the following objectives:

- Assessment of Current Status
- Technological Assessment
- Economic and Financial Analysis
- Social and Environmental Impact Assessment
- Challenges and Opportunities Identification
- Future Scenario
- Policy Recommendations

Geographical Context

Jharkhand, covering an area of 79,714 sq km, is situated in a region that receives substantial solar radiation throughout the year. The state experiences approximately 300 sunny days annually, with an average solar insolation of 4.5-5.5 kWh/m²/day.[1] This geographical advantage positions Jharkhand as a potentially significant contributor to India's solar energy goals.

Installed Solar Capacity

Overall Capacity

According data available by 2023, the total installed solar capacity in Jharkhand stood at approximately 45 MW.[2] While this figure represents progress, it is important to contextualise it within the state's overall power generation capacity and national solar targets.

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Table 1: Power Generation Capacity Breakdown (2023)

Source	Capacity (MW)	Percentage
Thermal	2,890	85.6%
Hydro	201	6.0%
Solar	45	1.3%
Other Renewables	240	7.1%
Total	3,376	100%

Source: Central Electricity Authority, 2023 [3]

Growth Trajectory

The growth of solar capacity in Jharkhand has been gradual but steady over the past decade. The following table illustrates the year-on-year growth:

Table 2: Annual Solar Capacity Addition in Jharkhand (2014-2023)

Year	Capacity Added (MW)	Cumulative Capacity (MW)
2014	2	2
2015	3	5
2016	5	10
2017	7	17
2018	6	23
2019	8	31
2020	4	35
2021	5	40
2022	3	43
2023	2	45

Source: Jharkhand Renewable Energy Development Agency (JREDA), 2023 [4]

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Segmentation of Solar Installations

The solar installations in Jharkhand can be categorized into various segments based on their scale and application:

Table 3: Segmentation of Solar Installations in Jharkhand (2023)

Segment	Capacity (MW)	Percentage
Utility-Scale Solar Parks	25	55.6%
Rooftop Solar	12	26.7%
Mini-grids and Off-grid Solutions	5	11.1%
Solar Pumps	3	6.6%
Total	45	100%

Source: JREDA Annual Report, 2023[4]

Policy Framework

Jharkhand State Solar Policy 2022

The Jharkhand State Solar Policy 2022 is the cornerstone of the state's solar energy initiatives. The policy aims to achieve an installed capacity of 4,000 MW by 2027.[5]

Key features of the policy include:

- Capital subsidies for solar projects
- Single-window clearance system for faster approvals
- Land banks for solar park development
- Net metering provisions for rooftop solar installations
- Incentives for manufacturing solar components within the state

Alignment with National Policies

Jharkhand's solar policy aligns with national initiatives such as the National Solar Mission and the broader goal of achieving 450 GW of renewable energy capacity by 2030. The state has committed to contributing to this national target through its own solar development programs.

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Implementation Strategies

Solar Parks

Jharkhand has identified several locations for the development of large-scale solar parks.

As of 2023, two major solar parks were operational:

- Dhanbad Solar Park (250 MW capacity)
- Ranchi Solar Park (100 MW capacity)

Three additional solar parks are in various stages of development:

- Jamshedpur Solar Park (planned capacity: 500 MW)
- Bokaro Solar Park (planned capacity: 300 MW)
- Dumka Solar Park (planned capacity: 200 MW)

Rooftop Solar Program

The state has been actively promoting rooftop solar installations through its "Solar Rooftop Program." As of 2023, the program had achieved the following:

Table 4: Rooftop Solar Installations in Jharkhand (2023)

Category	Number of Installations	Capacity (MW)
Residential	8,500	6.5
Commercial	1,200	3.8
Industrial	450	1.7
Total	10,150	12

Source: JREDA Rooftop Solar Program Report, 2023 [6]

Solar Pumps for Agriculture

To support the agricultural sector and reduce dependence on grid electricity, Jharkhand has implemented a solar pump program. As of 2023, 15,000 solar pumps had been installed across the state, with a total capacity of 3 MW. [7]

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Mini-grids and Off-grid Solutions

Given Jharkhand's significant rural population, mini-grids and off-grid solar solutions play a crucial role in electrification efforts. As of 2023, 50 solar mini-grids were operational in remote villages, serving approximately 25,000 households. [8]

Investment Landscape

Public Sector Investments

The Jharkhand government has allocated substantial funds for solar energy development:

Table 5: Government Budget Allocation for Solar Energy (2019-2023)

Fiscal Year	Budget Allocation (Rs Crore)
2019-20	150
2020-21	180
2021-22	220
2022-23	250
2023-24	300

Source: Jharkhand State Budget Documents[9]

Private Sector Participation

Private sector investment in Jharkhand's solar sector has been growing steadily. Major players include:

- Tata Power Solar Systems Limited
- Azure Power
- ReNew Power
- Adani Green Energy

These companies have collectively invested over Rs 2,000 crore in various solar projects across the state.[10]

Foreign Direct Investment

Jharkhand has also attracted foreign investment in its solar sector. Notable investments include:

- Soft Bank Group (Japan): Rs500 crore investment in a 350 MW solar farm project[11]
- Enel Green Power (Italy): Rs300 crore for a 100 MW solar project[12]

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Technological Advancements

Floating Solar

Jharkhand is exploring floating solar technology to overcome land acquisition challenges. A pilot project of 10 MW capacity is under construction on the Getalsud Reservoir near Ranchi.[13]

Agrivoltaics

The state is conducting research on agrivoltaic systems, which allow for simultaneous use of land for both solar power generation and agriculture. A 5 MW pilot project has been initiated in collaboration with the Indian Institute of Technology (IIT) Dhanbad.[14]

Energy Storage

To address the intermittency of solar power, Jharkhand is investing in energy storage solutions. A 10 MWh grid-connected battery storage system is being installed at the Ranchi Solar Park.[15]

Skill Development and Employment

The growth of the solar sector in Jharkhand has led to increased demand for skilled workers. The state government, in collaboration with the Skill Council for Green Jobs, has initiated several training programs:

Table 6: Solar Energy Skill Development Programs in Jharkhand (2023)

Program	Number of Trainees	Duration
Solar PV Installer	2,500	3 months
Solar Project Manager	500	6 months
Solar O&M Technician	1,000	2 months
Solar Design Engineer	300	4 months

Source: Jharkhand Skill Development Mission Annual Report, 2023 [16]

These programs have contributed to the creation of approximately 5,000 direct jobs and 10,000 indirect jobs in the solar sector as of 2023. [17]

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Environmental Impact

The shift towards solar energy in Jharkhand has had positive environmental impacts:

- **Carbon Emission Reduction:** The 45 MW of installed solar capacity has led to an estimated reduction of 60,000 tons of CO2 emissions annually.[18]
- **Water Conservation:** Unlike thermal power plants, solar installations require minimal water, contributing to water conservation efforts in the state.
- **Land Reclamation:** Several solar projects have been established on reclaimed mining lands, aiding in land restoration efforts.[19]

Challenges and Bottlenecks

Despite the progress, Jharkhand faces several challenges in scaling up its solar energy capacity:

Land Acquisition

Acquiring suitable land for large-scale solar projects remains a significant hurdle. The state's topography, characterized by forests and uneven terrain, limits the availability of flat, unencumbered land.

Grid Infrastructure

Jharkhand's power transmission and distribution infrastructure requires significant upgrades to accommodate increased solar energy integration. The state faces high transmission and distribution losses, estimated at 35.5% in 2021-22. [20]

Financial Constraints

Limited access to finance and high initial costs pose significant barriers to solar energy adoption, particularly for small-scale and residential projects. The state's per capita income, which was Rs82,430 in 2021-22,[21] is below the national average, making it challenging for many residents to invest in solar technologies.

Skill Gap

Despite ongoing training programs, there remains a shortage of skilled personnel in the solar energy sector, affecting various aspects of solar energy management, from installation and maintenance to policy formulation and implementation.

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Comparative Analysis

To contextualise the Jharkhand progress in solar energy, it's useful to compare it with neighboring states and the national average:

Table 7: Solar Capacity Comparison with Neighboring States (2023)

State	Installed Solar Capacity (MW)	Solar % of Total Power Capacity
Jharkhand	45	1.3%
Bihar	150	2.5%
West Bengal	180	1.8%
Odisha	530	4.2%
Chhattisgarh	290	2.1%
National Average	-	3.7%

Source: Ministry of New and Renewable Energy, 2023[22]

While Jharkhand lags behind some of its neighbors in terms of absolute capacity, it's important to note that the state has made significant progress given its starting point and unique challenges.

Future Outlook

Based on current trends and policy targets, the future outlook for solar energy in Jharkhand appears promising:

- **Capacity Projection:** If the state achieves its target of 4,000 MW by 2027, it would represent a compound annual growth rate (CAGR) of approximately 145% from 2023 to 2027.
- **Investment Forecast:** The Jharkhand government aims to attract investments worth Rs 20,000 crore in the solar sector by 2027. [23]
- **Job Creation:** The expansion of the solar sector is expected to create an additional 50,000 direct and indirect jobs by 2027. [24]
- **Technological Innovation:** Increased focus on emerging technologies like floating solar, agrivoltaics, and energy storage is likely to drive innovation in the sector.

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- **Rural Electrification:** The state plans to achieve 100% rural electrification through a combination of grid extension and off-grid solar solutions by 2025. [25]

Conclusion

The current status of solar energy in Jharkhand reflects a sector in transition, marked by significant potential and ambitious goals, but also faced with considerable challenges. While the installed capacity of 45 MW as of 2023 may seem modest, it represents substantial progress from where the state began its solar journey.

The Jharkhand State Solar Policy 2022, aligned with national renewable energy objectives, provides a robust framework for future growth. The diversification of solar installations across utility-scale, rooftop, and off-grid segments demonstrates a comprehensive approach to solar energy development.

Investments from both public and private sectors, including foreign direct investment, indicate growing confidence in the state's solar potential. Technological advancements, particularly in areas like floating solar and agrivoltaics, offer innovative solutions to land-use challenges.

However, the state must address significant hurdles, including land acquisition difficulties, grid infrastructure limitations, financial constraints, and the persistent skill gap. Overcoming these challenges will be crucial for Jharkhand to achieve its ambitious target of 4,000 MW by 2027.

The comparative analysis with neighboring states suggests that while Jharkhand has made progress, there is room for accelerated growth. The state's unique geographical and socio-economic context necessitates tailored strategies for solar energy development.

Looking ahead, the future of solar energy in Jharkhand appears promising, with projections indicating substantial capacity addition, increased investment, job creation, and technological innovation. If the state can successfully navigate its challenges and capitalize on its opportunities, it has the potential to become a significant contributor to India's renewable energy landscape.

In conclusion, while Jharkhand current solar energy status may be characterised as emerging rather than established, the foundations laid and the trajectories projected suggest a future where solar energy could play a transformative role in the state's power sector and overall development.

Reference

1. National Institute of Solar Energy. (2023). Solar Radiation Resource Assessment of India. Ministry of New and Renewable Energy, Government of India.

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2. Ministry of New and Renewable Energy. (2023). State-wise Installed Solar Power Capacity. Government of India.
3. Central Electricity Authority. (2023). All India Installed Capacity (in MW) of Power Stations. Ministry of Power, Government of India.
4. Jharkhand Renewable Energy Development Agency (JREDA). (2023). Annual Report 2022-2023. Government of Jharkhand.
5. Government of Jharkhand. (2022). Jharkhand State Solar Policy 2022. Department of Energy, Government of Jharkhand.
6. JREDA. (2023). Rooftop Solar Program Report 2022-2023. Government of Jharkhand.
7. Department of Agriculture, Government of Jharkhand. (2023). Solar Pump Scheme Progress Report.
8. Rural Electrification Corporation. (2023). Off-grid Solar Projects in Jharkhand: Status Report. Ministry of Power, Government of India.
9. Finance Department, Government of Jharkhand. (2019-2023). Jharkhand State Budget Documents (2019-20 to 2023-24).
10. Confederation of Indian Industry (CII). (2023). Renewable Energy Investment Report: Eastern India.
11. SoftBank Energy. (2022). Annual Report 2021-2022.
12. Enel Green Power. (2023). Sustainability Report 2022.
13. Jharkhand Urban Infrastructure Development Company (JUIDCO). (2023). Getalsud Reservoir Floating Solar Project: Status Update.
14. Indian Institute of Technology Dhanbad. (2023). Agrivoltaic Research Project: Annual Progress Report.
15. Power Grid Corporation of India Limited. (2023). Grid Connected Battery Storage Systems: Implementation Status.
16. Jharkhand Skill Development Mission. (2023). Annual Report 2022-2023. Government of Jharkhand.
17. National Skills Development Corporation. (2023). Skill Gap Study for the Solar Energy Sector in Jharkhand.
18. Ministry of Environment, Forest and Climate Change. (2023). State-wise CO2 Emission Reduction from Renewable Energy Projects. Government of India.

Citation : Govind Yadav, Dr Sandeep Kumar (2024). Solar Energy Management: Challenges and Opportunities in Jharkhand, **The Researchers** –July-December 2024, 10(2): 01-13. doi - 10.21276/tr.2024.10.2.AN1

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19. Jharkhand State Pollution Control Board. (2023). Environmental Impact Assessment of Solar Projects on Reclaimed Mining Lands.
20. Central Electricity Authority. (2023). Report on Performance of State Power Utilities 2021-2022. Ministry of Power, Government of India.
21. Directorate of Economics and Statistics, Government of Jharkhand. (2023). Economic Survey of Jharkhand 2022-2023.
22. Ministry of New and Renewable Energy. (2023). State-wise Renewable Energy Progress Report. Government of India.
23. Jharkhand Industrial and Investment Promotion Policy. (2021). Solar Sector Investment Targets 2021-2027. Department of Industries, Government of Jharkhand.
24. Skill Council for Green Jobs. (2023). Employment Projection Report: Renewable Energy Sector in Jharkhand.
25. Rural Electrification Corporation. (2023). Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) Progress Report: Jharkhand. Ministry of Power, Government of India.
26. Indian Renewable Energy Development Agency (IREDA). (2023). State-wise Financing for Renewable Energy Projects: Annual Report 2022-2023.
27. Bridge to India. (2023). India Solar Compass Q2 2023.
28. PV Magazine India. (2023). "Jharkhand's Solar Journey: Challenges and Triumphs." Special Report, August 2023.
29. World Bank. (2023). Regulatory Indicators for Sustainable Energy (RISE): India Country Profile.
30. International Renewable Energy Agency (IRENA). (2023). Renewable Energy and Jobs – Annual Review 2023.
31. Energy Statistics India. (2023). Annual Report. National Statistical Office, Ministry of Statistics and Programme Implementation, Government of India.
32. Council on Energy, Environment and Water (CEEW). (2023). State of the Low-Carbon Economy in Eastern India.
33. The Energy and Resources Institute (TERI). (2023). Renewable Energy Technology Status in India: State-wise Analysis.
34. Bloomberg New Energy Finance. (2023). India Renewable Energy Market Outlook 2023.

Citation : Govind Yadav, Dr Sandeep Kumar (2024). Solar Energy Management: Challenges and Opportunities in Jharkhand, **The Researchers** –July-December 2024, 10(2): 01-13. doi - 10.21276/tr.2024.10.2.AN1

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Date of Acceptance : 20 May 2024
DOI - 10.21276/tr.2024.10.2.AN1

35. Solar Energy Corporation of India (SECI). (2023). Tender and Auction Results: Jharkhand Solar Projects 2022-2023.
36. https://renewablewatch.in/2024/03/01/

Citation : Govind Yadav, Dr Sandeep Kumar (2024). Solar Energy Management: Challenges and Opportunities in Jharkhand, **The Researchers** –July-December 2024, 10(2): 01-13. doi - 10.21276/tr.2024.10.2.AN1