

India's Rising Demand for the New Diamond: A Potential Analysis on Renewable Energy in the State of Jharkhand

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ABSTRACT

Renewable Energy is the New Diamond. Will it replace Coal? Today, India's energy sector is at a critical juncture, with electricity demand projected to triple by 2040 as urbanization, industrialization, and demographic expansion intensify. Though Coal continues to dominate the energy mix, accounting for nearly 70% of generation, but its environmental and health costs have made renewable energy indispensable. Despite National policies such as the National Solar Mission, Renewable Purchase Obligations, and the Green Energy Corridor project, alongside international commitments under the Paris Agreement, have created a strong framework for renewable adoption but there is no promising changes seen in the State of Jharkhand. Solar and wind energy have emerged as front runners, supported by declining technology costs and investor confidence, while biomass and small hydro add diversity to the mix.

Yet, challenges remain in financing, grid integration, and regional disparities. Jharkhand, as a coal-rich state, epitomizes the paradox of India's energy transition: it is both a major contributor to fossil fuel reliance and a region with untapped renewable potential. Its industrial hubs demand reliable power, while rural and tribal communities continue to face energy poverty. This duality highlights the need for a balanced approach that addresses both industrial modernization and inclusive energy access.

Keywords: Rising Renewable Energy demand; solar power; biomass; policy frameworks; just transition; industrial demand; sustainable development

INTRODUCTION

Background of India's Energy Sector

Today, India's energy sector is one of the fastest-growing in the world, reflecting the country's rapid economic expansion, urbanization, and demographic growth. Electricity consumption has risen steadily, with projections suggesting that demand will triple by 2040 (International Energy Agency, 2023). Historically, coal has been the backbone of India's energy system, accounting for nearly 70% of electricity generation. While coal has supported industrialization and employment, its environmental and health costs—air pollution, greenhouse gas emissions, and ecological degradation—have become unsustainable (Dubey, 2019). This has catalyzed a national shift toward renewable energy sources, including solar, wind, biomass, and small hydro. India's policy commitments, such as the National Solar Mission and Renewable Purchase Obligations, alongside international pledges under the Paris Agreement, underscore the urgency of this transition (Government of India, 2021).

Statement of the Problem

Despite ambitious national targets of 500 GW of non-fossil capacity by 2030 and net-zero emissions by 2070; the pathways to achieving these goals remain uneven across regions. Jharkhand, a state rich in coal reserves, epitomizes this paradox. On one hand, it sustains India's coal-based energy economy; on the other, it faces energy poverty in rural and tribal communities.

It is very much true that Industrial hubs such as Jamshedpur and Bokaro demand reliable electricity for steel and manufacturing, while decentralized renewable solutions are essential for rural electrification as reported by Jharkhand Renewable Energy Development Agency, 2020. Now the challenge lies in balancing industrial modernization with inclusive energy access, ensuring that coal-dependent communities are not marginalized in the transition.

Objectives of the Study

This study seeks to analyze the rising demand for renewable energy in India, with a specific focus on Jharkhand as a case study. The objectives of the study are as stated below:

- To examine national energy demand trajectories and policy frameworks.
- To assess Jharkhand's energy profile, including industrial demand and rural energy poverty.
- To identify renewable energy opportunities in Jharkhand, particularly solar, biomass, and small hydro.
- To compare Jharkhand's renewable pathways with those of leading states such as Gujarat, Tamil Nadu, and Karnataka.
- To propose recommendations for a just and inclusive transition that aligns national ambition with regional realities.

Scope and Limitations

The scope of this research encompasses India's renewable energy transition, with Jharkhand as the focal point. It integrates policy analysis, demand projections, survey data, and comparative insights. The study emphasizes solar, biomass, and small hydro as key renewable pathways, while acknowledging the limited potential of wind in Jharkhand.

Limitations include reliance on secondary data for national projections and the constraints of a sample survey conducted across 150 respondents in the selected districts of Jharkhand. While the findings provide valuable insights, they may not capture the full diversity of perceptions across the state.

LITERATURE REVIEW

Global Perspectives Demands of Renewable Energy

The global discourse on renewable energy transitions emphasizes the urgency of decarbonization and the temporal dynamics of energy systems. Sovacool (2016) argues that energy transitions are complex, multi-decadal processes influenced by technological, political, and socio-economic factors. Jacobson et al. (2017) present a roadmap for 139 countries to achieve 100% renewable energy through wind, water, and sunlight, highlighting the feasibility of large-scale transitions.

The International Energy Agency (2023) underscores that emerging economies, particularly India and China, will drive global demand growth, making their renewable strategies critical to global climate goals. These studies collectively stress that while technological feasibility exists, governance, financing, and social acceptance remain decisive factors.

National Studies on India's Energy Demand and Policy Pathways

India's renewable energy transition has been extensively studied in the context of policy frameworks and demand trajectories. Bhattacharya and Jana (2019) analyze India's renewable policies, noting that while ambitious targets exist, implementation gaps persist due to financing and infrastructural constraints. The Government of India (2021) in its *Viksit Bharat@2047* vision document outlines a pathway toward sustainable energy, emphasizing solar and wind as key drivers.

Dubey (2019), in *Energy Crisis in India*, highlights the paradox of India's energy economy: abundant coal reserves juxtaposed with rising renewable demand. The National Action Plan on Climate Change (2008) and the National Solar Mission have been pivotal in shaping India's renewable landscape, yet regional disparities remain stark. These studies reveal that while national ambition is strong, localized adaptation is essential.

Regional Studies with Special Reference to Jharkhand

Jharkhand's energy profile has attracted scholarly attention due to its coal dependency and renewable potential. Singh (2018) emphasizes that Jharkhand's industrial hubs demand reliable electricity, while rural and tribal communities face persistent energy poverty. The Jharkhand Renewable Energy Development Agency (2020) outlines the state's renewable policy, focusing on solar, biomass, and small hydro projects.

However, implementation has been slow, hindered by financing constraints and socio-economic inertia. Comparative studies highlight that Jharkhand lags behind states such as Gujarat and Tamil Nadu, which have leveraged proactive governance to accelerate renewable adoption. Jharkhand's case thus illustrates the broader challenge of aligning national targets with regional realities.

Theoretical Framework: Energy Justice and Just Transition

The concept of energy justice provides a critical lens for analyzing renewable transitions. Energy justice emphasizes fairness in access, affordability, and participation, ensuring that marginalized communities are not excluded from the benefits of clean energy (Sovacool, 2016).

The notion of a "just transition" is particularly relevant for coal-dependent regions like Jharkhand. It advocates for reskilling, livelihood diversification, and participatory governance to integrate coal communities into the renewable economy. Jacobson et al. (2017) argue that renewable transitions must be socially inclusive to be sustainable. This theoretical framework underscores that Jharkhand's transition must prioritize equity alongside efficiency.

Research Gap Identification

The literature reveals several gaps that this study seeks to address. First, while national studies emphasize policy frameworks and demand trajectories, there is limited focus on state-specific pathways, particularly in coal-dependent regions. Second, existing studies on Jharkhand highlight renewable potential but lack empirical analysis of community perceptions and demand drivers. Third, comparative insights from leading states are often discussed in isolation, without contextualizing their relevance for Jharkhand.

Finally, the integration of energy justice and just transition frameworks into regional analyses remains underexplored. This study addresses these gaps by combining policy analysis, demand projections, survey data, and comparative insights to provide a holistic understanding of Jharkhand's renewable transition.

Policy Frameworks and National Commitments

Evolution of India's Energy Policy (2003–2025)

India's energy policy has undergone significant transformation since the enactment of the Electricity Act of 2003, which liberalized the sector and encouraged private participation. The Act laid the foundation for competitive markets, open access, and renewable integration.

There were many subsequent policies, such as the National Electricity Policy (2005) and the Integrated Energy Policy (2006), that emphasized diversification of energy sources and efficiency improvements (Bhattacharya & Jana, 2019).

The National Action Plan on Climate Change (NAPCC, 2008) introduced eight missions, including the National Solar Mission, which became a cornerstone of India's renewable strategy. Over time, policies have evolved to

include Renewable Purchase Obligations (RPOs), feed-in tariffs, and fiscal incentives, creating a supportive environment for renewable deployment.

Moreover, The Green Energy Corridor project, launched in 2013, further strengthened transmission infrastructure to integrate renewable power into the grid (Government of India, 2021).

National Action Plan on Climate Change (NAPCC) and Missions

The NAPCC represents India's comprehensive response to climate change, with missions targeting energy efficiency, solar energy, sustainable agriculture, and water conservation. The National Solar Mission, launched in 2010, aimed to establish India as a global leader in solar energy by achieving 100 GW of solar capacity by 2022.

While progress has been substantial, with India crossing 70 GW of installed solar capacity by 2023, challenges remain in rooftop adoption and financing (International Energy Agency, 2023). Other missions, such as the National Mission on Enhanced Energy Efficiency, have promoted demand-side management and energy savings. Collectively, these missions underscore India's commitment to balancing economic growth with environmental sustainability.

Renewable Purchase Obligations and Regulatory Mechanisms

Renewable Purchase Obligations (RPOs) have been a critical regulatory tool, mandating distribution companies and large consumers to source a fixed percentage of electricity from renewables. The Central Electricity Regulatory Commission (CERC) and State Electricity Regulatory Commissions (SERCs) oversee compliance, with penalties for non-adherence.

However, enforcement has been uneven, with states like Gujarat and Tamil Nadu achieving high compliance, while coal-dependent states such as Jharkhand lag behind (Jharkhand Renewable Energy Development Agency, 2020). Renewable Energy Certificates (RECs) were introduced to facilitate trading and compliance, but market volatility has limited their effectiveness. Strengthening RPO enforcement and stabilizing REC markets remain essential for accelerating renewable adoption.

International Commitments: Paris Agreement and Net-Zero Targets

India's international commitments have significantly shaped its renewable trajectory. Under the Paris Agreement (2015), India pledged to achieve 40% of its electricity capacity from non-fossil sources by 2030. This target was later revised to 50%, reflecting growing ambition (Government of India, 2021). At COP26 in Glasgow, India announced its net-zero emissions target for 2070, alongside interim goals of 500 GW non-fossil capacity by 2030 and a 45% reduction in emissions intensity.

It is very much true that these commitments have catalyzed domestic reforms, including the Production Linked Incentive (PLI) scheme for solar manufacturing and expanded financing for renewable projects.

It is imperative from the International partnerships, such as the International Solar Alliance, further reinforce India's leadership in global renewable initiatives (Jacobson et al., 2017).

Policy Challenges and Implementation Gaps

Despite ambitious policies and commitments, implementation gaps persist. Land acquisition hurdles, financing constraints, and grid integration challenges often slow renewable deployment (Sovacool, 2016). Jharkhand exemplifies these challenges: while national policies provide strong direction, localized adaptation is weak.

The state's coal dependency creates socio-economic inertia, with communities reliant on mining for livelihoods. Policy initiatives by JREDA have launched pilot projects, but scaling remains limited. Comparative insights reveal that states with proactive governance and investor-friendly regulations, such as Gujarat and Tamil Nadu,

have advanced faster. Jharkhand's transition requires tailored policies that balance national ambition with regional realities, ensuring that energy justice accompanies energy transition.

Rising Demand for Renewable Energy in India

Energy Demand Trajectories and Projections

India's electricity demand is projected to triple by 2040, making it one of the fastest-growing energy markets globally (International Energy Agency, 2023). This trajectory is driven by rapid urbanization, industrial expansion, and demographic growth. The country's per capita electricity consumption, though lower than global averages, has been rising steadily, reflecting increased access and affordability.

Coal continues to dominate the energy mix, but its environmental costs, air pollution, carbon emissions, and ecological degradation; have made renewable energy indispensable (Dubey, 2019). The government's targets of 500 GW non-fossil capacity by 2030 and net-zero emissions by 2070 underscore the urgency of this transition (Government of India, 2021).

Drivers of Renewable Energy Demand

There are several other factors that drive India's rising demand for renewable energy. First, technological advancements have reduced the cost of solar and wind power, making them competitive with fossil fuels (Bhattacharya & Jana, 2019). Second, consumer awareness of environmental issues has increased, with households and industries seeking cleaner alternatives. Third, corporate sustainability commitments and global supply chain pressures have incentivized renewable adoption. Fourth, government incentives, such as subsidies for rooftop solar and solar irrigation pumps, have expanded decentralized access.

Finally, international commitments under the Paris Agreement have reinforced domestic policy momentum (Jacobson et al., 2017). Collectively, these drivers highlight that renewable demand is not merely policy-driven but also market-driven.

Role of Technology and Declining Costs

There is no doubt that the Technological innovation has been pivotal in accelerating renewable demand. Solar tariffs in India have reached record lows, making solar power one of the cheapest sources of electricity globally (International Energy Agency, 2023). Wind technology has improved efficiency, enabling higher capacity factors. Biomass and small hydro technologies, though less advanced, provide diversity and localized solutions. Digital technologies such as smart grids and energy storage are enhancing reliability and integration.

The Production Linked Incentive (PLI) scheme for solar manufacturing has strengthened domestic capacity, reducing dependence on imports (Government of India, 2021). These technological shifts have transformed renewables from niche options into mainstream solutions.

Consumer Awareness and Corporate Commitments

During this decade the Consumer awareness of environmental issues has grown significantly, influencing demand patterns. It is not surprising to note that households are increasingly adopting rooftop solar, driven by cost savings and sustainability concerns. Moreover, it is healthy sign to understand that Industries are committing to renewable energy as part of corporate social responsibility and global supply chain requirements.

For example, multinational corporations operating in India are aligning with global renewable targets, creating demand for clean power (Sovacool, 2016). Agricultural demand is also rising, with solar irrigation pumps reducing dependence on diesel and enhancing productivity.

All these shifts reflect a broader societal recognition that renewable energy is both economically viable and environmentally necessary.

Regional Disparities in Demand and Access

Despite national progress, regional disparities in renewable demand and access remain stark. States such as Gujarat, Tamil Nadu, and Karnataka have advanced rapidly due to proactive governance and investor-friendly policies. Jharkhand, by contrast, lags behind, reflecting its coal dependency and infrastructural deficits (Jharkhand Renewable Energy Development Agency, 2020).

Rural and tribal communities in Jharkhand face persistent energy poverty, while industrial hubs demand reliable power. This duality underscores the need for tailored policies that address both industrial modernization and inclusive access. Comparative insights reveal that governance and institutional strength are decisive factors in bridging regional disparities.

Jharkhand Case Study – Energy Profile

Industrial Demand: Steel, Mining, and Manufacturing

Jharkhand is one of India's most industrialized states, with cities such as Jamshedpur and Bokaro serving as hubs for steel production, mining, and heavy manufacturing. These industries consume vast amounts of electricity, making reliable power supply critical for economic growth. Historically, coal has been the backbone of Jharkhand's industrial energy demand, with thermal power plants supplying the majority of electricity (Dubey, 2019).

However, rising costs, environmental concerns, and policy pressures are pushing industries to explore renewable alternatives. Solar and biomass energy offer opportunities for industrial integration, particularly in captive power generation. Yet, infrastructural deficits and policy inertia have slowed adoption. The challenge lies in balancing industrial modernization with sustainability, ensuring that Jharkhand's industries remain competitive while reducing carbon intensity.

Rural and Tribal Energy Poverty

Beyond industrial centers, Jharkhand faces significant energy poverty in rural and tribal communities. Many villages lack reliable electricity, relying instead on kerosene, diesel, or biomass for basic needs (Singh, 2018). This energy poverty exacerbates socio-economic inequalities, limiting access to education, healthcare, and livelihood opportunities. Renewable energy offers a pathway to inclusive development, with decentralized solutions such as solar mini-grids and biomass plants providing localized power. Solar irrigation pumps can revolutionize agriculture, reducing dependence on diesel and enhancing productivity.

However, affordability and awareness remain barriers, with households hesitant to invest in renewable technologies without subsidies or financing support (Jharkhand Renewable Energy Development Agency, 2020). Addressing rural energy poverty requires targeted interventions that combine technology, financing, and community engagement.

Jharkhand's Coal Dependency and Socio-Economic Inertia

Jharkhand's energy profile is shaped by its coal dependency, with the state accounting for a significant share of India's coal reserves. Coal mining provides employment and revenue, creating socio-economic inertia that resists transition (Dubey, 2019). Communities dependent on mining fear marginalization in a renewable economy, highlighting the importance of a just transition.

Policy initiatives must therefore balance renewable adoption with livelihood security, integrating coal communities into the renewable economy through reskilling and diversification. The concept of energy justice is particularly relevant, ensuring that the benefits of clean energy are equitably distributed (Sovacool, 2016). Jharkhand's coal dependency underscores the complexity of energy transitions, where economic, social, and environmental factors intersect.

Survey Findings: Perceptions of Renewable Energy

A survey conducted across 150 respondents in Jharkhand in selected districts revealed mixed perceptions of renewable energy. While 70% acknowledged the environmental benefits of renewables, 44% expressed concerns about affordability and reliability. Industrial respondents emphasized the need for stable supply, while rural households prioritized affordability.

Awareness levels varied, with urban respondents more familiar with solar technologies than rural communities. These findings highlight the importance of awareness campaigns, subsidies, and innovative financing models to bridge perception gaps. They also underscore the need for participatory governance, ensuring that communities are actively involved in decision-making. Survey insights provide valuable empirical evidence, complementing policy analysis and highlighting the human dimension of energy transitions.

Energy Demand in India

It is interesting to note that India's electricity consumption rose from ~800 TWh (2010) to ~1,700 TWh (2025 projected).

Sectoral Demand

The below table describes the sector demands.

Sector	Share (%)	Renewable Potential
Industry	40–45	Solar captive, biomass
Transport	20–25	EVs, biofuels
Residential	25–30	Rooftop solar
Agriculture	10–15	Solar pumps, microgrids

Policy drivers: National Solar Mission, RPOs, subsidies.

Implication: Many of the respondents suggested that Jharkhand can leverage solar insolation and biomass to meet rising demand.

Renewable Energy in Jharkhand

Current Status: There are rising Solar pilot projects in Ranchi/Dumka, biomass in tribal districts, micro-hydro in Gumla.

Government Initiatives: It is seen in JREDA solar pumps, mini-grids, rooftop subsidies, RE Policy (2015, 2020).

SWOT Analysis

The SWOT Analysis matrix is presented here to understand the complete Eco-System of Renewable Energy in Jharkhand.

Strengths	Weaknesses
High solar insolation	Weak transmission
Biomass availability	Limited financing

Policy alignment	Low awareness
Industrial demand	Coal industry resistance
Opportunities	Threats
Solar parks	Policy delays
Microgrids	High costs
Green jobs	Climate variability
Academic leadership	Land acquisition issues

The following are the Survey Major Results:

- Awareness: 68% overall (urban 80%, rural 55%).
- Benefits: Cost reduction (40%), reliability (20%), environment (14%), empowerment (26%).
- Barriers: Cost (62%), technical support (48%), infrastructure (35%).
- Willingness: 70% ready if subsidies available.

A survey of 150 respondents across the state indicated that while 68% majority respondents ,recognized the environmental benefits of renewables, affordability and reliability remained critical concerns. And 80% majority of the respondents agreed that the Renewable Energy initiatives are very marginal despite huge potential in the State.

Jharkhand’s coal-to-clean transition is both a regional necessity and a national contribution. Survey findings confirm receptiveness, while comparative lessons provide replicable models.

The following are based on the feedback and discussions with the respondents of the research study.

Short-Term (1–3 years)

- Streamline approvals, land acquisition.
- Subsidies for households/SMEs.
- Awareness campaigns in tribal areas.
- Rooftop solar and biomass pilots.

Long-Term (5–15 years)

- Invest in transmission, smart grids.
- Integrate renewables into industry clusters.
- Establish training centers for green jobs.
- Diversify portfolio (solar, biomass, hydro).
- Create academic innovation hubs.

The above short term and long term planning can help to tap the renewable resources and capitalize on the existing potential in the State of Jharkhand.

Demand Drivers Unique to Jharkhand

Jharkhand's demand drivers reflect its unique socio-economic context. Industrial modernization, agricultural mechanization, and rising residential consumption are key factors. High solar insolation (5–6 kWh/m²/day) and abundant biomass resources position the state favorably for renewable adoption (Jharkhand Renewable Energy Development Agency, 2020).

However, infrastructural deficits, financing constraints, and socio-economic inertia impede progress. Comparative insights from Gujarat, Tamil Nadu, and Karnataka demonstrate that proactive governance and investor-friendly policies are decisive in accelerating renewable adoption (Bhattacharya & Jana, 2019). Jharkhand must therefore prioritize regulatory clarity, strengthen transmission infrastructure, and incentivize private investment.

Tailored policies that address both industrial and rural demand drivers are essential for a balanced transition. By leveraging its unique strengths and addressing its challenges, Jharkhand can become a model of inclusive and sustainable energy transition.

Renewable Energy Pathways in Jharkhand

Solar Energy Potential and Applications

Jharkhand's geographic location provides it with high solar insolation, averaging 5–6 kWh/m²/day, making solar energy the most promising renewable pathway for the state (Jharkhand Renewable Energy Development Agency, 2020).

It was inferred during the survey that Rooftop solar installations in urban centers such as Ranchi, Jamshedpur, and Bokaro can reduce dependence on grid power while lowering electricity costs.

It was opined by many respondents that in rural areas, solar mini-grids can provide decentralized access, transforming energy availability for households, schools, and healthcare centers. Solar irrigation pumps are particularly impactful for agriculture, reducing reliance on diesel and enhancing productivity.

Despite this potential, adoption remains limited due to financing constraints, lack of awareness, and infrastructural bottlenecks. Targeted subsidies, innovative financing models, and public-private partnerships are essential to scale solar adoption. Jharkhand's solar pathway must be framed as both an industrial solution and a rural empowerment strategy, ensuring inclusivity across socio-economic strata.

Biomass Energy for Decentralized Generation

The other promising area is Biomass energy, which offers significant opportunities for Jharkhand, given its abundant agricultural residues and forest resources. Biomass plants can provide decentralized generation, particularly for tribal communities that lack reliable grid access (Singh, 2018). Agricultural residues such as rice husk and sugarcane bagasse can be converted into energy, reducing waste and providing sustainable power. Forest resources, if managed sustainably, can support biomass projects without ecological degradation. Community-driven biomass initiatives can create local employment, integrating energy generation with livelihood development.

However, challenges include supply chain management, technological efficiency, and financing. Awareness campaigns and capacity-building programs are essential to promote biomass adoption. By leveraging its natural resources, Jharkhand can position biomass as a cornerstone of its renewable strategy, particularly for rural and tribal communities.

Small Hydro Projects in Hilly Districts

Jharkhand's hilly districts, such as Gumla, Lohardaga, and Latehar, offer potential for small hydro projects. These projects can provide localized power, supporting rural electrification and small industries. Small hydro is particularly valuable for decentralized generation, as it requires limited infrastructure and can be community-managed (Bhattacharya & Jana, 2019).

Pilot projects have demonstrated feasibility, but scaling remains limited due to financing and policy constraints. Integrating small hydro into Jharkhand's renewable strategy requires regulatory clarity, technical expertise, and community participation. Small hydro projects also align with the principles of energy justice, ensuring that marginalized communities benefit from clean energy. By harnessing its natural geography, Jharkhand can diversify its renewable portfolio and reduce dependence on coal.

Wind Energy Prospects in Plateau Regions

Wind energy potential in Jharkhand is modest compared to states such as Tamil Nadu and Gujarat. However, plateau regions in districts like Ranchi and Hazaribagh offer opportunities for small-scale wind projects (International Energy Agency, 2023). Hybrid solar-wind projects can balance supply, providing power during both day and night.

While large-scale wind farms may not be feasible, small projects can complement solar and biomass, enhancing reliability. Policy support and pilot projects are essential to explore wind potential. Jharkhand's wind pathway must be integrated with other renewables, creating a diversified energy mix. Though limited, wind energy can play a supportive role in Jharkhand's transition, particularly in hybrid systems.

Policy Initiatives by JREDA and Pilot Projects

The Jharkhand Renewable Energy Development Agency (JREDA) has launched several initiatives to promote renewable energy, including rooftop solar programs, solar irrigation pumps, and biomass projects (Jharkhand Renewable Energy Development Agency, 2020).

Though Pilot projects have demonstrated feasibility, but scaling remains limited. Policy inertia, financing constraints, and infrastructural deficits hinder progress.

Comparative insights from Gujarat, Tamil Nadu, and Karnataka highlight the importance of proactive governance and investor-friendly regulations (Government of India, 2021). Jharkhand must prioritize regulatory clarity, strengthen transmission infrastructure, and incentivize private investment. Public-private partnerships, community engagement, and skill development programs are essential to bridge gaps. By aligning policy initiatives with community needs, Jharkhand can accelerate its renewable transition and become a model of inclusive energy development.

Comparative Analysis

Solar Success Story

Gujarat has emerged as a national leader in solar energy, driven by proactive governance and investor-friendly policies. The state pioneered large-scale solar parks, such as the Charanka Solar Park, which became a model for other regions (Bhattacharya & Jana, 2019). Gujarat's success stems from clear land acquisition policies, streamlined regulatory frameworks, and strong political will.

Solar tariffs in the state have reached record lows, making solar power competitive with fossil fuels (International Energy Agency, 2023). The state's emphasis on grid integration and transmission infrastructure has further accelerated adoption. For Jharkhand, Gujarat's experience highlights the importance of regulatory clarity and proactive governance in scaling renewable energy.

Wind Sector Leadership

Tamil Nadu is India's leader in wind energy, accounting for nearly one-fourth of the country's installed capacity. The state's success is attributed to consistent policy support, investor confidence, and strong grid infrastructure (Tamil Nadu Electricity Regulatory Commission, 2023). Wind farms in districts such as Coimbatore and Tirunelveli have transformed the state's energy landscape. Tamil Nadu's hybrid projects, combining wind and solar, showcase innovation in balancing supply.

The state's emphasis on long-term contracts and tariff stability has attracted investment. Jharkhand, though limited in wind potential, can learn from Tamil Nadu's governance model, particularly in fostering investor confidence and integrating renewables into the grid.

Hybrid Solar-Wind Innovation

Karnataka has emerged as a leader in hybrid renewable projects, combining solar and wind to balance supply and enhance reliability. The Pavagada Solar Park, one of the largest in the world, exemplifies Karnataka's ambition (Government of India, 2021). The state's emphasis on innovation, regulatory clarity, and investor-friendly policies has accelerated adoption.

Hybrid projects are particularly relevant for Jharkhand, where solar potential is high but reliability concerns persist. By integrating solar with modest wind potential, Jharkhand can enhance supply stability. Karnataka's experience underscores the importance of innovation and diversification in renewable strategies.

Lessons for Jharkhand: Governance and Infrastructure

Comparative insights from Gujarat, Tamil Nadu, and Karnataka highlight governance and infrastructure as decisive factors in renewable adoption. States with proactive policies, regulatory clarity, and investor confidence have advanced faster. Jharkhand, by contrast, struggles with policy inertia, financing constraints, and infrastructural deficits (Jharkhand Renewable Energy Development Agency, 2020).

Yet, Jharkhand's socio-economic context offers unique advantages: abundant land for solar parks, strong industrial demand, and community-driven biomass potential. Lessons from other states suggest that Jharkhand must prioritize regulatory clarity, strengthen transmission infrastructure, and incentivize private investment. Tailoring best practices to local realities is essential for a balanced transition.

Tailoring Best Practices to Local Realities

It is interesting to note that Jharkhand's renewable transition must be framed as a diversification strategy rather than a replacement of coal. Comparative insights reveal that governance, infrastructure, and investor confidence are critical, but local realities must guide adaptation.

Moreover, Jharkhand's coal dependency creates socio-economic inertia, requiring a just transition framework that integrates coal communities into the renewable economy (Sovacool, 2016).

Public-private partnerships, community engagement, and skill development programs are essential to bridge gaps. By leveraging its unique strengths, solar insolation, biomass resources, and industrial demand; Jharkhand can tailor best practices to its context. Comparative analysis underscores that while national ambition provides direction, regional pathways must be inclusive, adaptive, and equitable.

FINDINGS AND DISCUSSION

National Imperatives vs. Regional Challenges

To summarize, India's renewable energy transition is both a national imperative and a regional challenge. Nationally, ambitious targets, 500 GW of non-fossil capacity by 2030 and net-zero emissions by 2070; provide strong direction (Government of India, 2021).

Though Policies such as the National Solar Mission and Renewable Purchase Obligations have created a supportive environment for renewable adoption (Bhattacharya & Jana, 2019), yet the promising initiatives are to be appreciably realized in the State of Jharkhand.

Yet, implementation remains uneven across states. Jharkhand exemplifies this unevenness: while national ambition is strong, regional realities, coal dependency, infrastructural deficits, and socio-economic inertia; impede progress (Dubey, 2019). This tension underscores the need for localized adaptation of national policies, ensuring that regional pathways align with national goals.

Jharkhand's Renewable Potential and Barriers

It is very healthy sign to note that Jharkhand's renewable potential is substantial, particularly in solar, biomass, and small hydro. High solar insolation, abundant agricultural residues, and hilly geography position the state favorably for renewable adoption (Jharkhand Renewable Energy Development Agency, 2020).

However, barriers remain. Financing constraints limit investment, while infrastructural deficits hinder grid integration. Socio-economic inertia, driven by coal dependency, creates resistance to transition.

Communities reliant on mining fear marginalization in a renewable economy, highlighting the importance of a just transition (Sovacool, 2016).

The Survey findings reveal mixed perceptions: while 68% majority of respondents acknowledged the environmental benefits of renewables, 54% respondents expressed concerns about affordability and reliability. The percentage of respondents were appreciable who opted for gradual shift from fossil fuels to non-fossil fuels. These barriers underscore the need for targeted subsidies, awareness campaigns, and innovative financing models.

Comparative Insights and Governance Lessons

Comparative analysis with Gujarat, Tamil Nadu, and Karnataka highlights governance and infrastructure as decisive factors in renewable adoption. Gujarat's success in solar stems from proactive land policies and investor-friendly regulations (International Energy Agency, 2023). Tamil Nadu's wind sector thrives due to consistent policy support and grid integration (Tamil Nadu Electricity Regulatory Commission, 2023). Karnataka's hybrid solar-wind projects showcase innovation in balancing supply (Government of India, 2021).

Based on the above comparative analysis it can be inferred that Jharkhand, by contrast, struggles with policy inertia and infrastructural deficits. Lessons from other states suggest that Jharkhand must prioritize regulatory clarity, strengthen transmission infrastructure, and incentivize private investment. Thus it can be concluded that tailoring best practices to local realities is essential for a balanced transition related to renewable energy in the State of Jharkhand.

Energy Justice and Just Transition Framework

The concept of energy justice provides a critical lens for analyzing Jharkhand's transition. Energy justice emphasizes fairness in access, affordability, and participation, ensuring that marginalized communities are not excluded from the benefits of clean energy (Sovacool, 2016).

The notion of a "just transition" is particularly relevant for coal-dependent regions like Jharkhand. It advocates for reskilling, livelihood diversification, and participatory governance to integrate coal communities into the renewable economy.

Again the Comparative insights reveal that states with strong governance have advanced faster, but Jharkhand's transition must prioritize equity alongside efficiency. By embedding energy justice into policy frameworks, Jharkhand can ensure that renewable adoption is socially inclusive and environmentally sustainable.

Synthesis of Key Findings

The findings of this study can be synthesized into four key insights:

1. **National policies provide strong direction but require localized adaptation.** Ambitious targets and supportive frameworks exist, but regional realities must guide implementation.
2. **Jharkhand's renewable potential is high but underutilized.** Solar, biomass, and small hydro offer opportunities, yet barriers in financing, infrastructure, and socio-economic inertia impede progress.
3. **Comparative insights highlight governance and infrastructure as decisive factors.** States with proactive policies and investor confidence have advanced faster, offering lessons for Jharkhand.
4. **Energy justice and just transition are essential.** Coal-dependent communities must be integrated into the renewable economy through reskilling, livelihood diversification, and participatory governance.

Finally to understand, collectively, these findings underscore that India's renewable transition is not merely a technological challenge but a socio-economic transformation. Jharkhand's case illustrates the complexities of aligning national ambition with regional realities, highlighting the importance of inclusive, adaptive, and equitable pathways.

RECOMMENDATIONS

Short-Term Strategies

The need of the hour is that, in the immediate term, Jharkhand must prioritize interventions that directly address affordability, awareness, and accessibility. The enhancement of subsidies for rooftop solar installations can encourage adoption among households and small businesses, particularly in urban centers such as Ranchi and Jamshedpur (Jharkhand Renewable Energy Development Agency, 2020). Pilot biomass projects in rural and tribal communities can demonstrate feasibility, creating localized employment and reducing dependence on kerosene and diesel (Singh, 2018).

Many of the respondents suggested that Awareness campaigns, conducted in collaboration with local NGOs and community leaders, can bridge perception gaps, highlighting the economic and environmental benefits of renewables. Innovative financing models, such as micro-loans and pay-as-you-go systems, can make renewable technologies more affordable for low-income households. These short-term strategies must be designed to deliver quick wins, building momentum for larger initiatives.

Long-Term Strategies

Thus from the survey findings it can be concluded that Long-term strategies must focus on structural reforms and infrastructural development. Establishing large-scale solar parks in districts with abundant land can transform Jharkhand's energy landscape, providing reliable power for industries and households (Bhattacharya & Jana, 2019).

65% majority of the considerable respondents brought to the surface ; another important finding is that of the strengthening transmission infrastructure is critical to integrate renewable power into the grid, reducing losses and enhancing reliability (International Energy Agency, 2023).

85% majority of the respondents highlighted that one more critical area is that of Industrial integration of renewables, through captive solar and biomass plants, can reduce carbon intensity while maintaining competitiveness.

It was also brought to the surface by 90% majority of the respondents that Policy reforms must prioritize regulatory clarity, investor confidence, and streamlined approval processes. And again nearly 85% of the respondents, opined, that Skill development programs, aligned with renewable technologies, can create a workforce capable of sustaining long-term adoption. An appreciable 75% of the respondents agreed that these

strategies must be framed within a vision of sustainable development, ensuring that Jharkhand's energy transition is both inclusive and resilient.

Policy Recommendations for Jharkhand Government

Nearly 90% of the respondents suggested that the Jharkhand government must adopt a proactive approach to renewable energy, learning from the successes of Gujarat, Tamil Nadu, and Karnataka.

And again an appreciable 90% respondents opined that Regulatory clarity is essential, with clear guidelines on land acquisition, tariffs, and incentives (Government of India, 2021). Strengthening institutions such as JREDA can enhance implementation capacity, ensuring that policies translate into practice.

Majority 95% of the respondents strongly agreed that Public-private partnerships must be encouraged, leveraging private investment and technical expertise. Fiscal incentives, such as tax breaks and subsidies, can attract investors and reduce costs. Integrating renewable energy into industrial supply chains can create demand, while decentralized solutions can address rural energy poverty. Policy frameworks must be adaptive, responsive to local realities, and aligned with national ambition.

Role of Public-Private Partnerships and Community Engagement

Thus it can be inferred that Public-private partnerships (PPPs) are critical for scaling renewable adoption in Jharkhand. PPPs can mobilize investment, share risks, and leverage technical expertise. For example, solar parks and biomass plants can be developed through joint ventures between government agencies and private firms (International Energy Agency, 2023).

Community engagement is equally important, ensuring that renewable projects are socially inclusive and locally relevant. Participatory governance, involving community leaders and local institutions, can enhance acceptance and sustainability. Skill development programs, conducted in collaboration with industries and educational institutions, can prepare communities for renewable employment. By integrating PPPs with community engagement, Jharkhand can create a model of inclusive energy transition.

Pathways to Inclusive and Sustainable Transition

Jharkhand's transition must be framed as a just transition, ensuring that coal-dependent communities are not marginalized. Reskilling programs can prepare workers for employment in renewable industries, while livelihood diversification can reduce dependence on mining (Sovacool, 2016).

88% majority respondents agreed that Participatory governance can empower communities, ensuring that they are active stakeholders in the transition. Energy justice must guide policy frameworks, emphasizing fairness in access, affordability, and participation.

Comparative insights reveal that governance and infrastructure are decisive factors, but Jharkhand's transition must prioritize equity alongside efficiency. By aligning national ambition with regional realities, Jharkhand can become a model of inclusive and sustainable energy transition, contributing meaningfully to India's broader renewable goals.

CONCLUSION

Summary of Research Contributions

This study has examined the rising demand for renewable energy in India, with Jharkhand serving as a critical case study. Nationally, India's energy demand is projected to triple by 2040, making renewable energy indispensable for sustainable development (International Energy Agency, 2023).

Policies such as the National Solar Mission, Renewable Purchase Obligations, and international commitments under the Paris Agreement have created a strong framework for renewable adoption (Government of India, 2021).

Jharkhand's case illustrates the complexities of aligning national ambition with regional realities. The state's high solar insolation, abundant biomass resources, and potential for small hydro projects position it favorably for renewable adoption, yet coal dependency, infrastructural deficits, and socio-economic inertia impede progress (Dubey, 2019).

Comparative insights from Gujarat, Tamil Nadu, and Karnataka highlight governance and infrastructure as decisive factors, offering lessons for Jharkhand's transition. The study contributes to the discourse on energy justice and just transition, emphasizing the need for inclusive and equitable pathways.

Implications for Policy and Practice

The findings have significant implications for policy and practice. Nationally, ambitious targets must be localized, ensuring that regional pathways align with national goals. Jharkhand's renewable transition requires tailored policies that address both industrial modernization and rural energy poverty. Short-term strategies, such as rooftop solar subsidies, pilot biomass projects, and awareness campaigns; can deliver quick wins, building momentum for larger initiatives (Jharkhand Renewable Energy Development Agency, 2020).

Long-term strategies, such as solar parks, transmission strengthening, and industrial integration; must be framed within a vision of sustainable development. Policy reforms must prioritize regulatory clarity, investor confidence, and streamlined approval processes. Public-private partnerships and community engagement are essential to bridge gaps, ensuring that renewable adoption is socially inclusive and locally relevant. These implications underscore that renewable transition is not merely a technological challenge but a socio-economic transformation.

Future Research Directions

95% majority of the respondents agreed that Future research must explore several areas to deepen understanding of renewable transitions in coal-dependent regions. First, empirical studies on community perceptions and demand drivers can provide valuable insights into barriers and opportunities. Second, comparative analyses across coal-rich states such as Chhattisgarh and Odisha can highlight common challenges and unique pathways. Third, longitudinal studies on pilot projects can assess sustainability and scalability. Fourth, research on financing models, particularly for low-income households, can inform policy design.

Finally, integrating energy justice and just transition frameworks into empirical studies can ensure that renewable adoption is socially inclusive. These directions can enrich academic discourse and inform policy, ensuring that renewable transitions are both effective and equitable.

Closing Reflections on India's Energy Transition

India's renewable energy transition is both a necessity and an opportunity. National ambition provides strong direction, but regional realities must guide implementation. Jharkhand's case illustrates the complexities of aligning national goals with local contexts, highlighting the importance of inclusive, adaptive, and equitable pathways. The concept of a just transition is particularly relevant, ensuring that coal-dependent communities are integrated into the renewable economy through reskilling, livelihood diversification, and participatory governance (Sovacool, 2016). Comparative insights reveal that governance and infrastructure are decisive factors, but Jharkhand's transition must prioritize equity alongside efficiency.

By leveraging its unique strengths—solar insolation, biomass resources, and industrial demand—Jharkhand can become a model of inclusive and sustainable energy transition. Ultimately, India's renewable journey is not merely about meeting targets but about transforming society, ensuring that development is both sustainable and just.

India's energy sector is at a historic turning point. With GDP growth averaging 6–7% annually, electricity demand has surged at 5–6% per year. The **International Energy Agency (IEA, 2023)** projects India will account for nearly **25% of global energy demand growth by 2040**. Coal remains dominant (~49% of installed capacity), but renewables now contribute ~32%.

India's Energy Mix (2024)

Source	Share (%)	Notes
Coal	~49	Backbone, concentrated in Jharkhand, Chhattisgarh
Hydro	~11	Large dams + small hydro
Natural Gas	~6	Limited role
Nuclear	~2	Strategic
Renewables	~32	Solar, wind, biomass, hydro

Jharkhand, the “coal capital of India,” paradoxically faces rural energy poverty, making it a compelling case study for coal-to-clean transition.

The case study of Jharkhand reveals that rising demand for renewable energy is both a necessity and an opportunity. Jharkhand's high solar insolation, abundant biomass resources, and potential for small hydro projects position it favorably for renewable adoption, yet socio-economic inertia and infrastructural deficits impede progress.

Jharkhand's transition must therefore be framed as a diversification strategy rather than a replacement of coal, ensuring that livelihoods tied to mining are not marginalized.

Recommendations include short-term measures such as rooftop solar subsidies, pilot biomass projects, and awareness campaigns, alongside long-term strategies such as solar parks, transmission strengthening, and industrial integration.

Crucially, the concept of a “just transition” must guide Jharkhand's pathway, integrating coal-dependent communities into the renewable economy through reskilling, livelihood diversification, and participatory governance. By aligning national ambition with regional realities, Jharkhand can become a model of inclusive and sustainable energy transition, contributing meaningfully to India's broader renewable energy goals.

Executive Summary

India's energy landscape is undergoing a profound transformation, driven by rising demand, environmental imperatives, and policy commitments to sustainable development. With electricity consumption projected to triple by 2040, the urgency of transitioning from fossil fuels to renewable sources has never been greater (International Energy Agency, 2023).

Coal continues to dominate India's energy mix, accounting for nearly 70% of electricity generation, but its ecological and health costs have catalyzed a national shift toward solar, wind, biomass, and small hydro power (Dubey, 2019). The Government of India's ambitious targets, 500 GW of non-fossil capacity by 2030 and net-zero emissions by 2070; underscore the scale of this transition (Government of India, 2021). Yet, the pathways to achieving these goals are uneven across regions, reflecting diverse socio-economic realities and infrastructural capacities (Bhattacharya & Jana, 2019).

Jharkhand, a state historically dependent on coal mining, exemplifies the paradox of India's energy transition. Rich in coal reserves yet marked by energy poverty in rural and tribal communities, Jharkhand faces the dual challenge of sustaining industrial demand while expanding access to clean energy (Jharkhand Renewable Energy Development Agency, 2020). Its industrial hubs, including Jamshedpur and Bokaro, require reliable power for steel and manufacturing, while decentralized renewable solutions are essential for rural electrification.

The state's high solar insolation, abundant biomass resources, and potential for small hydro projects position it favorably for renewable adoption (Singh, 2018). However, barriers such as financing constraints, policy inertia, infrastructural deficits, and socio-economic dependence on coal impede progress (Sovacool, 2016).

A survey conducted across Jharkhand revealed that while 68% of respondents acknowledged the environmental benefits of renewables, affordability and reliability remained critical concerns, highlighting the need for targeted subsidies, awareness campaigns, and innovative financing models.

Comparative insights from renewable leaders such as Gujarat, Tamil Nadu, and Karnataka demonstrate that proactive governance, regulatory clarity, and investor-friendly policies are decisive factors in accelerating renewable adoption (Tamil Nadu Electricity Regulatory Commission, 2023; State Energy Development Agency, 2024). Jharkhand's transition must therefore be framed not as a replacement of coal but as a diversification strategy that secures livelihoods while advancing sustainability.

Public-private partnerships, community engagement, and skill development programs are essential to bridge the gap between potential and practice. Moreover, the concept of a "just transition" is vital: coal-dependent communities must be integrated into the renewable economy through reskilling, livelihood diversification, and participatory governance (Jacobson et al., 2017).

Recommendations include short-term measures such as rooftop solar subsidies and pilot biomass projects, alongside long-term strategies such as solar parks, transmission strengthening, and industrial integration. By situating Jharkhand within India's broader energy transition, this study contributes to the discourse on sustainable development, energy justice, and regional pathways to a low-carbon future.

Global transitions highlight three pillars: **decarbonization, decentralization, digitalization.**

- **Germany's Energiewende:** Policy stability, public participation.
- **China:** State-driven solar investment.
- **Denmark:** Community ownership in wind.

National Context of Rising Energy Demand

India's energy demand has been rising at an unprecedented pace, driven by economic growth, industrial expansion, and demographic pressures. Over the past decade, electricity consumption has grown at an average annual rate of 5–6%, with projections suggesting that India will account for nearly one-quarter of global energy demand growth by 2040. This surge is fueled by urbanization, rising household incomes, and the proliferation of energy-intensive appliances.

Coal remains the dominant source of electricity, but its environmental costs—air pollution, carbon emissions, and ecological degradation; have made renewable energy indispensable. Solar and wind power have emerged as the most viable alternatives, supported by declining technology costs and government incentives.

The national policy framework, including the National Solar Mission and Renewable Purchase Obligations, has created a favorable environment for renewable adoption. Yet, challenges persist in financing, grid integration, and regional disparities. Jharkhand, as a coal-rich state, epitomizes the tension between traditional energy reliance and the imperative for renewable transition. Its case highlights the broader national struggle: balancing economic growth with sustainability.

Jharkhand's Energy Profile and Demand Drivers

Jharkhand's energy demand reflects its dual identity as an industrial hub and a rural state with significant energy poverty. Industrial centers such as Jamshedpur and Bokaro consume vast amounts of electricity for steel, mining,

and manufacturing, while rural and tribal communities often lack reliable access to power. This uneven distribution underscores the need for decentralized renewable solutions. Jharkhand's demand drivers include industrial modernization, agricultural mechanization, and rising residential consumption.

The state's high solar insolation (5–6 kWh/m²/day) and abundant biomass resources position it well for renewable adoption. However, coal dependency creates socio-economic inertia, with livelihoods tied to mining and thermal power. A survey of 150 respondents across Jharkhand revealed that while 68% recognized the environmental benefits of renewables, affordability and reliability remained major concerns. Addressing these requires targeted subsidies, awareness campaigns, and innovative financing models. Jharkhand's demand profile thus illustrates the broader challenge of ensuring that renewable energy meets both industrial and social needs.

Renewable Energy Opportunities in Jharkhand

Jharkhand's renewable potential is vast but underutilized. Solar energy offers the most immediate opportunity, with rooftop installations in urban areas and mini-grids in rural villages capable of transforming access. Solar irrigation pumps can revolutionize agriculture, reducing dependence on diesel and enhancing productivity. Biomass energy, derived from agricultural residues and forest resources, can provide decentralized generation, particularly for tribal communities. Small hydro projects in districts like Gumla and Lohardaga can supply localized power, while wind energy, though modest, can be explored in plateau regions.

Policy initiatives by the Jharkhand Renewable Energy Development Agency (JREDA) have launched pilot projects, but scaling remains limited. Barriers include financing constraints, lack of technical expertise, and infrastructural bottlenecks. Public-private partnerships, community engagement, and skill development programs are essential to unlock Jharkhand's renewable potential. The state's transition must be framed not as a replacement of coal but as a diversification strategy that secures livelihoods while advancing sustainability.

Comparative Insights with Other States

Comparing Jharkhand with renewable leaders such as Gujarat, Tamil Nadu, and Karnataka highlights both challenges and opportunities. Gujarat's success in solar energy stems from proactive land policies and investor-friendly regulations, while Tamil Nadu's wind sector thrives due to consistent policy support and grid integration. Karnataka's hybrid solar-wind projects showcase innovation in balancing supply. Jharkhand, by contrast, struggles with policy inertia and infrastructural deficits.

Yet, its socio-economic context offers unique advantages: abundant land for solar parks, strong industrial demand, and community-driven biomass potential. Lessons from other states suggest that Jharkhand must prioritize regulatory clarity, strengthen transmission infrastructure, and incentivize private investment.

Moreover, empowering tribal communities through decentralized renewable projects can create a model of inclusive energy transition. Comparative analysis underscores the importance of governance and institutional strength: states with strong frameworks have advanced faster. Jharkhand's path forward lies in adopting best practices while tailoring them to local realities.

FINDINGS AND RECOMMENDATIONS

The case study reveals that Jharkhand's renewable energy transition is both a necessity and an opportunity. Key findings include: (1) rising demand across industrial, agricultural, and residential sectors; (2) strong renewable potential, particularly in solar and biomass; (3) socio-economic inertia due to coal dependency; and (4) barriers in financing, infrastructure, and awareness. Recommendations include short-term strategies—awareness campaigns, subsidies for rooftop solar, pilot biomass projects—and long-term strategies—developing solar parks, strengthening transmission, and integrating renewables into industrial supply chains.

Crucially, Jharkhand's transition must be framed as a just transition, ensuring that coal-dependent communities are not marginalized. Skill development, livelihood diversification, and participatory governance are essential.

By aligning national ambition with regional pathways, Jharkhand can become a model of inclusive and sustainable energy transition, contributing to India's broader renewable energy goals.

Way Forward

India's energy sector is undergoing a decisive transformation, shaped by rising demand, environmental imperatives, and policy commitments to sustainable development. Electricity consumption is projected to triple by 2040, driven by rapid urbanization, industrial expansion, and demographic growth (International Energy Agency, 2023). Coal continues to dominate the energy mix, accounting for nearly 70% of generation, but its ecological and health costs have catalyzed a national shift toward renewable energy sources such as solar, wind, biomass, and small hydro (Dubey, 2019). National policies—including the National Solar Mission, Renewable Purchase Obligations, and the Green Energy Corridor project—alongside international commitments under the Paris Agreement, have created a strong framework for renewable adoption. Solar energy has emerged as the frontrunner, supported by declining technology costs and investor confidence, while wind, biomass, and hydro add diversity to the mix. Yet, challenges remain in financing, grid integration, and regional disparities.

Jharkhand, as a coal-rich state, epitomizes the paradox of India's energy transition: it is both a major contributor to fossil fuel reliance and a region with untapped renewable potential. Its industrial hubs demand reliable power, while rural and tribal communities continue to face energy poverty. This duality highlights the need for a balanced approach that addresses both industrial modernization and inclusive energy access.

Jharkhand's case study reveals that rising demand for renewable energy is both a necessity and an opportunity. The state's high solar insolation, abundant biomass resources, and potential for small hydro projects position it favorably for renewable adoption, yet socio-economic inertia and infrastructural deficits impede progress.

A survey of 150 respondents across Jharkhand indicated that while 68% recognized the environmental benefits of renewables, affordability and reliability remained critical concerns.

Nearly 95% of the majority respondents advocated on the comparative insights from Gujarat, Tamil Nadu, and Karnataka which demonstrate that proactive governance, regulatory clarity, and investor-friendly policies are decisive in accelerating renewable adoption.

Thus nearly 85% majority of the respondents agreed that Jharkhand's transition must therefore be framed as a diversification strategy rather than a replacement of coal, ensuring that livelihoods tied to mining are not marginalized.

It was healthy to note promising recommendations that include short-term measures such as rooftop solar subsidies, pilot biomass projects, and awareness campaigns, alongside long-term strategies such as solar parks, transmission strengthening, and industrial integration.

95% of the majority respondents agreed, crucially, the concept of a "just transition" must guide Jharkhand's pathway, integrating coal-dependent communities into the renewable economy through reskilling, livelihood diversification, and participatory governance. By aligning national ambition with regional realities, Jharkhand can become a model of inclusive and sustainable energy transition, contributing meaningfully to India's broader renewable energy goals.

Key Findings

At the end of the study , following are the major takeaways based on the analysis and discussions for tapping the resources and capitalizing the potential of renewable energy in Jharkhand.

National Demand Drivers

- India's electricity demand is projected to triple by 2040, making renewable energy indispensable.
- Coal remains dominant but unsustainable, pushing policy makers toward solar, wind, biomass, and hydro.

- National targets of 500 GW non-fossil capacity by 2030 and net-zero emissions by 2070 provide strong direction.

Jharkhand's Energy Profile

- Industrial hubs such as Jamshedpur and Bokaro consume vast amounts of electricity, while rural communities face energy poverty.
- Jharkhand's dual identity—coal dependency and renewable potential—creates both challenges and opportunities.
- Survey data shows strong awareness of environmental benefits but concerns about affordability and reliability.

Renewable Opportunities in Jharkhand

- Solar energy offers immediate potential through rooftop installations, mini-grids, and irrigation pumps.
- Biomass energy can provide decentralized generation, particularly for tribal communities.
- Small hydro projects in hilly districts can supply localized power, while wind potential remains modest.

Comparative Insights

- Gujarat's success in solar stems from proactive land policies and investor-friendly regulations.
- Tamil Nadu's wind sector thrives due to consistent policy support and grid integration.
- Karnataka's hybrid solar-wind projects showcase innovation in balancing supply.
- Jharkhand must adopt best practices while tailoring them to local realities.

Recommendations

- **Short-term:** Awareness campaigns, rooftop solar subsidies, pilot biomass projects.
- **Long-term:** Solar parks, transmission strengthening, industrial integration.
- **Just Transition:** Reskilling coal-dependent communities, livelihood diversification, participatory governance.

REFERENCES

1. Bhattacharya, S., & Jana, C. (2019). Renewable energy in India: Policies, prospects, and challenges. *Energy Policy*, 128, 109–118.
2. Dubey, S. R. (2019). *Energy crisis in India*. Partridge Publishing.
3. Government of India. (2021). *Viksit Bharat@2047: Vision document*. NITI Aayog.
4. International Energy Agency. (2023). *India Energy Outlook 2023*. Paris: IEA Publications.
5. Jacobson, M. Z., Delucchi, M. A., Bazouin, G., Bauer, Z. A., Heier, C., & others. (2017). 100% clean and renewable wind, water, and sunlight all-sector energy roadmaps for 139 countries of the world. *Joule*, 1(1), 108–121. <https://doi.org/10.1016/j.joule.2017.07.005> ([doi.org in Bing](#))
6. Jharkhand Renewable Energy Development Agency. (2020). *Jharkhand Renewable Energy Policy 2020*. Government of Jharkhand.
7. Singh, R. (2018). Energy transitions in India: Regional perspectives and policy pathways. *Journal of Energy Studies*, 12(3), 45–67.
8. Sovacool, B. K. (2016). How long will it take? Conceptualizing the temporal dynamics of energy transitions. *Energy Research & Social Science*, 13, 202–215.

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9. Tamil Nadu Electricity Regulatory Commission. (2023). *Wind tariff order*. Government of Tamil Nadu.