Roadmap for an equitable Green Economic Diversification in Jharkhand

Technical Brief

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CLIMATE POLICY INITIATIVE

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ABOUT CPI

CPI is an analysis and advisory organization with deep expertise in finance and policy. Our mission is to help governments, businesses, and financial institutions drive economic growth while addressing climate change. CPI has offices in Brazil, India, Indonesia, South Africa, the United Kingdom, and the United States.

EXECUTIVE SUMMARY

As India moves steadily toward a net-zero future, the coming years would be important for the state of Jharkhand to define its transition process. While the state has historically relied on solid fossil fuel mining and associated industrial activity, national decarbonization objectives imply that solid fossil fuel demand for the power sector could peak between 2030 & 2035 (MoC 2022) and decline thereafter. This shift unlocks a new wave of growth which can be built on clean & green technologies, advanced manufacturing, and strategic investment in people and infrastructure. Jharkhand's industrial legacy, skilled workforce and natural resource availability provide a strong foundation for leading India's green economy transformation.

KEY FINDINGS

Jharkhand is well-positioned to build powerful new engines of economic growth by leveraging opportunities in green and emerging sectors such as clean power generation, green molecules, electric mobility, and equipment manufacturing. The state's mineral strengths, industrial capabilities, and strategic market access enable competitive industrial clusters for solar PV, energy storage, biofuels, hydrogen, and electric vehicle (EV) component production. These industries offer high-value investment, future-ready technology development, and deeper domestic value-chain capture, and can shift the state from a raw-material supplier to a clean-tech manufacturing hub. Coordinated policies and timely capital deployment could anchor these sectors in a resilient and modernized economy, that scales new revenue streams while accelerating industrial innovation and sustainability. Key findings of our analysis are following:

1. Green and emerging sectors can become major economic engines

High-potential diversification opportunities include renewable power deployment, green molecules (biofuels, hydrogen, ammonia), electric mobility and logistics, and green equipment manufacturing (solar modules and battery systems). These sectors combine value addition, technological advancement, and deeper local supply-chain development—anchoring new long-term revenue streams.

2. New job creation can exceed solid fossil-fuel linked employment through planned transition

New job opportunities could scale rapidly through the development of manufacturing and micro-, small-, and medium-sized enterprises (MSMEs). With structured reskilling and redeployment programs, workers can transition into industrial, construction, logistics, and green technology roles that offer improved income security and formalisation.

3. Estimated investments of USD 41.4 billion required

Revenue impacts from the decline in solid fossil fuels in the conventional power sector can potentially be substituted by a diversified green portfolio through timely mobilisation of investments. Potential state tax revenue sources, springing from targeted investments, include:

Figure ES 1: Revenue substitution potential of key green sectors:

Green molecules:	USD 21.8 billion investment could lead to USD 350 million in annual tax revenue for the state.
Sustainable Mobility and Components:	USD 14.3 billion investment could lead to USD 680 million in annual tax revenue for the state.
Green Equipment Manufacturing:	USD 5.3 billion investment could lead to USD 403 million in annual tax revenue for the state.

As per CPI analysis, collectively, these sectors could generate an estimated state tax revenue of USD 1.43 billion per year.

KEY RECOMMENDATIONS

To navigate this shift effectively, Jharkhand could adopt a formal statewide Green Transition plan characterized by five-year action cycles and strong cross-departmental participation. This strategy could leverage the state's existing mineral and industrial strengths to position Jharkhand as a manufacturing hub for green manufacturing, ensuring value chains are developed locally. The key recommendation of our analysis is shown in the figure ES 2:

Figure ES 2: Key recommendations

- **Adopt a statewide Green Transition plan**
- **Prioritize diversification in mining-focused districts**
- **Accelerate workforce transition programs**
- **Protect community welfare during the transition**
- **Strengthen enabling infrastructure**
- **Leverage industrial and mineral strengths**
- **Deploy a dedicated transition financing framework**

Scaling these ambitions requires a skilled workforce and strengthening of the enabling infrastructure, including fast-tracking power transmission, industrial parks, and logistics corridors, alongside permitting reforms to reduce investor risk. Underpinning this transformation is the need for a dedicated transition financing framework that could utilize fossil fuel revenues and public finance to crowd-in private capital through blended mechanisms. To further delve into these mechanisms, CPIs next publication in this series will focus on a "**Just Transition Financing Framework**", outlining specific mechanisms to mobilize the capital required for Jharkhand's green economic transformation.

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LIST OF ABBREVIATIONS

Bn	Billion
CCL	Central Coalfields Limited
CIL	Coal India Limited
CSR	Corporate Social Responsibility
DMF	District Mineral Foundation
ECL	Eastern Coalfields Limited
EV	Electric Vehicle
GoI	Government of India
GST	Goods & Services Tax
GW	Gigawatt
GWh	Gigawatt-hour
ILO	International Labour Organization
MMTPA	Million Metric Tons Per Annum
Mn	Million
MoC	Ministry of Coal
MoEFCC	Ministry of Environment, Forest and Climate Change
MoSPI	Ministry of Statistics and Programme Implementation
MSME	Micro, Small and Medium Enterprises
MT	Million Tonne
MW	Megawatt
NZ	Net zero
PSU	Public Sector Undertaking
PV	Photovoltaic
RE	Renewable Energy

1. INTRODUCTION & CONTEXT

The global imperative to address climate change has catalyzed widespread commitments by nations to adopt low-carbon technologies and move toward a net-zero future. However, the success and sustainability of this transition hinge upon its inclusivity and equity. As per the International Labour Organization (ILO), the "just transition" concept seeks to reconcile ambitious climate goals with social and economic inclusiveness(ILO 2025). It aims to mitigate the impacts on fossil-fuel-dependent regions while expanding access to decent and green employment opportunities.

India has made significant commitments through its nationally determined contributions (GoI 2022).These include reducing the emission intensity of its gross domestic product by 45% (from 2005 levels) and achieving 50% of its installed electricity capacity from non-fossil fuel-based sources by 2030 (GoI 2022). Overall, India's climate strategy focuses on expanding renewable energy (RE) capacity to 500 GW, enhancing carbon sequestration, promoting the adoption of clean mobility, and advancing green hydrogen production (UNDP 2025). These efforts are cornerstones of India's broader objective of achieving net-zero emissions by 2070 (MoEFCC 2023).

Despite a strong momentum in RE deployment, India's current electricity supply mix is dominated by conventional power. In FY 2025, about 76% of electricity generation was from conventional power plants (MoSPI 2025). Additionally, the solid fossil fuel mining sector employed around 5 lakh workers across more than 350 mines in FY 2024-25 (MoC 2025a).

Solid fossil fuel production in India rose 72% from 609 MT in FY 2015 to 1,048 MT in FY 2025 to meet surging domestic demand, from especially power sectors (PIB 2025). In Dec 2022, the Ministry of Coal, Government of India estimated that solid fossil fuel consumption is expected to peak between 2030 and 2035 (MoC 2022). In line with India's commitment to achieve Net Zero by 2070, the power sector is expected to decarbonize and supporting green electrification of transport, industries and decarbonization in other sectors.

While national commitments set the stage, the nature of India's transition is distinctly subnational. States rich in solid fossil reserves, notably Jharkhand, Odisha, Chhattisgarh, West Bengal, and Madhya Pradesh, depend on mining and related industries as a key component of the economy, providing a significant share of state revenues, employment, and funds for local development. These states also face complexities on key socioeconomic indicators, which could render them vulnerable to the risks of an unplanned or rapid transition (NITI Aayog 2023a).

CPI's previous analysis identified Jharkhand as one of the states most exposed to transition-related economic complexities, given its reliance on solid fossil fuels and other minerals (CPI 2023a). These complexities may translate into substantial economic impact—approximately INR 726 billion (USD 8.7 billion[1]) per year for key stakeholder groups, including the state government, public sector undertakings (PSUs), workers, and local communities (CPI 2023b). A complementary CPI study further demonstrated that while the transition impacts traditional livelihoods, it also opens opportunities—particularly through emerging green industries with high employment potential (CPI 2024).

1 Conversion rate used in the entire analysis USD = INR 85

Recognizing these complexities and emerging opportunities, the Government of Jharkhand has taken proactive measures. A Task Force on Just Transition has been established to protect stakeholders who depend on solid fossil fuel-dominated value chains and to steer a more equitable shift toward new economic base (Task Force-Sustainable Just Transition, Jharkhand 2025). A successful transition would require a granular understanding of the long-term impacts on Jharkhand's economy, especially from the mining and conventional power generation sectors, which underpin the state's public finances and industrial ecosystem.

In FY 2023, mining accounted for nearly 80% of Jharkhand's non-tax revenue, growing at an annualized rate of 12.3% between FY 2019 and FY 2024 (PRS INDIA 2025). As per estimates, in FY 2025 alone the state received INR 5,045 crore (USD 593 million) in fiscal revenues, equivalent to 9.4% of its total revenue, from two subsidiaries of Coal India Limited (CIL) operating in Jharkhand;[2] Central Coalfields Limited (CCL) and Eastern Coalfields Limited (ECL). The detailed breakdown of estimated state receipts from CIL's operations in Jharkhand is presented in Table 1.

Table 1: State receipts from CIL's operations in Jharkhand, INR Crore (USD million)

REVENUE STREAM	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025
CIL Revenue *(Jharkhand operations)*[3]	16,740 (1,969)	16,537 (1,945)	21,047 (2,476)	23,218 (2,732)	23,307 (2,742)
State GST	297 (35)	315 (37)	352 (41)	365 (43)	393 (46)
Royalties	1,651 (194)	1,863 (219)	2,402 (283)	2,520 (296)	2,564 (302)
District Mineral Foundation Fund contributions	467 (55)	556 (65)	715 (84)	757 (89)	770 (91)
Mining cess	-	-	-	-	675 (79)
GST compensation CESS	-	3,425 (403)	3,336 (392)	3,887 (457)	4,210 (495)

Source: *CPI Analysis*

With the shift to clean energy accelerating under India's climate commitments, Jharkhand may face a revenue impact that could affect public expenditure, PSU performance, employment, and social development funding, including corporate social responsibility (CSR) fund flows. For a state where mining is an economic mainstay and a major employer, an unplanned transition could deepen regional inequalities and hinder growth.

To mitigate the impacts while capturing new economic opportunities, stakeholders would need a clear picture of the state's long-term plans. Anticipating impacts enables strategic diversification, targeted investments, and a social safety approach that could ensure that transition remains

2 CPI analysis based on CCL and ECL annual reports
3 Considered only CCL and ECL revenue data; ECL's data is not disaggregated between coking and non-coking solid fossil fuels.

equitable, fair and economically sustainable. This study delivers that foresight through scenario-based economic modeling and sector-led investment planning, guided by three core objectives:

- **Quantifying long-term transition impacts** on PSU earnings, state revenues, employment, and CSR fund flows through different scenarios up to FY 2070.
- **Developing a phased green economic diversification roadmap** aligned with the evolving magnitude of impacts and emerging market opportunities.
- **Estimating capital requirements for new growth sectors** suitable for driving industrial expansion and sustained job creation in Jharkhand.

The analysis focuses primarily on solid fuel value chains associated with conventional power, using scenario modeling to project multi-decadal impact. The insights derived from this exercise inform a structured diversification strategy and associated investment needs, as elaborated in the following sections.

2. ANALYSIS & RESULTS

Assessing long-term potential impacts of India's conventional power sector decarbonization on Jharkhand requires a realistic picture of how India's power system and the role of solid fossil fuels within it evolve. The analysis adopts a top-down approach: national-level decarbonization objectives are examined first, and those consistent with stated ambitions are adapted to the state context. This chapter outlines the scenario framework and modeling approach used to project the long-term power generation mix, and the resulting trajectory of solid fossil fuel production in Jharkhand.

2.1 SCENARIOS OF ANALYSIS

To assess how India's conventional power sector could evolve under different transition speeds, two scenarios were constructed, as shown in Table 2. The "Net Zero 2070" scenario reflects alignment with India's stated net-zero commitment, while the "Ambitious 2060" tests a more ambitious decarbonization trajectory for the power sector.

Table 2: Scenarios of analysis

SCENARIO	PERIOD	DESCRIPTION
Net Zero 2070 (NZ 2070)	2036-2070	▪ Baseline trajectory aligned with India's official 2070 net-zero pledge. ▪ Conventional power generation peaks in the projected year and declines reaching zero by 2070.
Ambitious 2060 (AM 2060)	2036-2060	▪ Faster-transition trajectory represents heightened climate ambition. ▪ Conventional power generation declines to zero earlier in 2060, supporting electrification and decarbonization of other sectors.

2.2 BOUNDARIES AND ASSUMPTIONS

The modeling focuses on the conventional power sector, the largest consumer of solid fossil fuel in India, and the principal determinant of mining activity in Jharkhand. The boundaries and assumptions of the analysis are shown in Table 3 and Table 4, respectively.

Table 3: Boundaries of analysis

BOUNDARIES	DETAILS
Analysis period	FY 2025 to FY 2070
Sectors covered	Conventional power generation and its upstream mining supply chain
Entities considered	State-operated enterprises (CCL & ECL)
Electricity demand	India Energy Security Scenario 2047 (IESS v3) — Determined Effort Scenario (NITI Aayog 2023b)

Table 4: Assumptions of analysis

ASSUMPTIONS	RATIONALE
Import substitution by 2030	Reducing reliance on imported solid fossil fuels (MoC 2025b)
No consideration of power exports	Focus on domestic demand
Jharkhand's share to the national supply remains constant	Allows isolated analysis of national demand shifts

2.3 INDIA'S POWER SECTOR DECARBONIZATION

CPI modeled the trajectory for India's conventional power-sector transition across the two scenarios to examine how the generation mix could evolve under varying timelines for achieving net-zero. The modeling incorporates both demand evolution and technology shifts, as shown in Table 5.

Table 5: Inputs to India's Decarbonization Pathways

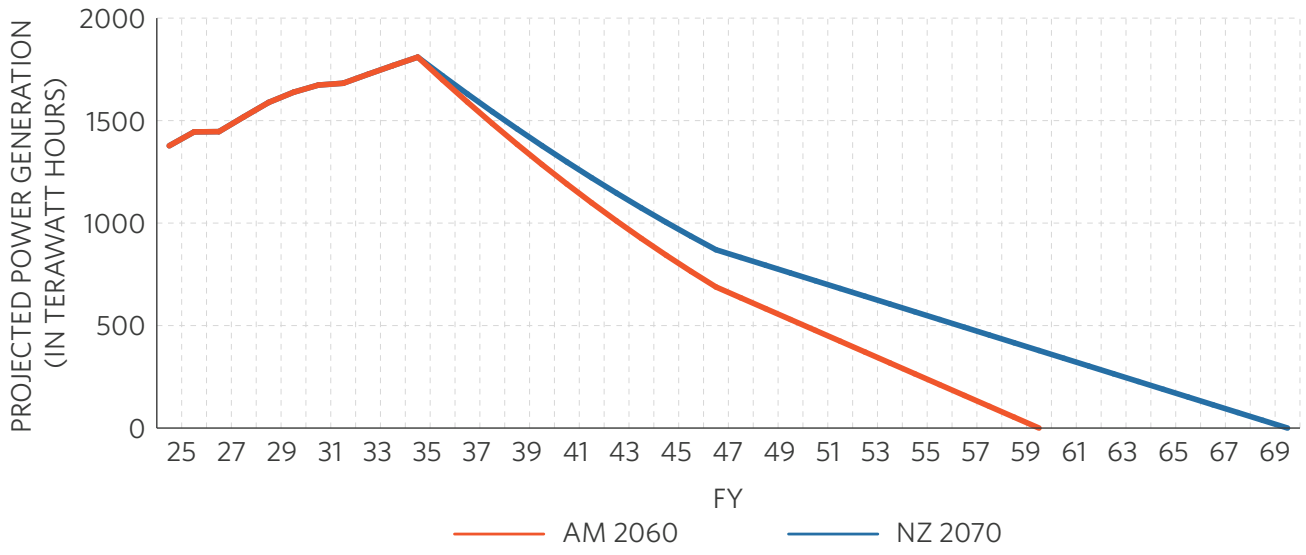
Input	REFERENCE
Electricity Demand (till 2047)	• Derived from IESS v3 up to 2047 — Determined Effort Scenario (NITI Aayog 2023b)

Electricity Demand (2047-2070)	• Extended thereafter using assumptions (that CPI has validated with sectoral experts):
	  • **FY 2048–60:** 3% compound annual growth rate
	  • **FY 2061–70:** 2% compound annual growth rate

Generation Mix Transformation	• RE rapidly scales to offset declining conventional power output • Resulting decline in conventional power varies across scenarios

As per estimates from the CPI modeled trajectory, projected solid fossil fuel-based power generation in India across the two scenarios is shown in the Figure 1 below.

Figure 1: Projected solid fossil fuel-based power generation in India, by scenario



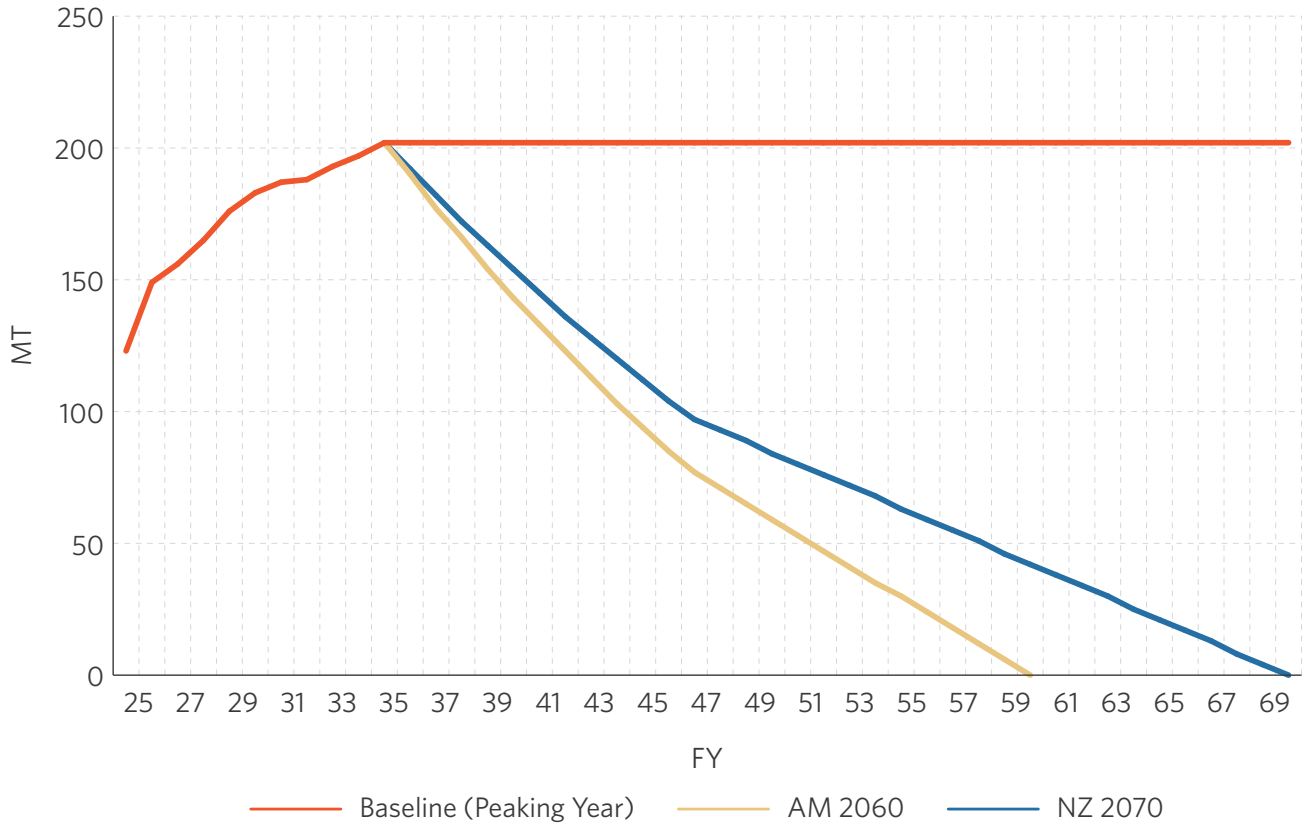
Source: *CPI analysis*

2.4 PROJECTIONS FOR JHARKHAND

Economic impact on Jharkhand is directly tied to the national conventional power sector transition. Under a baseline "no-transition" trajectory, the scenarios assumes continued revenue flow even after demand peaks. The scenarios projects non-coking solid fossil fuel output to be approximately 183 million tonnes (MT) by 2030 and peak at approximately 203 MT, in line with the estimates of solid fossil fuel demand peak between 2030 and 2035 (MoC 2022). This assumes the mining entities to maintain its current overall share of around 17% of India's solid fossil fuel supply to the power sector. Beyond 2035, however, the scenarios diverge depending on the transition route. The plotted trajectories in Figure 2, based on modeled production curves, show the distinct the following outcomes:

- **AM 2060:** Production begins to fall after the 2035 peak, output reduces steadily across the 2040s and early 2050s. The scenario results in mining output being approximately 71% lower cumulatively than baseline expectations.
- **NZ 2070:** The scenario projects the decline to be slower and over a longer period. The scenario results in mining output being approximately 61% lower cumulatively than baseline expectations.

Figure 2: Projected non-coking solid fossil fuel production in Jharkhand



Source: *CPI Analysis*

Based on current production trends and the above projections, we further break down the projected production of solid fossil fuels that key mining entities in Jharkhand are expected to supply to meet power-sector demand in order to maintain their respective market share. The projected cumulative solid fossil fuel production by scenario is summarized in Table 6.

Table 6: Projected cumulative solid fossil fuel production in Jharkhand, by scenario (MT)

MINING ENTITY	BASELINE (2036-70)	AM 2060 (2036-60)	NZ 2070 (2036-70)
CCL	5,001	1,429	1,962
ECL	1,148	328	450
Others*	919	263	361
TOTAL	**7,067**	**2,019**	**2,772**

*Others consist of commercial and captive mines

Source: *CPI Analysis*

3. LONG-TERM ECONOMIC IMPACTS OF TRANSITION

Building on the transition trajectories modeled earlier, this chapter quantifies the long-term economic impacts of declining demand for solid fossil fuels for Jharkhand. The analysis concentrates on the two CIL subsidiaries with significant mining operations in the state—CCL and ECL—and evaluates their contribution to state finances, employment, and community development. These two entities are analyzed, as they:

- Produce the bulk of solid fossil fuel consumed in India's conventional power sector
- Sustain a large formal and informal labor force
- Contributes to state through royalties, taxes, and District Mineral Foundation
- Support local social development through CSR and procurement,

Figure 3: Key economic implications of the transition

Declining conventional power generation could impact on PSU revenues and state finances to the livelihoods and welfare of mining-dependent communities, as shown Figure 3. Reduced solid fossil fuel demand after 2035 could impact local economies of Jharkhand's mining districts.

3.1 PSU REVENUE AND EMPLOYMENT

Reduction in solid fossil-fuel production could translate into impacts in corporate revenue and workforce demand for state-linked enterprises. CPI developed revenue and workforce projections by applying historical performance indicators: revenue per tonne and workers per tonne, to future solid fossil fuel output under each scenario. The estimated cumulative impact on PSU revenue and labor demand across scenarios is summarized in Table 7.

Table 7: Cumulative impact on PSU revenue and labor demand (FY 2036 to FY 2070)

SCENARIO	PSU REVENUE IMPACT	CUMULATIVE IMPACT ON EMPLOYMENT
	INR Crore (USD Bn)	Man-years
Baseline vs AM 2060	1,001,909 (USD 118 bn)	2,645,694
Baseline vs NZ 2070	852,431 (USD 100 bn)	2,251,015

Source: *CPI Analysis*

A faster transition would shorten the period over which PSU restructuring, retraining, and redeployment would be required.

EMPLOYMENT IMPACT AND SPILLOVERS

As per CPI estimates, direct employment reduction in mining could peak at roughly 1 lakh (1,00,000) jobs per year, depending on pace of the transition. This impact could ripple into transport, logistics, ancillary services, and the informal economy, while reduced household spending could erode local markets and strain public services. Districts with few alternative industries could face higher impact. For every formal mining job at risk, additional livelihoods in the surrounding economy are also exposed (CPI 2023b). Industries like trucking, mandi traders, and grocery stores, often entirely dependent on mining-driven spending—could be impacted unless new economic anchors emerge.

3.2 IMPACT ON STATE REVENUES

The most immediate and quantifiable impact on Jharkhand lies in the state's finances, which are linked to the revenue from the solid fossil fuel sector. This dependency is multi-layered, with substantial revenue streams flowing to the state exchequer through several mechanisms. Understanding these streams reveals the scale of the challenge. The four primary components of solid fossil fuel-related revenue for the state are shown in the Table 8.

Table 8: Components of solid fossil fuel revenue collected by the state

REVENUE STREAM	CURRENT ROLE	TRANSITION VULNERABILITY
Royalty (14% of the sale price)	Largest revenue source	Directly tied to volume and pricing—revenue shrinks in lockstep with declining solid fossil fuel output.
State GST (18% rate)	Major tax inflow	Sensitivity to both production and market value—contraction accelerates under any fuel substitution or pricing impacts.
District Mineral Foundation (30% of royalty)	Key financing for mining-focused districts	Impacts local welfare funds early; high social dependence with no transition linked replacements currently defined.
Mining Cess (INR 250/T)	Newly strengthened state fiscal rights	Impacts flow of state finances

Source: *CPI Analysis*

CPI's analysis estimated potential impacts on Jharkhand's state revenue:

- Under an **AM 2060** aligned transition, cumulative state revenue impacts exceed around USD 36 billion
- Under the **NZ 2070** aligned transition, the state could face a cumulative impact of approximately USD 30 billion in revenue, as summarized in Table 9 .

Table 9: Projected cumulative impact on state revenue sources (FY 2036 to FY 2070)

			in INR Crore (USD bn)
SCENARIO	**ROYALTY**	**STATE GST**	**TOTAL**
AM 2060	184,831 (22)	118,820 (14)	303,651 (36)
NZ 2070	157,255 (18)	101,093 (12)	258,348 (30)

*Calculated based on the average gross sales per tonne for each entity over the last five years

Source: *CPI Analysis*

3.3 IMPACT ON SOCIAL DEVELOPMENT

Social development using mining-linked funds underpin public spending in underserved regions. State revenue impacts could translate to reduced social expenditure, increasing pressure on mining-dependent districts unless alternative support systems are established. Table 10 presents the key social development funding sources.

Table 10: Key sources of social development fund

MECHANISM	DEPENDENCE LINK	OUTCOMES
District Mineral Foundation	Falls with royalty reduction	Reduced funding for social expenditure like health & sanitation, resettlement and skill development
CSR	Falls with PSU profit reduction	Impact on spending on education, community welfare, and women's workforce programs
Local informal labor economy	Falls with wage spending	Demand reduction in local goods and service markets

Source: *CPI Analysis*

Mining-focused districts, which at times may be socioeconomically disadvantaged, could face compounded impacts of state revenues and reduced local welfare spending at the same time. Since CSR funds are directly linked to PSU earnings, this decline would proportionally reduce social spending in communities, requiring increased government spending as shown in Table 11.

Table 11: Projected cumulative impacts on social development funding sources (FY 2036 to FY 2070)

			in INR Crore (USD bn)
SCENARIOS	**IMPACT ON DMF***	**IMPACT ON CSR***	**TOTAL**
AM 2060	55,449(6.5)	2,660(0.31)	58,109(6.8)
NZ 2070	47,177(5.6)	2,263(0.27)	49,440(5.9)

* DMF (District Mineral Foundation) funds have been calculated as 30% of the royalty amount, and CSR has been estimated using the average CSR expenditure per tonne for each entity over the past five years.

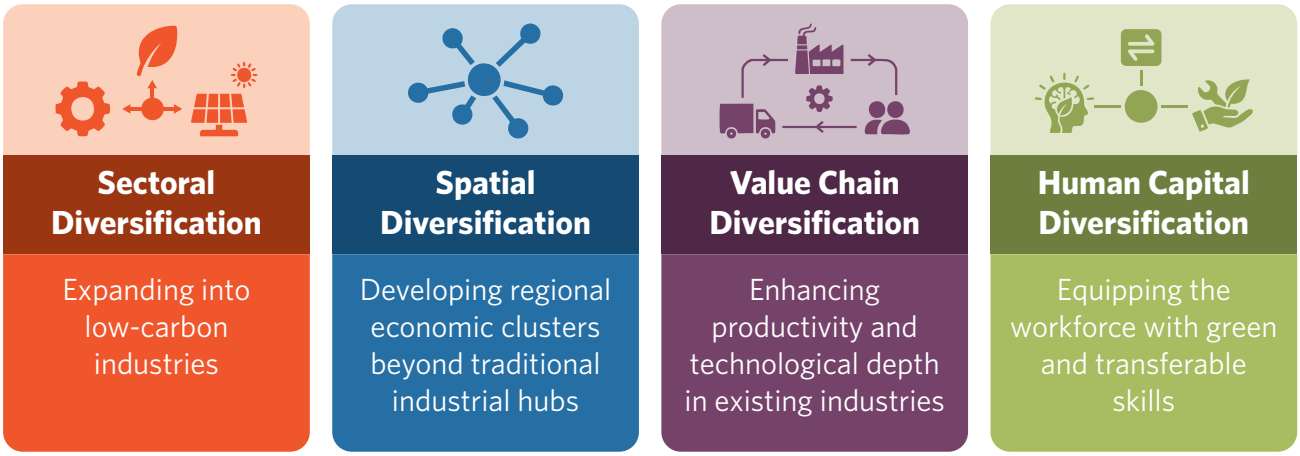
Source: *CPI Analysis*

4. FRAMEWORK FOR GREEN ECONOMIC DIVERSIFICATION

Economic diversification refers to the process of broadening a region's economic base by reducing dependence on a narrow set of sectors or commodities (UNFCCC 2025). In the context of a just and equitable energy transition, diversification aims to enhance economic resilience, protect livelihoods, and create new sources of growth as the fossil fuel industry declines. This section presents a strategic framework for economic diversification in Jharkhand, which is crucial to achieving a transition that is just and equitable.

Global experiences show that transforming from a solid fossil-based economy to a greener and cleaner one requires balancing people's social and economic needs with environmental goals (UNFCCC 2023). Green diversification can serve both adaptation and mitigation goals, helping economies absorb impacts from the decline of carbon-intensive sectors while advancing sustainable development. This can be driven through four key areas, as shown in the Figure 4 below.

Figure 4: Key pillars of economic diversification



A just & equitable transition in Jharkhand hinges on the state's economic growth in new, sustainable directions. This involves identifying clean and emerging growth sectors, expanding existing high-potential opportunities, and gradually limiting emissions-intensive sectors such as solid fossil fuels. By leveraging its abundant human capital, natural resources, and strategic location, Jharkhand has strong potential to pursue economic diversification.

4.1 TRANSITION CHALLENGES AND OPPORTUNITIES

Jharkhand has abundant human capital, natural resources, and a strategic location; it also presents unique complexities that would need to be acknowledged in planning. Table 12 presents the key transition complexities for Jharkhand.

Table 12: Key transition complexities and their impact for Jharkhand

COMPLEXITIES	IMPACT FOR JHARKHAND
SUBSTITUTION OF JOBS AND REVENUE	Solid fossil fuel revenues are high value, and jobs are geographically concentrated; fully replacing them would require a wide sectoral shift.
SKILL MISMATCH FOR EMERGING INDUSTRIES	New-sector jobs are often more technical and less labor-intensive, requiring up-skilling and re-skilling programs
MODERATE RENEWABLE ENERGY RESOURCE	Relatively lower technical potential could limit RE-linked expansion
GEOGRAPHIC MOBILITY OF LABOR	Workforce relocation could be hindered by gaps in housing, land, and social infrastructure.

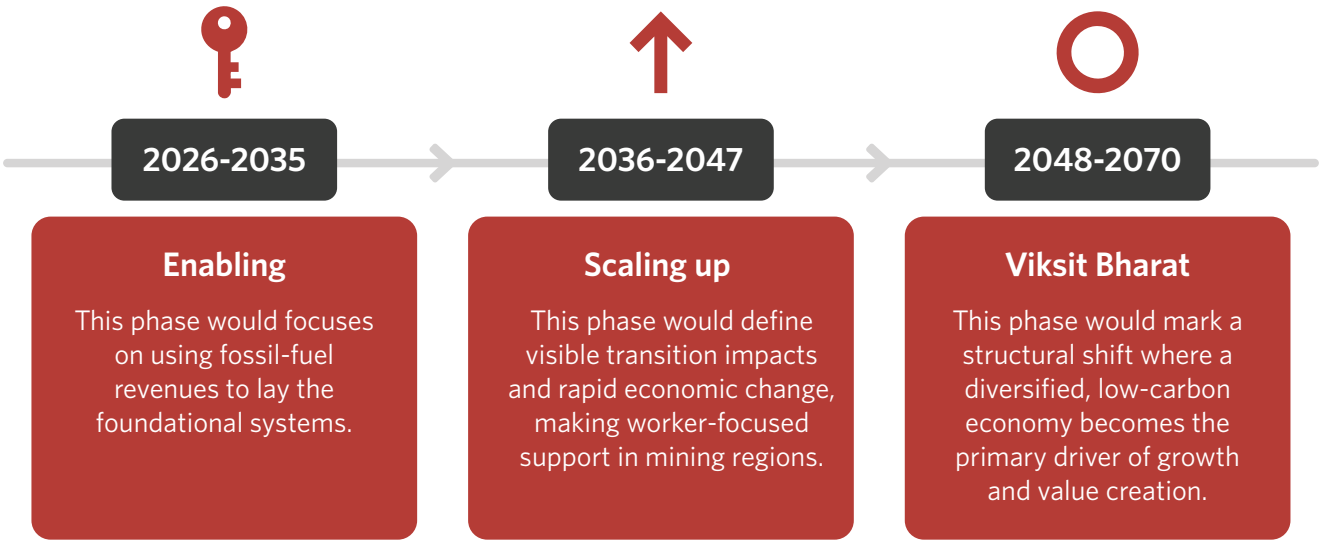
Source: *CPI Analysis*

These complexities coexist with powerful opportunity levers: the growth of manufacturing in eastern India, green technology localization, the potential of agroforestry and farm economy, and the repurposing of mine land for productive use. Harnessing these opportunities would require a structured, phased strategy.

4.2 THREE-PHASE STRATEGIC FRAMEWORK

Considering the long-term economic impacts, particularly the Net Zero 2070 secenario, the economic diversification framework could be structured into three interconnected phases to generate green, inclusive, and long-term growth. Each phase would align with the evolving economic risk profile, fiscal capacity, and workforce needs over time as show in Figure 5 below.

Figure 5: Strategic Framework for an Equitable Economic Diversification



Source: *CPI Analysis*

4.2.1 ENABLING PHASE (2026-35)

This phase would represent a period where fossil fuel revenues could be utilized for reinvestment in diversification related institutional frameworks. This could be the decade to build infrastructure, institutions, and human capital—the core enablers of an equitable low-carbon economy. The key focus and priorities are summarized in Table 13.

Table 13: Focus and priorities in the enabling phase

ECONOMIC CONTEXT	MINIMAL DISRUPTION; WINDOW TO BUILD RESILIENCE CAPACITY
KEY FOCUS	Leverage solid fossil fuel revenues for reinvestment in foundational pillars. This includes development of supportive institutional structures, constructing new infrastructure and launching workforce development programs.
SECTOR PRIORITIES	Initiate large-scale renewable energy, clean mobility infrastructure, and green molecules. Attract private investment in high-growth existing sectors (e.g., manufacturing, construction, textiles). Strengthen livelihoods through investments in agro-processing and forest-based enterprises.
WORKFORCE AND FINANCE	Focus on early skilling. Public capital could help de-risk and create an environment for future private investment.

Source: *CPI Analysis*

4.2.2 SCALING-UP PHASE (2036-47)

During this period, transition impacts could become tangible and economic substitution would need to accelerate. Mining-focused districts could be prioritized geographically to ensure that workers transition to comparable or improved livelihoods. Table 14 outlines the focus and priority actions required during the scaling-up phase.

Table 14: Focus and priorities in the scaling-up phase

ECONOMIC CONTEXT	GRADUAL DECLINE IN PSU REVENUE AND LOCAL EMPLOYMENT BEGINS.
KEY FOCUS	Accelerate the expansion of green infrastructure, industries, and livelihoods to absorb the economic impacts from the decline of the solid fossil fuel sector.
SECTOR PRIORITIES	• Scale up investments in clean energy, bioenergy, and hydrogen-based industries. • Drive technological upgrades in existing high-growth sectors to improve competitiveness and cleanliness. • Expand support for rural entrepreneurship and MSMEs, especially in mining-focused districts.
WORKFORCE AND FINANCE	Strategic focus would need to shift to large-scale job creation, reskilling, and redeployment, particularly for semi-skilled workers transitioning from mining and conventional power to new and emerging sectors. The phase could require a blend of public and private finance.

Source: *CPI Analysis*

4.2.3 VIKSIT BHARAT (2048-70)

This period would mark a profound structural shift: a diversified economy as the primary engine of growth. This would align with the national objective of achieving a "Viksit Bharat" by 2047 (NITI Aayog 2025). The objective in this phase would shift from absorbing impacts to maximizing value creation in a mature, low-carbon economy. A detailed overview of the focus areas and priorities for the Viksit Bharat phase is presented in Table 15.

Table 15: Focus and priorities in the Viksit Bharat phase

ECONOMIC CONTEXT	OPPORTUNITIES IN A DIVERSIFIED GREEN ECONOMY WOULD OVERSHADOW THE IMPACT OF THE DECLINE IN FOSSIL REVENUES
KEY FOCUS	A diversified economy would be established and the focus shifts to sustaining long-term green growth by enhancing productivity, innovation, and resource efficiency.
SECTOR PRIORITIES	▪ Strengthen research and development, resource efficiency, and recycling to build a robust circular economy ▪ Drive innovation and value addition.
WORKFORCE AND FINANCE	▪ Strategies would need to emphasize advanced skilling, higher education, and innovation-driven employment. ▪ Financing could be driven by more diversified and mature innovation-funding mechanisms.

Source: *CPI Analysis*

Jharkhand has a valuable runway to redesign its development model. The success of its roadmap hinges on:

- **Pace of transition** among state agencies, PSUs, industry, and communities.
- **Supporting institutional frameworks:** Developed through policy reforms, structural strengthening and stakeholder partnerships
- **Spatial targeting of Support:** prioritizing development in mining-focused districts first.
- **Directional finance:** Effective utilization of public capital during the enabling phase is reinvested toward diversification foundations.
- **Workforce-first design:** protecting people while transforming industries.

With timely investment, the transition can unlock new engines of growth and improve long-term economic resilience.

5. GREEN DIVERSIFICATION AND INVESTMENT REQUIREMENTS

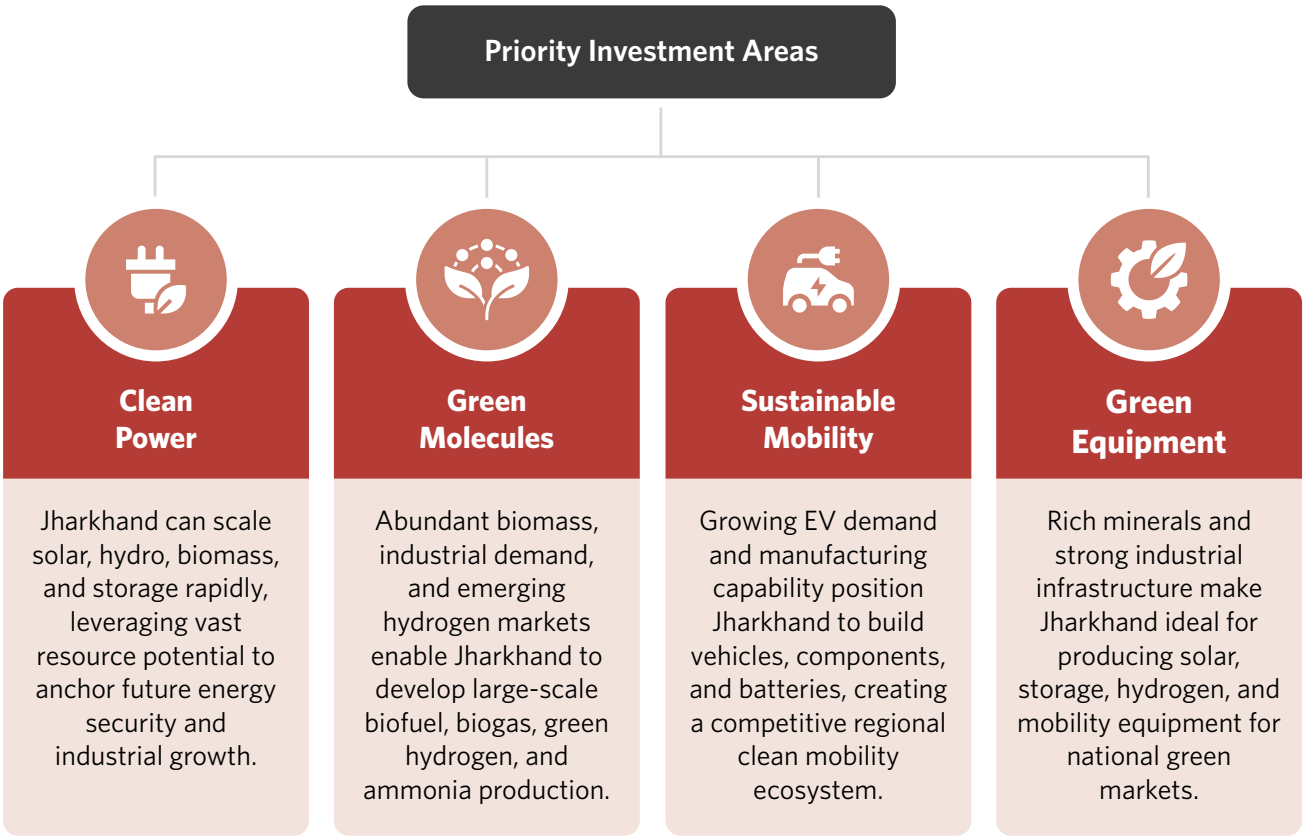
The gradual reduction in solid fossil fuel reliance could impact Jharkhand's natural resources-led revenue model. While green and emerging sectors may form the core of the state's future growth, they may substitute the financial and employment contributions of solid fossil fuels with strategic support for scaling. An equitable transition would eventually depend on additional support—to high-growth industries and expanding rural entrepreneurship and MSMEs.

However, for analysis, this chapter focuses on assessing how much of the revenue gap can be filled by green and emerging sectors, and the level of capital investments required. It identifies the priority sectors, estimates their potential economic contribution, and outlines the financing architecture needed to scale them effectively.

5.1 GREEN AND EMERGING SECTORS

The sectors identified in Figure 6 could leverage Jharkhand's industrial heritage, mineral resources, and location advantages to build a future-ready economic base. They can provide a mix of high-value revenue, scalable employment, and technological advancement.

Figure 6: Priority areas for investment for Green Diversification



Source: *CPI Analysis*

5.1.1 CLEAN POWER GENERATION

Expanding renewable energy would be foundational to Jharkhand's transition, enabling new industries while reducing dependence on conventional power. Deployment could be structured in phases to maximize investment uptake and local-sector development. Accelerating land clearances and transmission infrastructure would be essential to enable early investments. The clean power technologies and potential capacity additions are summarized in Table 16.

Table 16: Clean power technologies and potential capacity additions

TECHNOLOGY	STRATEGIC DIRECTION	DEPLOYMENT POTENTIAL
SOLAR PV	Utility-scale and distributed models	▪ **15,700 MW** in FY 2027–30 (enabling phase) ▪ **23,185 MW** in FY 2031–35, including agrivoltaics, floating solar, and industrial rooftops
SMALL HYDRO & BIOMASS	Quick deployment in rural clusters	▪ **1,500 MW** small hydro and decentralized biomass, leveraging crop and forest residue
ENERGY STORAGE	Grid stability and renewable integration	▪ **3,500 MW** in **Phase 1** and 20,500 MW in **Phase 2**, through pumped hydro energy storage and battery energy storage systems.

Source: *CPI Analysis, based on (CEED 2025)*

5.1.2 GREEN MOLECULES PRODUCTION

Green molecules present a high-potential diversification opportunity. Near-term opportunities, such as solid-fossil-fuel gasification, can leverage existing resources, while medium- and long-term investments in biofuels, green hydrogen, and green ammonia could position Jharkhand within future energy value chains. Clean fuels can leverage Jharkhand's feedstock availability, rail infrastructure, and industrial demand hubs. These industries can be co-located within existing solid-fuel industrial townships to repurpose skilled labor and infrastructure. Table 17 outlines the areas for investment and the corresponding potential production capacity for Jharkhand.

Table 17: Clean fuels and potential production capacities

SEGMENT	POTENTIAL ANNUAL PRODUCTION CAPACITY	STRATEGIC VALUE
Bioethanol	1.5 bn liters	▪ Agro-industry linkages and rural value capture
Compressed biogas	1.5 MMTPA	▪ Supports waste-to-energy and rural employment
Green hydrogen/ammonia	1 MMTPA	▪ Enables green manufacturing and mobility sectors ▪ Export and fertilizer sector applications

Source: *CPI Analysis*

5.1.3 SUSTAINABLE MOBILITY AND COMPONENTS MANUFACTURING

Transport electrification, especially in logistics, presents both manufacturing and employment opportunities. Investments could be directed toward EV and hydrogen powered commercial vehicles manufacturing, as outlined in the Table 18. Related infrastructure and a lithium-ion cell and battery-pack manufacturing ecosystem also hold strong potential for value-creation.

Table 18: Sustainable mobility and potential demand

VEHICLE SEGMENT	POTENTIAL ANNUAL PRODUCTION CAPACITY (no. of units)	OPPORTUNITY FOCUS
ELECTRIC VEHICLES		• Assembly and supply-chain localization • Collaboration with original equipment manufacturers • Fleet operations in mining corridors • Hydrogen logistics fleets anchored to industrial clusters
2-Wheelers	10,00,000	
Cars	2,00,000	
Light Commercial	75,000	
Medium and Heavy Commercial	50,000	
HYDROGEN ICE TECHNOLOGY		
Medium and Heavy commercial	25,000	

Source: *CPI Analysis*

5.1.4 GREEN EQUIPMENT MANUFACTURING

The growth of RE generation and the production of green molecules would foster the development of green equipment manufacturing and adjacent industries. With its rich mineral resources, strategic location, and skilled workforce, Jharkhand could be a promising location for a green energy equipment manufacturing hub in India. These industries could cater to clean power, clean mobility, and green molecules industries in the state and also create indirect jobs along the value chains. The green equipment manufacturing potential capacity and opportunity focus are summarized in Table 19.

Table 19: Green equipment manufacturing potential capacity

TECHNOLOGY	POTENTIAL MANUFACTURING CAPACITY	OPPORTUNITY FOCUS
SOLAR MODULES	20 GW per year	Integrated cell and module manufacturing
LI-ION BATTERIES	20 GWh per year	Cell and battery-pack assembly for power and EV applications

Source: *CPI Analysis*

5.2 REVENUE SUBSTITUTION AND INVESTMENT REQUIREMENTS

Transition linked annual impact on state revenues in Jharkhand are estimated to peak at USD 1.43 billion per year. This impact could be addressed through green diversification, as shown in Table 20. The contribution of green and emerging sectors would depend on the speed and scale of investments. The methodology used for estimating the numbers are discussed in the Annexure 1.

Table 20: Revenue substitution and cumulative investment required

Revenue source	Cumulative investment required	Annual Industry Revenue generation potential	Annual State Revenue substitution potential
Estimated peak loss in state revenue: (due to fossil fuel for conventional power)	**INR 12,181 Cr. (USD 1.43 bn) per year**		
Estimated potential of green & emerging industries			
Green Molecules Production:	INR 185,300 Cr. (USD 21.8 bn)	INR 57,035 Cr. (USD 6.71 bn)	INR 2975 Cr. (USD 350 mn)
Sustainable Mobility & Components Manufacturing:	INR 121,550 Cr. (USD 14.3 bn)	INR 64,600 Cr. (USD 7.6 bn)	INR 5780 Cr. (USD 680 mn)
Green Equipment Manufacturing	INR 45,050 Cr. (USD 5.3 bn)	INR 49,300 Cr. (USD 5.8 bn)	INR 3426 Cr. (USD 403 mn)
Total	**INR 351,900 Cr. (USD 41.4 bn)**	**INR 170,935 Cr. (USD 20.1 bn)**	**INR 12,181 Cr. (USD 1.43 bn)**

Source: *CPI Analysis*

While exact revenue generation would depend on market uptake and investment timelines, these sectors collectively could replace a significant share of fossil revenue when scaled effectively.

5.3 FINANCING MECHANISMS

Financing an economic transformation of this scale would require a portfolio of capital sources working in coordination, as outlined in the Table 21 below.

Table 21: Various financing mechanisms

SOURCE	STRATEGIC ROLE
STATE/CENTRAL PUBLIC FUNDS	Bulk of early-phase investment; create initial project pipeline
PRIVATE SECTOR CAPITAL	Scale up manufacturing and mobility markets
CONCESSIONAL FINANCE	Multilateral development banks/development finance institutions de-risk innovative, early-stage technologies
INTERNATIONAL CLIMATE FINANCE	Align with mitigation and adaptation priorities
GREEN/SOVEREIGN BONDS	Fund large clean power and storage infrastructure

Source: *CPI Analysis*

Transition-linked finance could be front-loaded during the enabling phase (2025-35) to avoid reliance on declining revenues from solid fossil fuels later. To ensure effective capital mobilization and accountability, a dedicated transition financing framework would be required.

6 RECOMMENDATIONS

Jharkhand stands at a pivotal moment in its economic history. The transition creates that creates complexities also presents new opportunities. Green and emerging sectors, particularly clean energy, clean mobility, green molecules, and green equipment manufacturing, can build a more resilient and diversified economy. If developed strategically and early, these sectors have the potential to replace most solid fossil fuel-linked revenues to the state and generate large-scale employment, especially through value-chain development and manufacturing localization. The decade from 2025 to 2035 could be decisive. This "enabling phase" offers a unique window during which solid fossil fuel revenues remain strong enough to finance the foundations of a diversified green economy. Early investments in infrastructure, skills development, and industrial ecosystems would be the key determinants for making Jharkhand's transition planned and prosperous. CPI's key recommendations are listed in the Figure 7:

Figure 7: Key Recommendations

Adopt a statewide Green Transition plan	• Formalize a comprehensive transition pathway into a structured plan with five-year action cycles. • Strengthen cross-department coordination and establish accountability mechanisms for smooth execution.
Prioritize diversification in mining-focused districts	• Anchor new industries, skilling centers, and manufacturing zones close to the affected workforce. • Integrate mine closure planning with industrial redevelopment.
Accelerate workforce transition programs	• Launch district-based skilling, apprenticeships, and redeployment pathways. • Establish partnerships with industry for targeted hiring pipelines in new sectors.
Protect community welfare during the transition	• Effectively utilise District Mineral Foundation (DMF) and CSR spending for social infrastructure. • Support informal and induced employment through enterprise promotion and social protection.
Strengthen enabling infrastructure	• Fast-track transmission, industrial parks, logistics, and green mobility corridors. • Ensure permitting reform and land-use clarity to reduce investor risk.
Leverage Jharkhand's industrial and mineral strengths	• Position the state as a manufacturing hub for renewable equipment, electrolyzers, and battery systems. • Develop local value chains that retain economic benefits within the state.
Deploy a dedicated transition financing framework	• Use solid fossil fuel revenues and public finance to crowd-in private capital. • Structure blended finance mechanisms for green industrial projects.

The clean energy transition is a historic pivot opportunity, which could transform the current fossil-fuel-dependent into a diversified green, future-ready, and inclusive economy. In this series of work, CPI has designed a framework for financing an equitable and green transition, which would be outlined in our subsequent publication titled "**Just Transition Financing Framework**".

7. ANNEXURE 1: ESTIMATION OF REVENUE SUBSTITUTION POTENTIAL & INVESTMENT REQUIRED

This section outlines the methodological framework used to estimate the investment potential for establishing green industries in Jharkhand. The estimation process combines a bottom-up assessment of production capacity with unit capital expenditure (CAPEX) norms derived from current market trends, future projections, state/national policy targets and investment announcements.

A1. Figure 1: Steps for calculating revenue generation potential and investment requirements

STEP 1

The first step entails estimating the annual aggregate annual revenue generated by the production and sale of green goods. This potential is based on achieving maximum "Substitution Potential"—defined as the production capacity local green industries can realistically develop to replace incumbent technologies or serve new demand between 2030 and 2050.The assumptions for maximum production capacity across three key sectors are detailed below.

A1. Table 1: Production capacity assumptions for Green Molecules

SEGMENT	POTENTIAL ANNUAL PRODUCTION CAPACITY	RATIONALE
Bioethanol	1.5 bn liters	7.5% of the projected national demand for 2050[4]
Compressed biogas	1.5 MMTPA	2.5% of overall national potential, which is estimated at 50 MMTPA[5]
Green Hydrogen/Ammonia	1 MMTPA	3.4% of the national capacity expansion plan of 29 MMT by year 2050[6]

Source: *CPI Analysis*

4 CSTEP. 2024. Towards The Long-Term Sustainability Of Ethanol Use In India. [accessed Dec 2025] .https://cstep.in/wp-content/uploads/2025/06/Towards-the-long-term-sustainability-of-ethanol-use-in-India.pdf

5 EAC International Consulting. 2023. Enablers And Challenges – Indian Compressed Biogas (Cbg) Industry. [accessed Dec 2025] https://task37.ieabioenergy.com/wp-content/uploads/sites/32/2023/05/Knowledge-Paper_Indian-CBG-Industry_IFGE_EAC_April-2023_18042023-1.pdf

6 MNRE. 2024. PM Narendra Modi Unveils Vision to Make India Global Hub for Green Hydrogen. [accessed Dec 2025] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2053689&reg=3&lang=2

A1. Table 2: Production capacity assumptions for Sustainable Mobility

VEHICLE SEGMENT	POTENTIAL ANNUAL PRODUCTION CAPACITY (no. of units)	RATIONALE
ELECTRIC VEHICLES		**CPI analysis based on:** ▪ National/ State electrification targets ▪ Current sales in the state from Vahan Dashboard and future sales projection ▪ Existing OEMs, manufacturing facilities, sales, investments in green hydrogen ICE engine manufacturing in Jharkhand ▪ Trends in increasing market demand
2-Wheelers	1000,000	
Cars	200,000	
Light Commercial	75,000	
Medium and Heavy Commercial	50,000	
HYDROGEN ICE TECHNOLOGY		
Medium and Heavy commercial	25,000	

Source: *CPI Analysis*

A1. Table 3: Production Capacity Assumptions for Green Equipment Manufacturing

SEGMENT	POTENTIAL ANNUAL PRODUCTION CAPACITY	RATIONALE
Solar PV	20 GW/year	▪ EUPD group projects Solar PV cell manufacturing capacity to reach 171 GW & modules manufacturing to 280 GW by 2030 in India[7] ▪ With the production capacity set to increase beyond 2030, our assumption is that Jharkhand could capture at least 7% of this opportunity by developing and integrated cell and module manufacturing capacity
Li Ion Battery	20 GWh/year	▪ NITI Aayog projects India's annual demand for Battery Energy Storage Systems to reach to about 210 GWh per year by 2030[8] and set to increase going forward ▪ Our assumption is that Jharkhand could capture 10% of this opportunity and build and integrated cell and battery pack manufacturing capacity

STEP 2

Following the revenue projection, this step estimates the State Goods & Services Tax (SGST) payable by the business. Specifically, it calculates the tax revenue accruing to the state based on the aggregate revenue generated from the sales of green goods.

It is important to acknowledge that while current GST rates are preferential to incentivize the manufacturing and adoption of green technologies, these rates may increase as the industry matures and market penetration deepens. Therefore, for this analysis, we have modelled a scenario where rates align with non-green products:

7 EUPD.GROUP.2025 India's Solar Manufacturing Industry Shifts From Scale to Global Competitiveness. [accessed Dec 2025]. https://eupd-group.com/indias-solar-manufacturing-industry-shifts-from-scale-to-global-competitiveness/

8 NITI.Aayog.2022. Advanced Chemistry Cell Battery Reuse and Recycling Market in India.[accessed Dec 2025]

- 12% GST assumed for Green Technologies (Solar PV, Li-Ion Batteries, and Green Molecules).
- 18% GST assumed for Electric Vehicles (at parity with Internal Combustion Engine vehicles).

STEP 3

The final step in the process is to estimate the capital investments required to substitute the state revenue impact by setting up green manufacturing. This represents the total capital expenditure necessary to establish the manufacturing and production facilities capable of generating the estimated revenue and tax. Investment requirements were calculated using unit CAPEX norms derived from recent industry benchmarks, as detailed below:

A1. Table 4: Green Molecules CAPEX Assumptions

SEGMENT	CAPEX	Units	Reference
Bioethanol	8,000 (941)[9]	INR Cr (USD Mn) per Bn Litres	CPI estimates based on investment announcements, schemes and news article references in footnotes
Compressed Biogas	6,000(706)[10]	INR Cr (USD Mn) per MMTPA	
Green Hydrogen	160,000(18,824)[11]		

A1. Table 5: Clean Mobility Capex Assumptions

SEGMENT	CAPEX	Units	Reference
Electric 2W	4 (0.5)	INR Cr (USD Mn) per 1,000 units of vehicle production	CPI Analysis based on recent investments in vehicle segment-wise EV manufacturing facilities across India
Electric Cars	80 (9.4)		
Electric LCVs	85 (10)		
Electric MCVs	800 (94)		
Electric HCVs	1,000 (118)		
Hydrogen HCVs	2,000 (235)		

Source: *CPI Analysis*

9 Green Permits. 2025. Ethanol Production Plant Setup Cost in India. [accessed Dec 2025]. https://www.greenpermits.in/ethanol-production-plant-setup-cost-in-india/

10 EAI.2025. India Compressed Biogas (CBG) Strategy for the CEO – Market Size, Project Costs, Technology, Policies. [accessed Dec 2025] .https://www.eai.in/consulting/co3/opps/10

11 PIB. 2025. Unlocking India's Green Hydrogen Production Potential. [accessed Dec 2025] https://www.pib.gov.in/PressNoteDetails.aspx?ModuleId=3&NoteId=155990&id=155990&reg=3&lang=1

A1. Table 6: Green Equipment Manufacturing

SEGMENT	CAPEX	Units	Reference
Solar PV (Cell & Module)	1,640 (193)	INR Cr (USD Mn) per GW	CPI Analysis based on recent investments in Integrated Solar PV and Li-Ion battery manufacturing facilities in India
Li Ion Battery (Cell & Battery Pack)	600 (70)	INR Cr (USD Mn) per GWh	

Source: *CPI Analysis*

SUMMARY OF INVESTMENT REQUIRED

A detailed summary of the category and segment wise estimated capital investments required is presented in the table:

A1. Table 7: Detailed summary of investment required by the category and segments

CATEGORY	ASSUMED PEAK ANNUAL PRODUCTION CAPACITY	In INR Crore/ USD Bn
		CUMULATIVE CAPITAL INVESTMENT REQUIRED
A. GREEN MOLECULES PRODUCTION:		
Bioethanol	1.5 Bn Liters	12,000 (1.4)
Compressed Biogas	1.5 MMTPA	13,500 (1.6)
Green Hydrogen/Ammonia	1 MMTPA	1,60,000 (19)
Total A		**185,300 (21.8)**
B. SUSTAINABLE MOBILITY & COMPONENTS MANUFACTURING:		
Electric 2-Wheelers	10,00,000 per year	4,000 (0.5)
Electric Cars	200,000 per year	16,000 (1.9)
Electric LCVs	75,000 per year	6,400 (0.8)
Electric MCVs	25,000 per year	20,000 (2.4)
Electric HCVs	25,000 per year	25,000 (2.9)
Hydrogen ICE HCVs	25,000 per year	50,000 (5.9)
Total B		**121,550 (14.3)**
C. GREEN EQUIPMENT MANUFACTURING		
Solar PV (Cell & Module)	20 GW/year	32,800 (3.9)
Li Ion Battery (Cell & Battery)	20 GWh/year	12,000 (1.4)
Total C		**44,050 (5.3)**
TOTAL A+B+C		**3 51,900 (41.4)**

Source: *CPI Analysis*

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