The Energy Transition Opportunity: Emerging Green Jobs in Jharkhand

Technical Brief

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CLIMATE POLICY INITIATIVE

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ABOUT CLIMATE POLICY INITIATIVE

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 seven offices around the world in Brazil, India, Indonesia, South Africa, the United Kingdom, and the United States.

LIST OF ABBREVIATIONS

AGTS	Accelerated Green Transition Scenario
APS	Aspirational Policy Scenario
CBG	Compressed Biogas
DRE	Distributed Renewable Energy
EV	Electric Vehicle
EPC	Engineering, Procurement and Construction
FTE	Full-time Equivalent
GDP	Gross Domestic Product
GH2	Green Hydrogen
GHG	Green House Gases
GoI	Government of India
GoJ	Government of Jharkhand
ICE	Internal Combustion Engine
ILO	International Labour Organisation
IRENA	International Renewable Energy Agency
JIIPP	Jharkhand Industrial and Investment Promotion
LCV	Light commercial vehicle
MoF	Ministry of Finance
MNRE	Ministry of New and Renewable Energy
MeitY	Ministry of Electronics and Information Technology
MSME	Micro, Small and Medium Enterprises
MW	Megawatt
MMTPA	Million metric tons per annum
M&HCV	Medium and Heavy Commercial Vehicle
NDC	Nationally Determined Contributions
NGHM	National Green Hydrogen Mission
O&M	Operations and Maintenance
PSP	Pumped Storage Projects
RE	Renewable Energy
SHP	Small Hydro Power
USD	United States Dollars

EXECUTIVE SUMMARY

Jharkhand's ongoing energy transition has the potential to transform the state's employment landscape by generating substantial direct and indirect green jobs across various sectors and their related value chains, including for clean power, clean mobility, and green molecules. However, creating such opportunities will require substantial investment, primarily from the private sector.

This study sets out two scenarios- **Ambitious Policy Scenario (APS)** and **Accelerated Green Transition Scenario (AGTS),** created by CPI to project the number of green jobs that could be created in Jharkhand by 2030.

The APS envisions a future where Jharkhand sets ambitious targets for renewable energy, green manufacturing, and electric vehicle adoption. It assumes robust policy support, significant investment in green infrastructure, and a focus on skill development and training. **Under this scenario, Jharkhand is projected to create 81,332 direct and 3,11,410 indirect green jobs by 2030.**

The AGTS explores an even more rapid and transformative pathway to a green economy. This represents a more aggressive approach to investment and policy implementation in green sectors (with significantly higher targets than ambitious policy scenarios), **with the potential to create 1,37,172 direct and 4,92,924 indirect green jobs by 2030.**

Increased consumer spending by those employed in these new direct and indirect jobs would also create induced jobs. Our scenarios indicate that Jharkhand can significantly expand employment opportunities by applying a comprehensive set of policies. The findings underscore the importance of ambitious policies and targeted investments to maximize green job creation.

The recommendations emphasize promoting green industries and developing a skilled workforce to support Jharkhand's transition to a sustainable economy. Key strategies include investing in biofuel and green hydrogen production, expanding renewable energy capacity, and attracting investment in electric vehicle (EV) manufacturing and green equipment production. Additionally, establishing specialized Green Skills Training Centers and fostering collaborations between industry and academia will ensure that training programs meet the demands of the green economy. A focus on reskilling and upskilling initiatives will help workers adapt to new job opportunities in these emerging sectors.

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1. INTRODUCTION AND CONTEXT

India plans to meet its climate objectives by cutting the emission intensity of its GDP by 45% from 2005 levels by 2030, as stated in its updated Nationally Determined Contribution (NDC). These efforts are supported by the country's target of having about 50% of total electric power come from renewables by 2030 (MoEFCC, 2023). This strategic transition to renewable energy (RE) sources like solar and wind power is motivated by the need to reduce greenhouse gas (GHG) emissions and air pollution while also boosting energy security. This will support the country's objective of becoming net-zero by 2070 (MoEFCC, n.d.) while also ensuring sustainability.

To meet its ambitious RE targets, the Government of India (GoI) is investing substantially in clean energy technologies. However, the energy transition is not without its challenges, particularly the need to balance competing priorities of economic development and environmental sustainability. In addition, India's RE goals could intensify regional disparities, with states abundant in solar and wind resources benefiting more than others. As the share of RE grows in the energy mix, states with limited solar and wind resources may have to reduce their thermal power generation and import electricity from states rich in renewables (Mitra & Chandra, 2023).

Jharkhand, an eastern state with abundant mineral resources, possesses the second-largest solid fossil fuel reserves of India and was the country's third-largest solid fossil fuel producer in FY'23 (Ministry of Coal, 2023). More than a quarter of the state's revenue comes from fossil fuel mining. Several of its districts are deeply integrated in the solid fossil fuel ecosystem, which contributes a significant portion of their GDP and employment, alongside energy-intensive industries like automotive steel production. **This has led to a heavy reliance on solid fossil fuel, with related industries driving the state's economy and employment landscape.**

Jharkhand's economic model, deeply rooted in solid fossil fuel, faces significant risks and potential disruptions, including socioeconomic challenges, in the face of climate change and the shift away from carbon-intensive energy sources. The GoJ has proactively established a multi-departmental Taskforce on Sustainable Just Transition, which is mandated to comprehensively assess and strategize the state's transition from fossil fuels, focusing on critical areas such as diversifying livelihoods, transitioning to RE, decarbonizing industries, and mobilizing climate finance (GoJ, n.d.).

IMPACT ON ECONOMY AND LIVELIHOODS

While creating employment and economic growth, solid fossil fuel mining has also been linked to underdevelopment in key areas including education, health, and employment diversification (Chamberlain, 2013). The finite nature of solid fossil fuel resources poses sustainability challenges for related income generation, with an inverse association between solid fossil fuel mining and livelihood sustainability in affected villages (Yadav, Bhagat, & Yadav, 2019). Socially, solid fossil fuel mining has had mixed effects, such as altering traditional rural community structures by replacing caste hierarchies with professional ones and raising economic aspirations (Singh & Singh, 2022).

NEED FOR A JUST TRANSITION

While the transition to a green economy will impact most jobs only slightly, certain occupations will undergo significant changes, leading to the emergence of new jobs and the decline of other conventional roles. The International Labour Organization (ILO) advocates for a just transition, that ensures fairness and inclusivity. This means providing support and opportunities for workers in declining industries to transition into new, sustainable careers. Jharkhand's heavy reliance on solid fossil fuel mining necessitates a strategic shift to economic diversification and green energy for a sustainable future, thus necessitating a just transition.

STUDY OBJECTIVE

This study examines and estimates the emerging job opportunities in Jharkhand resulting from the ongoing energy transition. It provides an overview of the state's evolving energy landscape, identifies critical sectors with reasonable job creation potential, and proposes policy recommendations to maximize the socioeconomic benefits of this transition. Our findings highlight the need for strategic investments in workforce training and skill development to ensure a smooth transition and inclusive growth.

2. LITERATURE REVIEW

The ILO broadly defines green jobs as those in sectors and industries dedicated to environmental preservation and conservation. While sustainable energy sources like clean power and biofuels are readily recognized as a green industry, other industries such as clean mobility, water management, solid waste management, and green buildings are in general considered green due to their direct or indirect environmental and climate change impacts. For this study, we have narrowed our focus to the key sectors of clean mobility, clean power, and green molecules for green job assessment due to their relevance to the ongoing energy transition in India.

2.1 GREEN JOBS POTENTIAL

India's transition to a net-zero economy could contribute more than USD 1 trillion in economic opportunity by 2030 and create 50 million green jobs by 2070 (WEF, 2021). The country's energy, mobility, industry, green buildings, and agriculture sectors are poised for substantial growth. Growth in the electric vehicle (EV) sector alone is expected to create 10 million direct and 50 million indirect jobs in India by 2030 (MoF, 2023). Furthermore, the rooftop solar sector alone is expected to 1.7 million direct and indirect jobs (MNRE, 2024).

In the context of Jharkhand, adopting renewables, developing clean mobility, and green molecule manufacturing sectors are the most promising to attract investments, create diverse job opportunities, and strengthen the state's economic resilience.

- **The GoJ aims to promote Jharkhand as an industrial hub for EVs, electronics manufacturing, ethanol, and other high-priority sectors** (GoJ, 2021)
- **The 2021 Jharkhand Industrial and Investment Promotion Policy (JIIPP) aims to attract USD 12 billion in investments including the green sectors and create 500,000 jobs in the state** (GoJ, 2021)**.**

2.1.1 GREEN MOLECULES

Green molecules such as biofuels, hydrogen, and their derivatives have a critical role to play in accelerating the energy transition and in achieving climate goals, especially in heavy industries and mobility (WEF, 2024). While electrification remains pivotal in reducing emissions, sectors like aviation, shipping, and steel production, which are inherently reliant on chemical processes, require alternative decarbonization strategies. Jharkhand, a heavily industrialized state dominated by these sectors, faces unique decarbonization challenges. "Green molecules," derived from RE sources, offer a viable solution, replacing fossil fuel-based feedstocks in hard-to-abate industries and expanding energy access. Table 1 outlines support from the national level and in Jharkhand for the use of green molecules.

Table 1: National- and State-Level Support for Green Molecules

BIOETHANOL	▪ The GoI's Ethanol Blending Program targets the use of a 20% ethanol mix in petrol by 2025, prompting the GoJ to introduce an ethanol policy in 2022 to support ethanol production in the state. ▪ In 2024, the GoJ partnered with a private company to establish ethanol plants at five locations, with operations set to begin by the end of 2024, creating over 5,000 direct jobs.
COMPRESSED BIOGAS	▪ Comprising mainly methane and a small percentage of CO_2 (<4%), CBG is gaining traction in Jharkhand, driven by a partnership between GAIL Limited and the Ranchi Municipal Corporation under which a CBG plant has been established. ▪ Further, 4 plants with a total capacity of 28 Tons per day TPD is under construction and two more with a total capacity of 106 TPD are under construction in Jharkhand (MoJS, n.d.)
GREEN HYDROGEN and AMMONIA	▪ India's ambitious National Green Hydrogen Mission (NGHM), 2023 aims to achieve an annual production capacity of 5 MT green hydrogen by 2030, generating 6,00,000 jobs (MNRE, n.d.). ▪ Jharkhand has established a dedicated task force in 2023 to develop and execute tailored green hydrogen strategies (GoJ, n.d.)

Bioethanol is an alcohol-based fuel derived from agricultural feedstock like sugarcane, maize, and other starch-rich or sugar-rich crops. In Jharkhand, the focus on bioethanol production is part of the larger national initiative to promote biofuels under the National Biofuel Policy.

Compressed biogas (CBG) is a renewable fuel produced from the anaerobic digestion of organic waste such as agricultural residue, cattle dung and municipal solid waste. CBG can be used as an alternative to Compressed Natural Gas (CNG). The GoI is promoting CBG production under the Sustainable Alternatives Towards Affordable Transport (SATAT) which aims to attract around USD 4.5 billion in investment and facilitate the establishment of 5,000 CBG projects for production of 15 MMT by 2024 (MoPNG, 2023).

Hydrogen is used in industrial processes, in fuel cells for electricity generation, and to power vehicles. Ammonia is used as a fertilizer—in the form of salts, solutions, or anhydrous gas—to increase the yields of crops. Jharkhand, with 75% of its districts heavily reliant on solid fossil fuel and hard-to-abate industries, presents a unique opportunity for green hydrogen-based decarbonization (GoJ, n.d.). The state is a potential hub for both green hydrogen/ammonia consumption and production due to its industrial base, including a large fleet of heavy-duty vehicles, a robust MSME sector, and vast demand from iron and steel manufacturing.

2.1.2 CLEAN POWER

India had an estimated 988,000 RE jobs in 2022 (ILO, 2023)**.** According to IRENA (2020), for every USD 1 million investment, renewables generate an average of 7.5 full-time jobs compared to only 2.65 for fossil fuels.

Jharkhand's clean energy transition faces significant headwinds, including limited RE resources, a heavy reliance on solid fossil fuel, and historical underinvestment in energy infrastructure. These factors, coupled with strained state finances due to a high fiscal deficit, pose challenges to achieving the state's ambitious RE targets, despite its potential to meet growing power demands through renewable sources.

As of FY'24, Jharkhand's energy infrastructure is dominated by thermal power (87.3%), which makes up 2,607 MW of the state's total 2,984 MW power capacity. RE sources account for the

remaining 12.7%, with the majority (191 MW) coming from hydropower (Central Electricity Authority, 2024).

Figure 1: Installed Power Generation Capacity in Jharkhand (in MW)

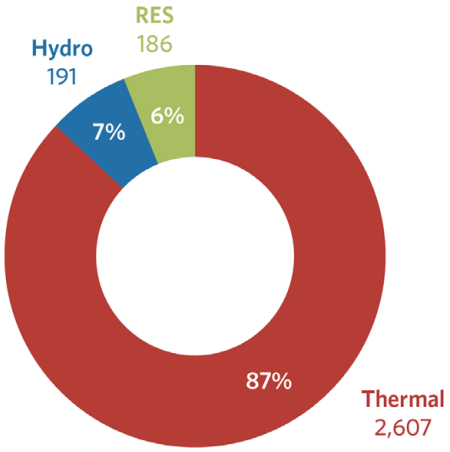

Figure 2: RE potential in Jharkhand (in MW)

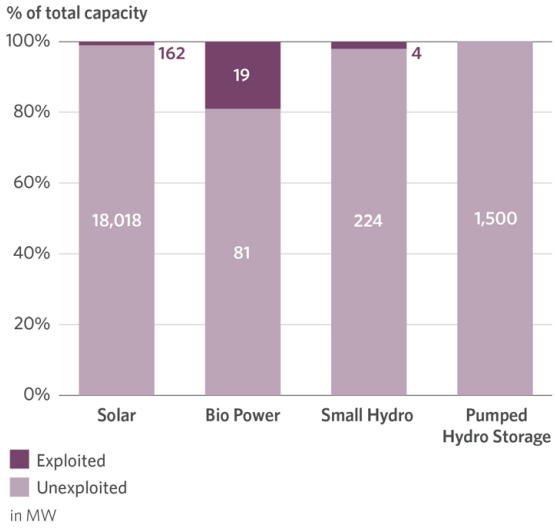

Table 2: Status of clean power in Jharkhand

SOLAR PV	▪ Jharkhand experiences abundant solar irradiance throughout the year, with opportunities for both large-scale and distributed solar projects. ▪ The state has 340 sq. km of abandoned mined-out land that could be used for solar power facilities. ▪ The current installed solar capacity of 162 MW (FY'24) (MNRE, 2024) is small compared to the state's estimated potential of 18.1 GW.
BIOPOWER	▪ Jharkhand's robust agricultural sector and extensive forest cover offer substantial opportunities for bioenergy production. ▪ The current installed capacity of biopower projects is 19.1 MW (FY'24) (MNRE, 2024), though the state has an estimated potential of 146.3 MW (NIBE, 2023).
SMALL HYDRO	▪ Jharkhand's abundant rivers and streams provide ample opportunities for small hydropower projects, offering decentralized electricity generation, particularly in remote areas, and promoting local development ▪ While the state has identified a significant exploitable resource of 228 MW (GoJ, 2023) for small hydropower, only 4 MW (MNRE, 2024) is currently operational, indicating a substantial untapped potential.
PUMPED STORAGE	▪ Jharkhand has an estimated exploitable potential of 1,500 MW in pumped hydro storage (Central Electricity Authority , 2023) ▪ The Damodar Valley Corporation is developing a 1.5 GW pump storage facility in the state's Bokaro district at the cost of US 750 million (NIC, 2018) ▪ Further discarded mines in Jharkhand, including solid fossil fuel mines, can be used as reservoirs for off-river pumped storage.

2.1.3 CLEAN MOBILITY

Jharkhand's automotive sector, a cornerstone of the state's economy, presents both challenges and opportunities amid the global shift towards cleaner transportation. While currently centered on internal combustion engine (ICE) vehicles, the state's robust infrastructure and skilled workforce position it favorably for EV manufacturing. Additionally, with advancements in hydrogen ICE technology and strategic investments, Jharkhand is poised to emerge as a leader in the production of hydrogen-powered trucks, catering to the needs of the hard-to-electrify heavy-duty vehicle segment (Cummins, 2023).

Table 3: State Support and Initiatives in Clean Mobility

ELECTRIC VEHICLES	▪ Jharkhand's EV Policy 2022 aims to position the state as a leading hub for EV manufacturing in Eastern India by offering incentives and promoting EV adoption and production (GoJ, 2022). ▪ By 2027, the policy targets the production of advanced chemical cell batteries and the establishment of a Centre of Excellence for EVs in the state (GoJ, 2022).
HYDROGEN ICE VEHICLES	▪ In 2023, Jharkhand signed an MoU with TCPL Green Energy Solutions to establish India's first green hydrogen automotive component manufacturing plant (Cummins, 2023). ▪ In 2024, TCPL opened a state-of-the-art facility with a USD 42 million investment, expected to employ 1,000 direct and indirect workers (Moneycontrol, 2023) and produce over 4,000 hydrogen ICEs and 10,000 advanced battery systems annually.

2.1.4 GREEN EQUIPMENT MANUFACTURING

The growth of RE generation and the production of green molecules is fostering the development of green equipment manufacturing, and adjacent industries. With its rich mineral resources, strategic location, and skilled workforce, Jharkhand is a compelling location for a green energy equipment manufacturing hub in India. The state's proactive policies, commitment to sustainable development, and recent investments in industrial infrastructure further enhance its attractiveness to investors and manufacturers. These industries may feed clean power, clean mobility, and green molecules industries in the state and create indirect jobs along their value chains.

Table 4: Potential of Green Equipment Manufacturing in Jharkhand

LITHIUM-ION BATTERIES	▪ Jharkhand's rich graphite reserves and lithium extraction potential make it an ideal location for battery manufacturing, crucial for the growing demand in electric mobility and RE storage. ▪ The state government's focus on building a comprehensive battery manufacturing ecosystem, supported by investor incentives, creates a favorable environment for industry growth.
SOLAR PANELS	▪ GoJ initiatives to promote solar energy adoption and supportive policies for manufacturers create a favorable investment climate for the solar sector. ▪ The state's solar power potential, proximity to ports, and skilled labor availability makes it ideal for scalable and cost-effective solar panel manufacturing, further boosted by government incentives like tax breaks and subsidies.

WIND TURBINES	▪ The Indian government aims for 30 GW of offshore wind installations by 2030, with the current wind industry supporting around 4,000 domestic small and medium enterprises (CEEW, 2019), boosting the local economy and global competitiveness. ▪ Jharkhand's heavy industry companies, like MECON and HEC, are well-positioned to contribute to wind energy component manufacturing, leveraging their expertise in metallurgical engineering and heavy machinery.
POWER/ EV ELECTRONICS	▪ A dedicated electronics system design and manufacturing cluster has been established near Jamshedpur to position Jharkhand as a key hub in this sector. ▪ The Adityapur Electronic Manufacturing Cluster Ltd, a special-purpose public company, manages this greenfield project, which covers 82 acres and includes 92 units with plug-and-play facilities (MeitY, n.d.).

3. METHODOLOGY AND RESULTS

This study uses the employment coefficient method to assess the green job opportunities and potential in Jharkhand in the three key sectors of clean mobility, clean power, and green molecules and the indirect jobs that may get created in the value chain. We estimated the potential green jobs in Jharkhand using the following three-step methodology (for further details, see Annexure I).

- **Step 1:** Industry segments with green growth potential in the state were identified, studied and mapped to show their unexploited potential.
- **Step 2:** Full-time equivalent (FTE) jobs were estimated through secondary research and data analysis.
- **Step 3:** The projected annual job creation was then extrapolated for the analysis period (FY'26 to FY'30).

Further, we constructed two scenarios with different capacity targets to evaluate the impact of policy targets and investment on green job growth, as shown in Table 5.

Table 5: Scenarios of analysis

#	Scenario Name	Description
1	**Ambitious Policy Scenario (APS)**	▪ This scenario envisions a future where Jharkhand sets ambitious targets for RE deployment, green manufacturing, and EV adoption. ▪ It assumes robust policy support, significant investments in green infrastructure, and a focus on skill development and training programs.
2	**Accelerated Green Transition Scenario (AGTS)**	▪ This scenario explores an even more rapid and transformative pathway to a green economy. ▪ It assumes accelerated policy interventions, greater investments and skill development initiatives in RE and other green technologies, and a concerted effort to attract green businesses and industries to the state.

3.1 BOUNDARIES AND LIMITATIONS

The analysis focuses on the period from FY 2026 to FY 2030 to explore near-term job creation potential. It includes direct and indirect jobs but excludes induced jobs due to data limitations. Key industries considered are clean power (solar, biopower, small- hydro) and green molecules like biogas and hydrogen, driven by local potential and policies. The clean mobility sector includes electric and hydrogen vehicles, with a focus on rising demand and local investments. Table 6 lists out the boundaries & limitations of our analysis including the period of analysis.

Table 6 Boundaries of Analysis and limitations:

Criteria	Inclusions	Limitations/ Remarks
PERIOD OF ANALYSIS	FY 2026 – FY 2030	This date range was selected to understand job creation potential in the near future
JOB TYPES	▪ Direct jobs ▪ Indirect jobs	Induced jobs have not been estimated due to the unavailability of data on induced employment.
Industry	**Technology/ Segment**	**Rationale**
CLEAN POWER	▪ Solar PV ▪ Biopower ▪ Small hydro power ▪ Pumped storage	▪ Pumped storage has been considered since hydel-based power has existing unexploited potential in Jharkhand.
GREEN MOLECULES	▪ Compressed biogas (CBG) ▪ Bioethanol ▪ Green hydrogen ▪ Green ammonia	▪ Policy, schemes, technical potential, and demand in state exist for all these green molecules
CLEAN MOBILITY	**Electric Vehicle (EV):** ▪ 2W and 3W ▪ Car /jeeps/ SUV ▪ Light commercial vehicles	▪ Increasing sales trend, demand for EVs and existing automotive industry in Jharkhand
	Hydrogen ICE vehicles ▪ Medium and Heavy Commercial Vehicles	▪ Increasing awareness of and demand for zero-emission freight vehicles ▪ Investments by Cummins in Green Hydrogen engine manufacturing at Jamshedpur

3.2 RESULTS

The APS predicts that Jharkhand will create 392,742 direct & indirect green jobs by 2030, primarily driven by the green molecules and clean power sectors. Under the AGTS, this projection rises to 630,096, underscoring the substantial growth potential in the state's green employment landscape.

Table 7: Green jobs projected under APS and AGTS

INDUSTRY	APS		AGTS	
	Direct	Indirect	Direct	Indirect
GREEN MOLECULES	51,482	2,25,127	77,222	3,37,690
CLEAN POWER	20,975	41,908	42,200	66,484
CLEAN MOBILITY	8,875	44,375	17,750	88,750
TOTAL	**81,332**	**3,11,410**	**1,37,172**	**4,92,924**

We disaggregate the jobs creation projections by subsector in Annexure II.

4. RECOMMENDATIONS

The following recommendations for promoting green industries and skilling a green workforce are crucial for Jharkhand to successfully generate green jobs and transition to a sustainable economy.

- **Invest in biofuel development:** Identify land for feedstock, promote advanced technologies, and establish infrastructure to unlock economic opportunities and rural employment in the feedstock value chain.
- **Transition to green hydrogen:** Collaborate with neighboring states to establish green hydrogen production facilities so that the fuel can be used to ensure greening of industries and create potential export opportunities.
- **Accelerate clean power generation**: Expand solar and other RE capacities to reduce reliance on fossil fuels and enhance energy security. This can be done through policies to promote rooftop solar, streamlining approvals for RE projects, and investing in grid infrastructure to accommodate increased RE generation.
- **Attract investment in EV manufacturing:** Leverage the potential for job creation in EV assembly and component production, while addressing the impact of a shift in this industry on informal workers through reskilling initiatives.
- **Promote green equipment manufacturing:** Encourage growth in this sector to absorb the workforce from heavy industry, providing alternative employment opportunities and supporting a just transition.

It is also imperative to implement skill development initiatives that equip the workforce with the necessary expertise to thrive in emerging green sectors. The recommendations below will aid Jharkhand in achieving this goal.

- **Establish specialized Green Skills Training Centers** offering comprehensive programs across the green sectors discussed above.
- **Foster collaborations with industry and academia** to ensure that curricula align with green economy demands and leverage technology for broader reach.
- **Focus on reskilling and upskilling initiatives**, strengthen career guidance, and monitor the effectiveness of skill development programs.

By implementing these measures, the state government can proactively foster a green economy and ensure dignified and sustainable employment opportunities for its workforce.

ANNEXURE I: METHODOLOGY

STEP 1: MAPPING INDUSTRY SEGMENTS TO THEIR UNEXPLOITED POTENTIAL IN THE STATE

The mapping of industry segments/technologies with their unexploited potential is based on the estimated technical potential, recently announced policies, studies, and current investments in Jharkhand:

- For "green molecules," the production capacity in Jharkhand by 2030 is assumed to be 5% (under the APS) and 7.5 (under the AGTS) of India's national targets announced for each technology in their respective policies, to be achieved by 2030 or earlier.
- For "clean power" deployment capacity, state-level policy targets have been extrapolated by technology until 2030 (or capped at the maximum potential estimated by the MNRE) under the APS, with further enhancements (multipliers in range of 1.5-2) under the AGTS
- For "clean mobility", the manufacturing capacity by segment has been projected based on the anticipated demand within the state by 2030 in the APS, and further increased by a factor of 2 to account for potential exports out of the state.

Table 8: Capacity Target Assumptions under the APS and AGTS

Category	Unit	Estimated Potential (P)/ Policy Target (T)	APS Target	AGTS Target
CLEAN POWER: INSTALLATION TARGET BY 2030				
SOLAR PV- UTILITY	MW	18,180 (P, MNRE)	3,500	7,000
SOLAR PV- DISTRIBUTED	MW		1,000	2000
BIOPOWER	MW	146.31 (P, NIBE)	100	146.3
SMALL HYDRO	MW	228 (P, GoJ)	76	114
PUMPED HYDRO STORAGE	MW	1,500 (P, CEA)	1,500	1,500
GREEN MOLECULES: ANNUAL PRODUCTION CAPACITY BY 2030				
COMPRESSED BIOGAS	MMTPA	15 (T, SATAT)	0.75	1.125
BIOETHANOL	Million Liters	10,160 (T, EBP)	508	762
GREEN HYDROGEN	MMTPA	5 (T, NGHM)	0.25	0.375
GREEN AMMONIA	MMTPA	5.8 (T,NGHM)	0.29	0.435

Category	Unit	Estimated Potential (P)/ Policy Target (T)	APS Target	AGTS Target
CLEAN MOBILITY: MANUFACTURING FACILITY BY 2030				
ELECTRIC 2/3 WHEELERS	units	Assumption based on CPI analysis CPI Analysis Based on Press Release: TCPL Green Energy Solutions	1,00,000	2,00,000
ELECTRIC CARS	units		1,00,000	2,00,000
ELECTRIC LCVs	units		50,000	100,000
HYDROGEN ICE ENGINES	units		10,000	20,000
HYDROGEN M&HCVS	units		10,000	20,000

STEP 2: ESTIMATION OF FTE COEFFICIENTS

A full-time equivalent (FTE) or job year is a ratio that compares the time an employee spends on a specific task or project in a year to the standard total working hours for that year. The FTE formula converts short-term or temporary employment into a full-time equivalent or job year.

- All job numbers in this analysis represent FTE employment, calculated using FTE coefficients.
- These coefficients were sourced from previous studies or derived by the author based on publicly available employment data, investment announcements, press releases, or scheme related documents.

The FTE coefficients by segment/technology used in estimating green jobs are listed along with the sources in the table below:

Table 9: List of FTE Coefficients:

CATEGORY	TYPE OF JOB	UNIT	FTE/ YEAR	SOURCE	REFERENCE
CLEAN POWER					
SOLAR PV- UTILITY	Direct-EPC	per MW	2.95	CEEW & NRDC, 2022	India's expanding clean energy workforce
	Direct- O&M	per MW	0.5		
SOLAR PV- Distributed	Direct-EPC	per MW	24.22		
	Direct- O&M	per MW	3.8		
SOLAR PV- All	Indirect	per MW	2.56	CPI Analysis	Press Release, MoP, GoI
BIOPOWER	Direct-EPC	per MW	7	CEEW, 2019	Future skills and job creation with renewable energy in India
	Direct- O&M	per MW	9.24		
	Indirect	per MW	34.77		
SMALL HYDRO POWER (SHP)	Direct-EPC	per MW	13		
	Direct- O&M	per MW	0.84	ICIMOD, 2023	
	Indirect	per MW	0.2		Working Paper on Green Jobs

CATEGORY	TYPE OF JOB	UNIT	FTE/ YEAR	SOURCE	REFERENCE
PUMPED STORAGE PROJECTS (PSP)	Direct-EPC	per MW	2	VEERABALLI Project PSP	EIA Report, GoAP
	Direct- O&M	per MW	0.5		
	Indirect	per MW	5.6	World Bank, 2023	Report
GREEN MOLECULES PRODUCTION					
COMPRESSED BIOGAS (CBG)	direct	per MMTPA	80,946	CPI Analysis Based on references	MoPNG
	indirect		1,44,004		
BIO-ETHANOL	direct	per million litres	29		News Article
	indirect		128		
GREEN HYDROGEN	direct	per MMTPA	23,333		GH2 PLI Scheme
	indirect		96,667		
GREEN AMMONIA	direct	per MMTPA	23,333		
	indirect		96,667		
ELECTRIC VEHICLES & COMPONENTS MANUFACTURING:					
ELECTRIC 2&3W	Long Term	per unit	0.004	CPI Analysis based on reference	Ather
ELECTRIC CARS	Long Term	per unit	0.0275		JSW
ELECTRIC LCVS	Long Term	per unit	0.0275		JSW
H2 ICE ENGINE & VEHICLES MANUFACTURING:					
HYDROGEN ICE ENGINES	Long Term	per unit	0.25	Author's Analysis	Tata Cummins
HYDROGEN M&HCVS	Long Term	per unit	0.0275		JSW

STEP 3: EXTRAPOLATION OF GREEN JOBS

For estimating direct green jobs in clean power, the assumed target installed capacity for 2030 was evenly distributed across the analysis period i.e. 2026 & 2030, while also considering the construction period. For direct jobs green molecules and clean mobility, it was assumed that the annual production and manufacturing targets would be met by 2030. Further, the following formulas were applied to estimate both direct and indirect jobs:

FOR CLEAN POWER:

Green Jobs (EPC)=(TC-IC)×FTEE×(CP+0.5)

Green Jobs (O&M)=(TC-IC)×FTEO

Green Jobs (Indirect)=(TC-IC)×FTEI

Where,

TC is Target Capacity

IC is Installed or Existing Capacity

CP is Construction Period

FTEE is FTE coefficient for EPC jobs

FTEO is FTE coefficient for operation and maintenance jobs

FTEI is FTE coefficient for Indirect jobs in the segment

FOR GREEN MOLECULES AND CLEAN MOBILITY:

Green Jobs (P&M)=(PMC)×FTEPM

Green Jobs (Indirect)=(PMC)×FTEIV

Where,

PMC is the Production or Manufacturing capacity

FTEE is FTE coefficient for plant-level production or manufacturing jobs

FTEIV is FTE coefficient for indirect jobs across the value chain

ANNEXURE II: INDUSTRY WISE JOBS

Table 10: Jobs in Clean Power

CATEGORY	APS			AGTS		
CLEAN POWER	Direct		Indirect	Direct		Indirect
in MW	EPC	O&M		EPC	O&M	
SOLAR PV- UTILITY SCALE	4,108	1,741	1,792	8,238	3,491	3,584
SOLAR PV- DISTRIBUTED	8,317	3,262	540	18,005	7,062	1,080
BIOPOWER	227	748	33,867	356	1,175	53,254
SMALL HYDROPOWER	374	60	87	572	92	133
PUMPED HYDRO STORAGE	2,000	139	5,622	3,000	208	8,433
TOTAL	**15,025**	**5,950**	**41,908**	**30,171**	**12,029**	**66,484**

Table 11: Technology jobs in Green Molecules

GREEN MOLECULES	USE CASE	APS		AGTS	
		Direct	Indirect	Direct	Indirect
COMPRESSED BIOGAS	City gas distribution	24,284	1,08,003	36,426	1,62,005
ETHANOL	Petroleum blending	14,598	64,923	21,897	97,385
GREEN HYDROGEN	Steel	5,833	24,167	8,750	36,250
GREEN AMMONIA	Fertilizers	6,767	28,033	10,150	42,050
TOTAL		**51,484**	**2,25,127**	**77,222**	**3,37,690**

Table 12: Segment/Technology jobs in Clean Mobility

	APS		AGTS	
	Direct	Indirect	Direct	Indirect
ELECTRIC VEHICLES AND COMPONENTS				
ELECTRIC 2&3 WHEELERS	600	3,000	1,200	6,000
ELECTRIC CARS	2,750	13,750	5,500	27,500
ELECTRIC LCVS	2,750	13,750	5,500	27,500
HYDROGEN ICE ENGINES AND VEHICLES				
HYDROGEN ICE ENGINES	2,500	7,500	5,000	15000
HYDROGEN M&HCVS	275	825	550	1650
TOTAL	**8,875**	**38,825**	**17,750**	**77,650**

5. REFERENCES

CEEW. (2019). *A Second Wind for India's Wind Energy Sector: Pathways to Achieve 60 GW.* Retrieved from https://www.ceew.in/sites/default/files/ceew-study-on-indias-wind-energy-sector-scenarios-17July19.pdf

Central Electricity Authority. (2023). *REASSESSMENT OF 0NRIVER PUMPED STORAGE HYDROELECTRIC POTENTIAL IN INDIA.* Retrieved from chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://cea.nic.in/wp-content/uploads/hp___i/2023/08/Pumped_Storage_On_River_Final_compressed.pdf

Central Electricity Authority. (2024). *ALL INDIA INSTALLED CAPACITY (IN MW) OF POWER STATIONS.* Retrieved from chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://cea.nic.in/wp-content/uploads/installed/2024/03/IC_Mar_2024_allocation_wise.pdf

Chamberlain, S. (2013). Socio-Economic Development in India's Jharkhand: An Analysis of the Influence of Coal Mining. *SSRN*. doi:https://dx.doi.org/10.2139/ssrn.2386181

Chandra, R. (2017). Extractive States and Layered Conflict: The Case of Jharkhand's Electricity Sector. Retrieved from https://www.raponline.org/knowledge-center/extractive-states-and-layered-conflict-the-case-of-jharkhands-electricity-sector/

Cummins. (2023, Aug 25). *TCPL Green Energy Solutions Pvt. Ltd. (TCPL GES) signs MoU with Govt. of Jharkhand to power a cleaner India*. Retrieved from Tata Cummins: https://www.cummins.com/news/releases/2023/08/25/tcpl-green-energy-solutions-pvt-ltd-tcpl-ges-signs-mou-govt-jharkhand

GoJ. (2021). *Jharkhand Industrial Promotion Policy.* https://www.jharkhand.gov.in/PDepartment/ViewDocument?id=D014DO002SD00209082021090843146: Government of Jharkhand.

GoJ. (2022). *Jharkhand Electric Vehicle Policy 2022.* Ranchi: Government of Jharkhand. Retrieved from chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://cleanmobilityshift.com/wp-content/uploads/2022/10/Jharkhand-EV-Policy-2022.pdf

GoJ. (2023). *Economic Survey of Jharkhand.* Government of Jharkhand.

GoJ. (n.d.). *Green Hydrogen Mission*. Retrieved from Task Force-Sustainable Just Transition: https://www.justtransition-jharkhand.in/green-hydrogen/#:~:text=The%20Government%20of%20Jharkhand%20has,hydrogen%20mission%20in%20the%20state.

GoJ. (n.d.). *Task Force-Sustainable Just Transition*. Retrieved from Government of Jharkhand.

ILO. (2023). *Renewable Energy and Jobs: Annual Review 2023.* Retrieved from https://www.ilo.org/publications/renewable-energy-and-jobs-annual-review-2023

ILO. (n.d.). Green Jobs. Retrieved from https://libguides.ilo.org/green-jobs-en

IRENA. (2020). *Renewable Energy and Jobs: Annual Review* . Abu Dhabi: International Renewable Energy Agency.

MeitY. (n.d.). *Greenfield Electronic Manufacturing Clusters*. Retrieved from Ministry of Electronics & Information Technology: https://www.meity.gov.in/content/greenfield-electronic-manufacturing-clusters-0

Ministry of Coal. (2023). Provisional Coal Statistics 2022-23. Retrieved from chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://coal.gov.in/sites/default/files/2023-10/coal_171023.pdf

Mitra, S., & Chandra, R. (2023). DEEP DE-CARBONIZATION AND REGIONAL EQUITY. Retrieved from chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://nipfp.org.in/media/medialibrary/2023/10/WP_402_2023.pdf

MNRE. (2024, April 31). *Ministry of New & Renewable Energy*. Retrieved from Physical Achievements: https://mnre.gov.in/physical-progress/#

MNRE. (2024, Aug 12). *PM Surya Ghar: Muft Bijli Yojana.* New Delhi: Ministry of New & Renewable Energy. Retrieved from Explainer Details: https://static.pib.gov.in/WriteReadData/specificdocs/documents/2024/aug/doc2024812373601.pdf

MNRE. (n.d.). *National Green Hydrogen Mission*. Retrieved from MNRE: https://nghm.mnre.gov.in/overviews?language=en

MoEFCC. (2023). India achieves two targets of Nationally Determined Contribution well ahead of the time. Retrieved from https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1987752#:~:text=In%20August%202022%2C%20India%20updated,enhanced%20to%2050%25%20by%202030.

MoEFCC. (n.d.). *Net zero emissions target*. Retrieved from Press Information Bureau: https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1945472

MoF. (2023). *Economic Survey of India.* New Delhi: Ministry of Finance.

MoJS. (n.d.). *Galvanizing Organic Bio-Agro Resources Dhan Dashboard*. Retrieved from https://gobardhan.co.in/locate-plants?state=20&district=&plant_type=18&plant_status=

Moneycontrol. (2023). *Jharkhand government inks pact with TCPL GES for India's first green hydrogen 'fuel' project*. Retrieved from Moneycontrol.

MoPNG. (2023). *Government has set target to increase share of gas in energy mix up to 15 per cent by 2030*. Retrieved from Press Information Bureau.

NIBE. (2023). *Sardar Swaran Singh National Institute of Bio-Energy*. Retrieved from National Biomass Atlas of India: https://www.nibe.res.in/biomass-atlas.php

NIC. (2018). *Lugu Pahar Pumped Storage Project.* Retrieved from https://environmentclearance.nic.in/auth/FORM_A_PDF.aspx?cat_id=IA/JH/RIV/73970/2018&pid=New

Sattva Consulting. (2023). *GEARING UP THE INDIAN WORKFORCE FOR A GREEN ECONOMY.* Retrieved from chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://sscgj.in/wp-content/uploads/2023/05/Skills-Lanscape-for-Green-Jobs-Report.pdf

Singh, A. K., & Singh, Y. K. (2022). Social and Occupational Impact of Coal Mining in Dhanbad (Jharkhand) India - A Case Study. *40*(10), 66-77. doi:https://doi.org/10.9734/ajaees/2022/v40i1031041

WEF. (2021). *Mission 2070: A Green New Deal for a Net Zero India.* Retrieved from chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www3.weforum.org/docs/WEF_Mission_2070_A_Green_New_Deal_for_a_Net_Zero_India_2021.pdf

WEF. (2024). *The Rise of Green Molecules*. Retrieved from World Economic Forum: https://www.weforum.org/events/special-meeting-on-global-collaboration-growth-and-energy-for-development-2024/sessions/the-rise-of-green-molecules/

Yadav, A. K., Bhagat, R. B., & Yadav, V. (2019). Coal Mining and Access to Livelihood Capitals: Mines and Non-mines Affected Villages in Jharkhand (India). *Social Science Spectrum, 5*(1). Retrieved from https://www.socialspectrum.in/index.php/sp/article/view/157

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