

Technical Brief

Vulnerability Assessment of Mineral-Rich States to Energy Transition

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Abbreviations

Abbreviation	Definition
CG	Chhattisgarh
CIL	Coal India Limited
CSR	Corporate Social Responsibility
FD	Fiscal Deficit
GGI	Good Governance Index
GSDP	Gross State Domestic Product
GW	Giga Watt
JH	Jharkhand
MHA	Ministry of Home Affairs
MP	Madhya Pradesh
MW	Megawatt
OD	Odisha
RE	Renewable Energy
UNDP	United Nations Development Program
WB	West Bengal

1. Context

Over the past five decades, the expansion of conventional power generation capacity has enabled India to secure significant energy independence and has provided millions of Indians in the remotest corners of the country access to electricity. Coal currently accounts for 55% of India's energy demand. The domestic availability of this natural resource has led to the creation of a power generation infrastructure, largely primed to utilise this resource.

In India, extraction and mining of this valuable resource are concentrated in a few mineral-rich states. About 85% of the country's coal production is concentrated in the five eastern states of Chhattisgarh, Jharkhand, Madhya Pradesh, Odisha, and West Bengal. These are also amongst the most economically impoverished states, with limited additional economic drivers¹. As a result, the economies of these states rely heavily on this solid fossil fuel-based economy for generating revenue, ensuring employment, and financing social programs.

Going forward, India has committed itself to a net zero target by 2070, which will require India's energy mix to substantially shift from fossil fuels to greener energy sources. This transition will put these states, which are at the forefront of India's solid fossil fuel production, in a potentially vulnerable position.

While the transition is contingent upon multiple issues being taken care of, such as creation of adequate non-fossil generation capacity for energy security, effective yet acceptable financing options, and generation of alternate economic drivers, the transition seems inevitable and is likely to have a major impact on India's future. In the face of transition, the nature and viability of many economic activities revolving around coal mining and consumption in these states will be fundamentally altered. Some activities may shrink or disappear altogether; others may flourish.

While the transition is expected to bring net positive impact in the long run, in the short-to-medium term the transition could also cause significant economic disruption, dislocation of dependent population, and other costs and losses to individuals, businesses, communities, and states. If these impacts are left unaddressed, a low-carbon world may be achieved but it would not necessarily mean a more just world, despite its environmental and economic benefits, especially for states that will have stronger socioeconomic ramifications compared to other states. Therefore, securing a just transition is critical to minimize the impacts on all stakeholders associated with the domestic production and consumption of these solid fossil fuel resources.

This brief is the first part of CPI's initiative on "Facilitating Finance for Just Transition." The initiative will analyze the relative impact of energy transition on various states. This brief helps rank states based on their vulnerability to an energy transition.

¹ [RBI](#)

2. Vulnerability assessment

Vulnerability assessment acts as a means to identify states facing relatively higher potential transition risks, thereby helping focus efforts on facilitating just transition in such states. CPI has undertaken a vulnerability assessment of Indian states based on their standing on multiple parameters indicating the possible implications of the energy transition on the socioeconomic parameters of these states. This entails a two-step process:

- (i) identification of states' considering solid fossil fuel production and consumption for electricity generation,
- (ii) ranking states based on parameters including economic, socio-political and environmental factors.

2.1 Identification of states

India is the second largest producer and consumer of coal. The reserves are predominantly spread across ten states. However, most of the production is concentrated in eastern and central India. The top five states account for more than 85% of production².

On the power production side, India has an installed capacity of more than 400 GW, third globally behind China and the USA³. The share of solid fossil fuel in installed capacity in the country is around 60% while its share in power production is more than three quarters of total generation⁴. The western, southern, and coastal regions of countries have high solar and wind potential, while the hills in the north and northeast are sources of hydropower in the country. Policymakers have over the years supported building conventional power generation capacities in the eastern and central regions of the country considering significant solid fossil fuel reserves in the region.

In our approach to identify states vulnerable to transition, we have selected the top five states for detailed study. The selection has been done based on two criteria's :

1. Dependency on conventional capacity for power generation - Share of conventional capacity in total power production capacity of the state, scored on a scale of 0-10.
2. Fossil fuel production – Annual fossil fuel mined vis-à-vis other key fossil fuel producing states, scored on a scale of 1-10.

This integrated approach has helped to identify states which would be impacted by transitioning away from this resource on both the production and consumption side. The table below shows the top five states on an integrated score:

² [Ministry of Coal](#)

³ [Statista](#)

⁴ [CEA](#)

Table 1: Identification of States

State	RE Capacity (In MW)	Fossil fuel-based capacity (In MW)	% Share of fossil fuel-based capacity	Score (A)	Fossil Fuel Production (Million Tonnes)	Score (B)	Total Score (A+B) = (C)	Rank
Odisha	628	4,858	89%	8.9	185.0	10.0	18.9	1
Chhattisgarh	1,295	12,222	90%	9.0	153.8	8.3	17.3	2
Jharkhand	103	2,195	96%	9.6	129.8	7.0	16.6	3
Madhya Pradesh	5,875	16,088	73%	7.3	138.0	7.5	14.8	4
West Bengal	606	8,583	93%	9.3	29.1	1.6	10.9	5
Telangana	5,090	9,439	65%	6.5	67.2	3.6	10.1	6
Maharashtra	11,678	25,254	68%	6.8	56.2	3.0	9.8	7
Bihar	390	6,826	95%	9.5	0.0	0.0	9.5	8
Uttar Pradesh	4,727	20,388	81%	8.1	18.1	1.0	9.1	9
Haryana	1,323	8,638	87%	8.7	0.0	0.0	8.7	10
Punjab	1,828	8,214	82%	8.2	0.0	0.0	8.2	11
Assam	184	403	69%	6.9	0.0	0.0	6.9	12

As evident from the table above, states from eastern and central India are more dependent on fossil fuel production and consumption than others. Further in this brief, we study the top five states in detail on defined parameters.

2.2 Vulnerability parameters

The five states identified for the detailed study were assessed on key parameters and bucketed into five dimensions:

- (1) Losses - fiscal and economic,
- (2) Physical – Vulnerability to climate risks,
- (3) Socioeconomic – Implication of Energy Transition (Loss to communities),
- (4) Diversification – Potential options for states, and
- (5) Political economy.

The parameters and rationale behind them are captured in the table below.

Table 2: Vulnerability Parameters

Dimension	Key Parameters	Rationale
Losses – Fiscal and Economic	States dependence on fossil fuel mining for revenue	Energy transition would impact states' tax and non-tax revenues generated from fossil fuel mining companies. Higher dependency implies higher vulnerability.
	States dependence on power sector for revenue	Energy transition would impact revenue generated for states by power generating companies
Physical - Vulnerability to Climate Risks	Vulnerability to physical climate risks	States' vulnerability to events like droughts, floods, and cyclones
	Disaster Resilience Index published by Ministry of Home Affairs (MHA) and United Nations Development Program (UNDP) in India	States' preparedness in tackling physical risks of climate change
Socioeconomic - Implications of Energy Transition (Loss to communities)	Direct and indirect employment in fossil fuel mining and power generation	Transitioning from traditional sources of energy to new sources of energy would directly impact workforce. The impacted individuals would either need to be reskilled or compensated for job loss
	Corporate social responsibility (CSR) funds spent in a state by NTPC and Coal India Limited (CIL) and subsidiaries	Companies working in the power sector value chain make a significant investment in community development, especially in mineral-rich states. This will be impacted in face of the energy transition
Diversification – Potential Options for States	Current dependence of the state on fossil fuels for power generation	Higher dependence of the state on fossil fuel for power generation could impact energy security in case of a transition
	Renewable energy (RE) potential to support transition	Higher RE potential can give comfort to the state in transitioning away from fossil fuels
	Contribution of fossil fuel-independent sectors in gross state domestic product (GSDP) (agriculture, banking and services)	Higher contribution of fossil fuel-independent sectors in GSDP could help minimize the impact on state finances
Political Economy – Provisions or Governances in the state for Adaptations and just transitions.	Good Governance Index (GGI) published by Department of Administrative Reforms & Public Grievances	GGI measures state capacity to deliver public services. A better GGI score indicates a state's strength in delivering services required for Just Transition
	State finances: Fiscal deficit (FD)/GSDP (8-year average, 2012-2020)	A stronger fiscal position could provide flexibility to states in managing the impact of Just Transition

2.3 States status on each parameter

Data for each of the vulnerability parameters defined in the previous sub-section were mined from the public domain and analyzed. The data for each indicator is a mix of secondary and derived data. The sub-sections below show states' standing on each of the parameters.

2.3.1 Fiscal and economic loss

Transition-induced fiscal and economic losses could impact state revenues. States with higher dependence on fossil fuel and the least diversified sources of revenue are likely to face the maximum impact. The table below captures the standing of each state on parameters related to fiscal and economic losses.

Table 3: Fiscal and Economic Loss

Parameters	Formula	CG	JH	MP	OD	WB
States dependence on fossil fuel mining for revenue ⁵	(Payment of royalty, cess, GST, and other levies by CIL and its subsidiaries) / (state's total own tax and non-tax revenue)	30%	35%	12%	18%	5%
States dependence on power sector for revenue ⁶	(Revenues from electricity duties and other charges)/ (state's total own tax and non-tax revenue)	6.1%	0.9%	3.4%	6.0%	3.8%

CG – Chhattisgarh, JH – Jharkhand, MP- Madhya Pradesh, OD – Odisha – West Bengal

Chhattisgarh and Jharkhand are highly dependent on fossil fuel-linked revenues with the least diversified sources of revenue. Chhattisgarh has more than 23 GW of conventional generating capacity translating into high investment at risk.

2.3.2 Physical risk

Physical risk pertains to states' vulnerability to climate change-induced events. The states have been assessed on two parameters under this dimension signifying threat and its preparedness in dealing with such a scenario.

Table 4: Physical Risk

Parameters	Formula	CG	JH	MP	OD	WB
Vulnerability to Physical Climate Risks ⁷	(Exposure * Sensitivity)/ Adaptive Capacity	0.087	0.067	0.182	0.368	0.257
Disaster Resilience Index (Disaster Preparedness) ⁸	Function of (Early Warning System, Emergency Operation Centre, Communication, Contingency plans, Awareness Generation, Resource Inventory, Media Participation, others)	14	7.5	16.5	22	24

Landlocked states (Chhattisgarh, Jharkhand, and Madhya Pradesh) are less vulnerable to cyclone-linked physical climate risk compared to coastal states (Odisha

⁵ [TERI](#)

⁶ [Prayas](#)

⁷ [CEEW](#)

⁸ [MHA](#)

and West Bengal). Higher physical risk has also translated into better preparedness of these coastal states to this risk.

2.3.3 Socioeconomic implications

A shift to greener sources of energy will impact the livelihoods of the workforce—directly and indirectly—employed in fossil fuel mining and fossil fuel-based power plants. Revenues of organizations involved in fossil fuel mining and power generation will also be impacted, which in turn would impact their ability to invest in communities as part of their CSR programs.

Table 5: Socioeconomic Implications

Parameters	Formula	CG	JH	MP	OD	WB
Total direct and indirect employment in fossil fuel mining and the fossil sector ⁹	$((\text{Direct} + \text{indirect employment per tonne of fossil fuel mined}) * (\text{fossil fuel mined})) + ((\text{direct} + \text{indirect employment per MW in fossil fuel-based power generation}) * (\text{fossil fuel-based power generation capacity}))/ \text{state population}$	0.8%	0.5%	0.3%	0.5%	0.05%
CSR spending by NTPC and Coal India Limited (CIL) and subsidiaries ¹⁰	CSR spend in state/ total CSR Spend	1%	1%	11%	48%	4%

Jharkhand has the maximum direct and indirect workforce employed in solid fossil fuel mining while Chhattisgarh has the maximum workforce employed in conventional power generation.

Odisha is prone to cyclones and other natural disasters resulting in organizations spending heavily on rebuilding and safety measures. Thus, Odisha corners the maximum CSR spending amongst these organizations.

2.3.4 Diversification

India has an integrated electricity grid which makes it possible to generate power in one part of the country and transport it to the consumption center. However, states prefer to have power plants within their boundaries as it helps in reducing transmission losses and costs. It also affords the states autonomy in deciding financial and operating aspects of the assets with greater flexibility. The states also benefitted from taxes and employment generated within the state. Thus, in case of transition, states could prefer to have the production of the greener sources of energy within state

⁹ TERI, NTPC & UBCV

¹⁰ ASHOKA

boundaries. Considering this, the table below captures states' potential to transition to greener sources of energy.

Table 6: Diversification Risk

Parameters	Formula	CG	JH	MP	OD	WB
Current dependence of the state on fossil fuels for power generation ¹¹	Installed fossil fuel-based capacity/ total capacity in state	96%	93%	74%	77%	87%
Renewable energy (RE) potential to support transition ¹²	Renewable energy potential in state/ current fossil fuel-based capacity in state	0.9	4.1	3.8	3.5	0.6
Contribution of fossil fuel-independent sectors in GSDP ¹³	Net state value added by economic activity in agriculture, banking and services/ net state value added by all economic activities	45%	47%	63%	46%	67%

The states with high conventional generation capacity such as Chhattisgarh may face issues in diversifying their energy sources. The higher dependence on fossil fuel for power generation coupled with below national average RE potential could impact the energy security of the state.

Three eastern states—Chhattisgarh, Jharkhand and Odisha—have the least diversified economies where its dependence on fossil fuel in state GSDP is prominent.

2.3.5 Political economy

The state's ability to manage transition will be dependent upon the strength of its balance sheet and its ability to deliver services required to impacted communities. The same has been measured in the form of state finances and the Good Governance Index (GGI) in the table below.

Table 7: Political Economy

Parameters	Formula	CG	JH	MP	OD	WB
Good Governance Index (GGI) ¹⁴	Function of fifty-eight Indicators from eight Sectors	0.54	0.50	0.65	0.45	0.38
State Finances ¹⁵	Fiscal Deficit/Gross State Domestic Product	2.9%	3.2%	3.2%	2.0%	3.4%

West Bengal has stretched finances and lower than-average GGI, indicating scope for improvement on both fronts.

¹¹ CEA

¹² MNRE

¹³ RBI

¹⁴ DARP

¹⁵ RBI

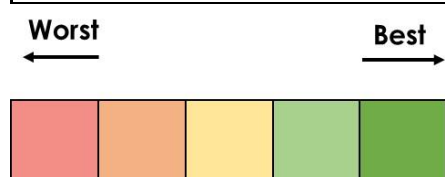
2.4 Ranking of states

The states were ranked based on aggregated score of the parameters defined in previous section.

The states were ranked on the parameters defined in the previous section.

Table 8: Ranking

Parameters	CG	JH	MP	OD	WB
Share of revenues from fossil fuel mining	8.4	10.0	3.4	5.1	1.4
Share of revenues from power generation	10.0	1.5	5.6	9.8	6.2
Vulnerability to climate extremes	2.4	1.8	4.9	10.0	7.0
Resilience to natural disasters	4.2	6.9	3.1	0.8	0.0
Population directly employed in fossil fuel mining and power generation	10.0	5.9	3.2	6.7	0.7
CSR spend by NTPC and CIL & subsidiaries	0.2	0.2	2.2	10.0	0.9
Current dependency of the state on fossil fuel for power production	10.0	9.7	7.7	8.1	9.1
Ratio of RE potential to current coal-based generation capacity	0.9	4.1	3.8	3.5	0.6
Contribution of fossil fuel independent sectors in GSDP	3.4	3.0	0.7	3.2	0.0
Good Governance Score	1.6	2.2	0.0	3.1	4.2
State Finances: FD/GSDP	8.4	9.3	9.4	5.9	10.0
Total (The sum of scores on each parameter)	59.4	54.7	44.1	66.3	40.1
Rank	2	3	4	1	5



Based on the score above, Odisha stands most vulnerable to transition closely followed by Chhattisgarh and Jharkhand.

3. Findings

Each state has its own specific set of issues; however, few things are prominent which impact one state more than another. A state-wise analysis is given below.

Odisha: Odisha emerges as the most vulnerable state. Being a coastal state, it is highly vulnerable to physical climate risks. It also corners the highest CSR spend from public sector undertakings (PSUs) in fossil power generation and fossil fuel mining vis-à-vis other states. The state, however, does have significant RE potential and can replace its existing fossil plants without impacting its energy security.

Chhattisgarh: Chhattisgarh is the second most vulnerable state on the list. It has the maximum conventional fuel capacity amongst the assessed states. This impacts the state on multiple parameters: high dependence on electricity for revenue, energy security and limited diversification options. Even though it is one of the least exposed state to physical climate risks, it also has very limited resilience to natural disasters. Additionally, it has the maximum proportion of the population dependent on solid fossil fuel mining.

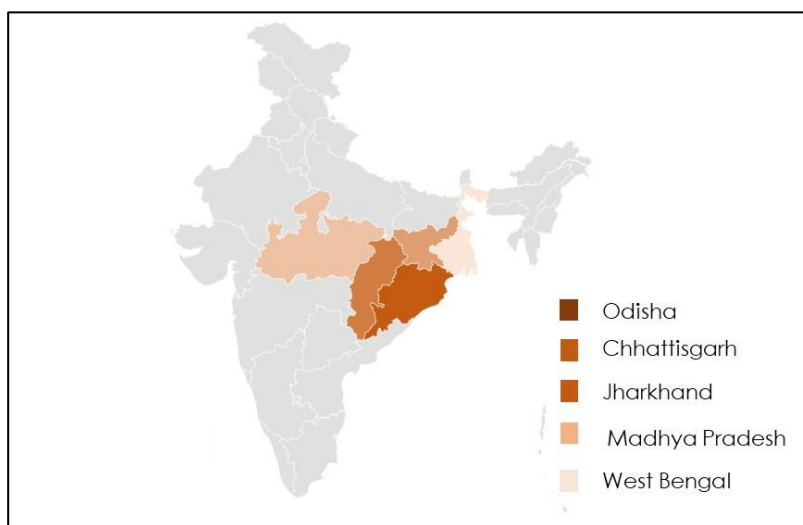


Figure 1: Vulnerability Heat Map of Assessed Indian States

Jharkhand: Jharkhand is heavily dependent upon fossil fuel mining for its state revenue with more than a quarter of its revenue coming from fossil fuel mining alone. The state does have RE potential to replace its existing fossil power plants; however, the ability of state finances to support the same is limited as state finances are stretched with an average fiscal deficit being on the higher side compared to other states.

Madhya Pradesh: Madhya Pradesh is in a better position compared to other states with less dependence on fossil fuels for revenue. However, the state does have significant investments in fossil power capacity translating into significant investment risk arising from the phase-down of these plants.

West Bengal: West Bengal commands a better position amongst all assessed states with a more diversified economy having lower dependence on fossil fuel for revenue. However, the state has significant fossil power capacity and lower than required replaceable RE potential, thereby risking its energy security in case of transition. The state finances too are stretched with the fiscal deficit being the highest among all assessed states.

4. Way forward

As per CPI analysis, the troika of mineral rich states – Chhattisgarh, Jharkhand and Odisha stand most vulnerable to energy transition. This is due to the substantial dependence of the state revenues and overall economies on extraction of solid fossil fuel and its utilization in energy and industrial goods production. A comprehensive energy transition would require detailed financial impact and need assessment of these states. The work would require significant will and commitment from respective states.

Jharkhand, which ranks third on cumulative ranking and first based on solid fossil fuel production alone has initiated the groundwork. It has set up a Just Transition Task Force aimed at identifying all relevant stakeholders, holding consultations and working on the development of requisite solutions.

CPI, with its expertise in technical and financial domains, is planning to work with other peer organizations and philanthropies, to help the most vulnerable states in modeling the impacts costs for a successful and just transition and designing requisite financing frameworks to support just economic transformation of the states.