Policy Brief

JUST TRANSITION IN ODISHA FOR GREEN GROWTH & GREEN JOBS

iFOREST
INTERNATIONAL FORUM FOR ENVIRONMENT, SUSTAINABILITY & TECHNOLOGY

Contents

A. Context

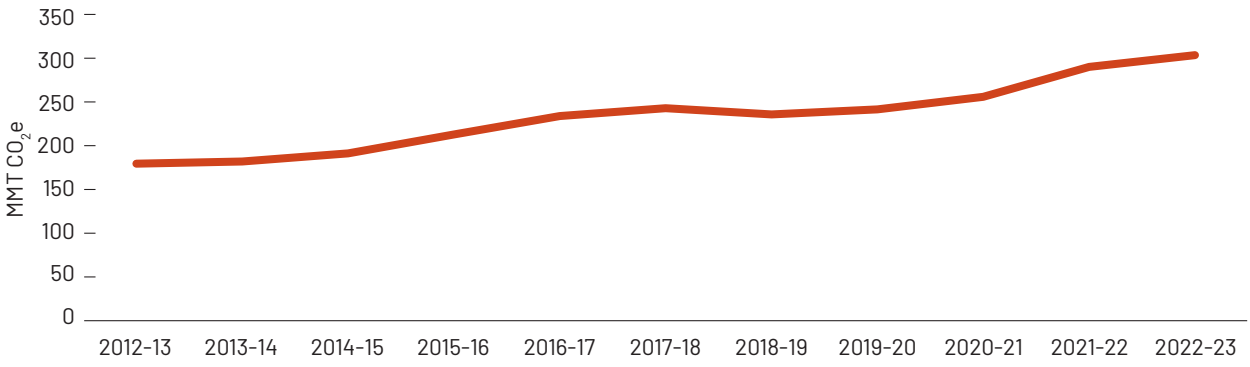
Odisha is one of India's most resource-rich states, being endowed with abundant coal, iron ore, and other mineral resources. The state is home to major industries such as steel, aluminium, cement, among others. In 2023-24, industrial sector contributed about 43.3% to the Gross State Value Added (GSVA), much higher than the national average of 27.6%. The state envisions becoming the 'industrial hub of Eastern India' and the trade and commerce gateway to South and East Asia.

Considering the trajectory of industrial growth, Odisha is a key state in realising India's net zero goals and steering the course of an accelerated and just energy transition. The state's greenhouse gas (GHG) emissions have increased at a compound annual growth rate (CAGR) of slightly over 5.6% over the last decade. As per 2022-2023 estimates, the total GHG emission is 305.2 million metric tonnes of CO_2 equivalent (MMT CO_2e), which is about 9.7% of India's total.

Depending on the growth rate of the Gross State Domestic Product (GSDP), emission intensity, and green economy policies, Odisha's total GHG emissions are projected to range between 493-782 MMT CO_2e by 2035-36. In a business as usual scenario, with trends similar to the past decade, emissions could reach 665 MMT CO_2e—more than double the current levels. Under a high-growth scenario, with 8% annual GSDP growth and unchanged emission intensity reductions, emissions may rise to 782 MMT CO_2e. However, in an NDC-aligned scenario, with 8% GSDP growth and a 45% reduction in emission intensity from 2005 levels, emissions would be 493 MMT CO_2e.

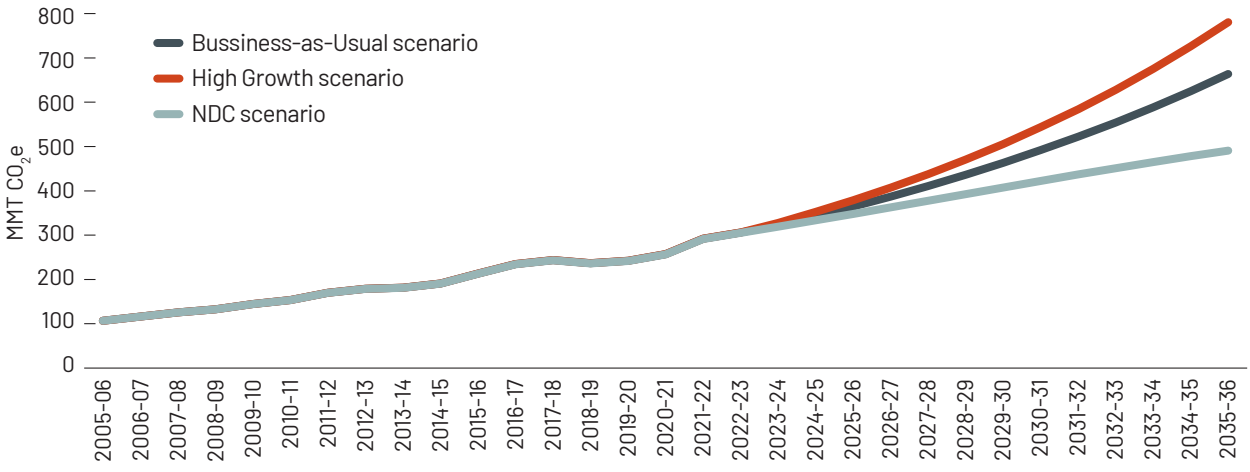
With large-scale industrial expansion planned—especially in the coal, iron and steel, and construction sectors—Odisha requires a comprehensive, cross-sectoral strategy to reduce the emission intensity of its economy and meet the emission intensity and renewable energy (RE) targets set by India. This approach must also focus on creating opportunities for green jobs, promoting sustainable economic growth, and ensuring an inclusive and just transition.

Figure 1: GHG emissions in Odisha



Source: iFOREST analysis

Figure 2: Projected GHG emissions under different scenarios



Source: iFOREST analysis

B. Just Transition Landscape: Sectors, Geographies and Dependency

1. Coal mining

The coal mining sector faces the risk of stranded assets due to climate goals and increasing competition from the renewable energy sector. Over the next 10 years, the state is likely to close six coal mines, highlighting the necessity for a just transition strategy that safeguards economic development and employment in the impacted regions.

About 24% of India's coal production comes from Odisha

Odisha is India's largest coal-producing state, accounting for about 24% of the country's coal production. The state has a coal production capacity of about 353 million metric tonnes per annum (MMTPA) and produced over 237 MMT of coal in 2023-24, combining commercial and captive mines. The Public Sector Undertaking (PSU) Mahanadi Coalfields Limited (MCL), a subsidiary of Coal India Limited (CIL), alone produced 206 MMT of coal.

The sector supports over 40,500 formal jobs and at least 1.6 times informal workers. Out of the total formal workers, 35,440 are with MCL. About 57% of the workers are engaged in mining activities in Talcher block of Angul district.

Table 1: Status of operational mines

Mine type	No. of mines	Production capacity (MMTPA)	Formal workforce
Opencast*	22	350.55	38,000
Underground	4	2.42	2,515
Total	**26**	**352.97**	**40,515**

Source: CIL, August, 2024, and latest environmental clearance letters of mines operational in the state. *Includes 15 commercial and seven captive mines.

Transition hotspots, challenges, and opportunities

Hotspots: Commercial and captive coal mines in Odisha, are spread over four districts. These include Angul, Sundargarh, Jharsuguda, and Sambalpur. Over 46% of the mines (12 mines) are in Angul district with a cumulative production capacity of 145 MMTPA.

Overall, Talcher block of Angul is the most important transition hotspot with nine operational mines with over 121 MMTPA production capacity. The block also has three closed mines. Apart from Talcher, the other important region is the Jharsuguda and Lakhanpur blocks of the Jharsuguda district. There are five operational mines in these two adjoining blocks with a cumulative production capacity of about 62 MMTPA. Additionally, in Jharsuguda block, there are three closed mines.

By 2030, six mines—four underground (UG) and two opencast (OC)—can be closed in the state. These mines are concentrated in Talcher and Jharsuguda blocks. Except for the two OC mines, all are low-producing, and out of the four UG mines, three are unprofitable. Additionally, by 2040, Talcher block will experience the transition of key mines, such as Lingaraj, Ananta, and Jagannath, due to exhaustion of resources. Overall, a total of six mines with about 80 MMT capacity will exhaust resources.

Coal mining sector should mitigate stranded asset risks by optimising production from existing mines

Challenges: A major concern for Odisha is the risk of stranded assets in the coal sector due to planned expansion and underutilisation of existing capacity. While the state has a coal production capacity of 352 MMT, the current output is only 235 MMT, meaning mines are operating at just 67% capacity. With the potential to increase production by over 100 MMT from existing mines, opening new coal blocks is inefficient, and may have no takers in the future.

Besides, nearly 99% of Odisha's coal produced by MCL is dispatched for power generation. As India advances towards renewable energy (RE) goals, coal demand is expected to peak by the mid-2030s, making new mines economically unviable.

Opportunities: In the next decade, the coal mining sector should focus on improving operational efficiency and optimising resource extraction from the operational mines. All the new mines being planned for the state must

go through an assessment of the prospects of demand considering the coal peak to mitigate the risk of stranded assets. Optimising the output from existing mines will also ensure more sustainable resource management.

11,000 hectares of coal mining land can be planned for repurposing by 2030

Planning economic diversification of coal districts will also be important to start creating alternative livelihood opportunities to ensure a smooth transition of the local communities and prevent any socio-economic disruptions. Repurposing of land available with coal mines provides a crucial opportunity for this.

In the immediate future, the opportunity lies with repurposing the land available with closed mines, and those that are going to exhaust their extractable resources or are economically unviable. Considering this, collectively, over 11,000 hectares (ha) of land can be planned for repurposing by 2030. This land is primarily in Talcher and Jharsuguda blocks.

Overall, in the coming decades, a planned reclamation and repurposing of mining land through a collaborative approach between the mining company(ies), the state government, and the local community will be crucial for optimising productive economic use of this valuable asset and ensuring economic continuity in mining districts and blocks.

Table 2: Land available with coal mines

Mine type	Land available (ha)
Commercial operational mines*	24,895.5
Captive operational mines	6,830
Closed mines	4,734
Total	**36,459.5**

Source: iFOREST analysis based on information obtained from MCL, 2024, and environmental clearance letters of mines; * Includes one mine to start operation soon

2. Coal-based power

The captive power plants associated with various industrial sectors should accelerate the integration of renewables to align with the Renewable Purchase Obligation targets and support overall industrial decarbonisation measures.

Odisha has one of the largest captive power plant (CPP) capacities in India, which is 16% of the country's total, given its large-scale industrial operations. Of the total 12.5 gigawatts (GW) of captive power capacity, 93% (11.7 GW) is coal-based. Overall, the total capacity of coal-based power in the state is 21 GW.

The sector is a key contributor to the state's GHG emissions. As per estimates for 2022-23, the coal-based thermal power plants (TPPs) contribute to about 49% (149.8 MMT CO_2e) of the state's total GHG emissions. The emissions from TPPs have grown at a CAGR of 6.3% over the last decade.

Overall, the sector formally employs nearly 32,300 people, out of which about 59% are with the CPPs. The informal jobs are likely to be much higher.

Table 3: Coal-based thermal power plants

Type	No. of plants	Capacity (GW)	Formal workforce
Utility	7	9.4	13,247
Non-utility (captive)	79	11.6	19,046
Total	**86**	**21**	**32,293**

Source: Capacity data based on the report of Central Electricity Authority, 2024, and Odisha Renewable Energy Development Agency, 2024. Worker numbers have been estimated based on company data, manpower requirement norms of Central Electricity Authority, 2024, and district-wise CPP data as obtained from GRIDCO, 2024

The coal-based power fleet in Odisha is relatively young considering both utility-scale and captive plants. Of utility-scale plants, only about 1.4 GW will reach 35 years of age in the next six to seven years. Considering CPPs, the assessment for plants with 100 MW and above capacity shows that these units started operating during the first decade of this century.

Transition hotspots, challenges, and opportunities

Hotspots: About 88% of the coal-based power capacity (combining utility-scale and captive plants) is concentrated in five districts- Angul, Dhenkanal, Jharsuguda, Sundargarh, and Sambalpur, which are the hubs of coal mining and industrial operations. Among these, Angul has the maximum installed capacity, about 6.7 GW, considering the operation of the NTPC plant, and three CPPs. Jharsuguda, which is a close second with about 5.7 GW installed capacity, has 11 plants (eight captive and three utility-scale).

Challenges: Odisha has a substantial number of CPPs, primarily fueled by coal. These plants help industries meet their electricity demands while reducing reliance on the state's grid. However, the heavy dependence on coal for power generation in these plants contributes significantly to GHG emissions. With the state's ambition and potential of industrial growth, the number of CPPs will also increase. Therefore, it is important to plan a transition of the CPPs to green energy sources.

1.4 GW of TPP capacity combining four units can be planned for repurposing by 2035

Opportunities: There are two crucial opportunities for transitioning the state's coal-based power sector - green transition of the CPPs, and repurposing of the existing old thermal power plants (TPPs) and energy assets.

Considering that greening the power sector and industrial decarbonisation will be crucial for Odisha's green transition, integrating RE sources in CPPs will be necessary. These units must accelerate RE integration to align with the Renewable Purchase Obligation (RPO) targets (43.33% overall RPO target by 2030) to support decarbonisation efforts. Further, the target of 11 GW of RE capacity by 2030, set by the State Government provides the necessary impetus for this.

The Odisha Renewable Energy Policy (2022) already offers several non-fiscal and fiscal incentives to support RE adoption by CPPs. These include fast-track approvals, specific exemptions on Electricity Duty, State Transmission Utility charges, and wheeling charges, among others.

Concerning the repurposing of energy assets, about 1.4 GW capacity combining four TPP units can be planned for repurposing by 2035. These include two units (200*2=400 MW) of the IB Valley Thermal Power Station (TPS) and two units (500*2=1,000 MW) of Talcher power station.

Table 4: Repurposing of TPP units by 2035

Plant name	Company	Location	Units that can be retired and repurposed	Capacity	Year by which reaching 35 years age
IB Valley TPS	Odisha Power Generation Corporation Ltd. (OPGCL)	Jharsuguda	1	200	2029
			2	200	2030
Talcher STPS	NTPC Ltd.	Angul	1	500	2030
			2	500	2031

Source: iFOREST analysis based on data of Central Electricity Authority, 2024, and environmental clearance letters of plants

Overall, repurposing the land available with TPPs is an important opportunity for industries to develop green energy infrastructure. Nearly 4,200 ha of land is available with the utility-scale plants. Besides, an estimated 5,904 ha of land is available with the CPPs operating in various districts. About 69% of the CPP land is concentrated in just three districts, Angul, Jharsuguda, and Sambalpur, the biggest industrial districts of the state.

3. Industry

With the ambition to make Odisha the industrial and manufacturing hub of Eastern India, and with more than 3.2 lakh formal employment in various factories, a just transition of industry will be a central agenda for greening Odisha's economy and boosting green job opportunities.

Odisha has 3,207 factories of which 2,697 were operational during the reference year 2021-22. The industries in the state with which these factories are associated have been classified into 'high, moderate, and low impact' categories for energy transition, considering their reliance on fossil fuels and the intensity of their energy use.

IMPACT CATEGORY OF FACTORIES

Factories are defined as *"any premises including the precincts thereof—(i) whereon ten or more workers are working, or were working on any day of the preceding twelve months, and in any part of which a manufacturing process is being carried on with the aid of power, or is ordinarily so carried on, or (ii) whereon twenty or more workers are working, or were working on any day of the preceding twelve months, and in any part of which a manufacturing process is being carried on without the aid of power, or is ordinarily so carried on"*. (The Factories Act, 1948).

The following are the various sectors that will fall under the high, moderate, and low-impact segments in the event of energy transition.

High impact: Sectors including iron and steel, coke ovens, refined petroleum products, electric motors, generators, batteries, cement, bricks, refractories, automobile and automobile components, basic chemicals, fertilizer, and nitrogen compounds, among others, will be highly impacted.

Moderate impact: Sectors including fabricated metals, pulp and paper, and pharmaceuticals, among others, will be moderately impacted due to the direct use of fossil fuels like coal and natural gas for process heat and electricity.

Low impact: Sectors including food processing, wood-processing and product industries, tobacco, computer and electronics, consumer goods, types of machinery, etc., will be less impacted due to energy transition.

High impact

Over 40% of the factories in Odisha will be highly impacted by the energy transition. These factories are highly significant for the economy for the following reasons:

40% of the factories that will be highly impacted by the energy transition engage 80% of all factory workers

- They account for over 90% of the total economic output and over 92% of the Gross Value Added (GVA) from all factories.
- They have over 78% of total factory employment and engage 80% of all factory workers.
- This segment also has a very high share of women workers, which is about 71% of all women workers (total women workers in factories is 16,403) engaged in various factories.
- These are highly energy-intensive and are responsible for around 96% of the total energy consumption from industries.

Moderate impact

Approximately 36% of the state's total factories will be moderately impacted by the energy transition. These factories account for:

- About 4.7% of the total economic output and 5.4% of the total GVA.
- Over 11.5% of total factory employment.
- About 3.4% of the total energy used by all factories and exhibit moderate energy intensity.

Low impact

Approximately 24% of the factories will face low impact from the energy transition as these have very low energy consumption and are responsible for about 0.8% of the total energy usage. These factories account for:

- About 4.4% of the total economic output and 2.3% of the total GVA.
- Over 10% of total factory employment.

Table 5: Characteristics of industries likely to be impacted by the energy transition

Characteristics	All factories	High impact		Moderate impact		Low impact	
		Value	Share of total (%)	Value	Share of total (%)	Value	Share of total (%)
1. Number of factories	3,207	1,297	40.4	1,149	35.8	761	23.7
a. Number of factories in operation	2,697	1,057	39.2	941	34.9	699	25.9
2. Total output (₹ Lakh)	4,68,79,707	4,26,12,003	90.9	22,03,707	4.7	20,63,997	4.4
3. Gross Value Added (GVA) (₹ Lakh)	1,00,09,291	92,36,293	92.3	5,41,582	5.4	2,31,416	2.3
4. Number of persons engaged	3,20,649	2,51,105	78.3	36,882	11.5	32,662	10.2
5. Total number of workers	2,70,401	2,16,370	80	28,797	10.7	25,234	9.3
a. Percentage of workers employed through contractors (%)	58.4	61.7		47.8		42.2	
b. Number of directly employed women workers	16,403	11,701	71.3	589	3.6	4,113	25.1
6. Total energy use (as per cost in ₹ Lakh)	35,05,724	33,55,888	95.7	1,20,600	3.4	29,236	0.8

Source: iFOREST analysis based on Annual Survey of Industries 2021-22, Government of India

IRON AND STEEL SECTOR

With about half of India's iron ore resources, Odisha is India's largest steel producer with a crude steel production capacity of about 33.5 MMTPA (as per the latest estimates). This is about 21% of the country's total. The state aims to massively expand the production capacity to 100 MMTPA by 2030 which will account for one-third of the crude steel production that the Government of India targets by 2030-31.

This will also mean a massive expansion of iron ore production in the state, with the state already having a production capacity of about 297 MMTPA and producing 169 MMT annually.

The sector is one of the largest contributors to the state's GHG emissions. As per estimates for 2022-23, the steel sector accounts for over 35% (105.7 MMT CO_2e) of the state's total GHG emissions.

The steel sector accounts for over 35% of Odisha's total GHG emissions

About 1.5 lakh (0.15 million) workers are associated with the crude steel plants. As per government information, over 48,000 of them are direct workers and the rest are indirect workers. The overall employment dependence can be still higher considering the high proportion of informal engagement in manufacturing sectors.

Besides crude steel-making units, over 22,700 workers are engaged with the sponge iron plants in various districts of the state.

A large number of workers are also associated with the iron ore mines that are closely related to steel production. Overall, it is estimated that over 31,800 workers are formally employed by these mines. Therefore, considering the value chain of the iron and steel sector, including employment in the factories (direct and indirect workers) and the mines, over two lakh (0.2 million) workers are formally employed.

Table 6: Iron and steel sector

Type of units	No. of units	Production capacity (MMTPA)	Formal workforce
Iron and steel plants	52	33.5	48,114
Sponge iron units	83	13.4	22,759
Total iron and steel units	**147**		**70,873**
Total iron ore mines	**67**	**297.2**	**31,800**

Source: iFOREST analysis based on data provided by the Department of Steel and Mines, Government of Odisha, 2024; and Joint Plant Committee Report 2022-23

Transition hotspots, challenges, and opportunities

Hotspots: The iron and steel-making units are concentrated in districts that are the largest producers of iron ore and coal. There are two large iron and steel clusters in the state.

Sundargarh district and adjoining Sambalpur and Jharsuguda districts constitute the largest crude steel-producing region with 24 plants and a cumulative production capacity of over 12.5 MMTPA. The other key steel production cluster is Angul and adjoining Dhenkanal district, with about 12.25 MMTPA collective production capacity. For sponge iron, Sundargarh has 50% of the sponge iron units with a production capacity of 3.3 MMTPA.

Challenges: With an ambitious target of reaching 100 MMT of crude steel production capacity by 2030, the key transition issue for the steel sector is the rapid transition to green steelmaking to reduce emissions from the sector while increasing efficient resource use. Another important aspect will be shifting the sponge iron units to cleaner production processes. At the same time, considering the large direct and indirect income dependence on this sector, a plan for workforce transition with well-designed skilling and reskilling measures will be crucial.

Opportunities: Odisha, with its significant share of India's steel production, holds a pivotal position in achieving India's industrial decarbonisation and energy transition goals. The state has an ambitious plan for developing green hydrogen/green ammonia hubs and developing a dedicated policy, which should be leveraged to develop a green steel sector in the state. One of the initiatives the state can take is to ensure that the future steel plants are hydrogen-ready.

100 MMT crude steel production target by 2030 necessitates rapid decarbonisation measures for the sector

Besides, the steel sector's growth trajectory in the state also needs to be aligned with the decarbonisation vision for the sector set forth by the Ministry of Steel, including enhancing energy efficiency, material efficiency, RE use, process transition, and deployment of carbon capture, utilization, and storage (CCUS) technologies.

ALUMINIUM

Odisha is the largest aluminium-producing state in India, accounting for 54% of the country's aluminium smelting capacity. The state also has almost 75% of India's total bauxite reserves which has supported the growth of the industry in the state.

80% of primary aluminium GHG emissions are related to the smelting process

The GHG emissions from the aluminium sector in Odisha have rapidly grown over the last decade, with a CAGR of 10% from 2012-13 to 2022-23. The estimated emissions from the sector in 2022-23 is about 4.5 MMT CO_2e.

Combining aluminium smelters and alumina refineries, the sector employs about 19,700 formal workers. The actual employment dependence is much higher considering informal workers associated with the sector.

Table 7: Aluminium sector

Unit type	No. of units	Production capacity (MMTPA)	Formal workforce
Aluminium smelter	5	2.79	15,398
Alumina refinery	3	5.78	4,300
Total aluminium and alumina units	**8**		**19,698**
Total bauxite mines	**5**	**21.61**	**4,830**

Source: iFOREST analysis based on data of Indian Bureau of Mines, 2023, and Odisha State Pollution Control Board, 2024

Transition hotspots, challenges, and opportunities

Hotspots: The aluminium smelters are located in key industrial districts, Angul, Sambalpur, and Jharsuguda. The refineries are located in the rural districts of Koraput, Rayagada, and Kalahandi. The latter three districts are also where the state's bauxite mines are concentrated.

Challenges: Aluminium production is an energy-intensive process and requires a constant supply of electricity. The key transition challenge in the aluminium sector is the change in the source of electricity, particularly for smelting, as about 80% of primary aluminium GHG emissions are generated from the smelting process.

Opportunities: The most important measure to reduce emissions from this sector is to source electricity from low-carbon or RE sources such as hydroelectric, solar, or wind power. Enhancing energy efficiency in both alumina refining and aluminium smelting processes will also be important.

CEMENT

60% of the cement production capacity is in Sundargarh, an industrial and mining hotspot

Unlike the steel and aluminium sectors, while Odisha does not dominate India's cement-producing landscape, it is important to consider a just energy transition as the industry leaders are considering that eastern and southern regions can lead the sector's expansion in the coming years.

There are 20 cement plants including integrated units, grinding units, and clinker units. While employment dependence on these plants is much less than in the steel sector, nonetheless it is significant. Overall, the formal workforce associated with the cement plants is about 6,116. Further, the sector is estimated to employ about 20,000 people downstream for every MMT of cement produced.

Table 8: Cement sector

Type of Unit	No. of units	Production capacity (MMTPA)	Formal workforce
Integrated unit	3	11.7	2,454
Grinding unit	15	23.1	2,312
Clinker unit	2	5.4	1,350
Total cement units	**20**		**6,116**
Total limestone mines	**5**	**21.6**	**865**

Source: iFOREST analysis based on data provided by Odisha State Pollution Control Board, 2024, and Indian Bureau of Mines, 2023

Transition hotspots, challenges, and opportunities

Hotspots: While cement units are located in six districts of Odisha, about 64% of the production capacity is concentrated in two districts, Sundargarh (over 13 MMTPA) and Cuttack (over 12 MMTPA). One integrated plant, both the clinker units, and 10 out of 15 grinding units are located in these districts.

Sundargarh also has the largest number (four) of limestone mines in the state, a raw material for cement production, and accounts for over 88% (15.43 MMTPA) of the state's limestone production capacity.

Challenges: Despite adopting commendable energy efficiency measures, a critical issue of energy transition for the cement sector is the shift to non-conventional and green energy sources for cement production. The cement industry currently relies heavily on coal, both for fuel and electricity.

Opportunities: To decarbonise the cement industry, reducing the proportion of clinker in cement will be essential. Clinkers can be substituted with alternative materials, such as fly ash, metal slag, or calcined clay. The use of limestone instead of clinker is also being considered as a viable option. Shifting to non-conventional energy sources in the production process will also be required. This may include, waste-derived fuels and hydrogen-based energy.

BUILDING AND CONSTRUCTION

The building and construction sector is a significant contributor to GHG emissions, primarily driven by energy use in construction processes, embodied carbon in building materials, and operational energy consumption.

Overall, buildings account for over 40% of India's total energy consumption, increasing at an annual rate of 8%

With over 98 lakh projected urban population by 2031, reducing emissions from the building and construction sector will be crucial

(including embodied plus operational energy). The sector contributes 32% to India's total GHG emissions, with embodied emissions making up 40% and operational emissions accounting for 60%.

The construction sector is an important component of Odisha's economy contributing 6.9% of the State GSVA and 16% of the industrial GSVA in 2023-24. The sector is also a significant employment generator. As of 2022-23 estimates, 17% of the total workforce in the state is engaged in the construction sector.

Transition hotspots, challenges, and opportunities

Hotspots: The urban and peri-urban areas of Odisha remain the hotspots for the green transition of the building and construction sector. The data on registered construction workers show that over 63% of the registered construction workers are concentrated in Cuttack, Sundargarh, and Khorda districts. Overall, about 14 districts in the state have at least over one lakh registered construction workers.

Challenges: The construction sector in Odisha is expected to grow significantly due to demographic and spatial changes from urbanisation, inter-state and intra-state migration, and the expansion of peri-urban areas. Between 2001 and 2011, the urban population in the state increased by 26.8%, which is double the national growth rate, reaching about 70 lakh people. By 2031, the urban population is expected to reach about 98.5 lakhs. The growth will create increased demand for buildings and other construction.

Opportunities: A key opportunity lies with the optimisation of material and resource use for the building and construction sector. Increasing material efficiency will involve the optimisation of resource use in the design, construction, and operation of buildings. Also, the construction of green buildings and increasing energy efficiency will be important. Simultaneously, decarbonisation of the cement, steel, and aluminium sectors will be crucial to minimise embodied emissions.

C. Overall Outlook

Considering Odisha's heavy reliance on fossil fuel sectors and fossil fuel-dependent industries, a just transition policy and strategy, addressing the socio-economic and environmental aspects of the energy transition will be crucial.

1. A planned transition of coal mining, coal-based power, and steel sector will be crucial for ensuring a comprehensive just energy transition and green growth over the next 30 years.

Odisha, with India's largest coal production capacity and a strong industry base powered by coal, will need comprehensive planning across various sectors to ensure a just energy transition in the state. However, three sectors are most significant to planning the transition — coal mining, coal-based power (utility and captive plants), and the steel sector. They account for about 84% of GHG emissions in the state. Besides, they account for about 14% of the formal workforce.

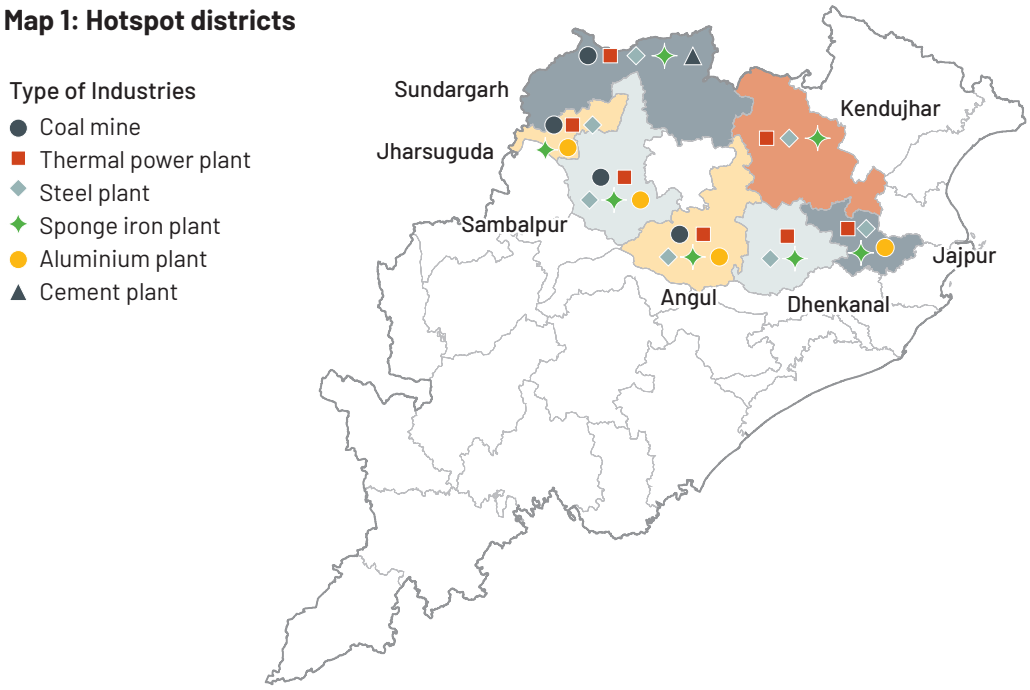
A planned transition of these sectors will help minimise disruptions to the workforce, manage the socio-economic impacts on local communities, and ensure that green growth pathways through industrial investments and restructuring emerge as viable alternatives to support robust green economic growth in the state in the coming years.

2. Seven districts, including the Angul-Dhenkanal energy and industrial cluster in the eastern part, and Jharsuguda-Sundargarh-Sambalpur in the north-western part are the hotspots for just energy transition.

Overall, seven districts are highly significant from an energy transition perspective. These include Angul, Dhenkanal, Jajpur, Jharsuguda, Sundargarh, Sambalpur and Kendujhar districts. These districts account for 100% of the coal mines and utility-scale coal-based power capacity. Besides, they also account for 88% of the coal-based captive power capacity considering the large presence of industrial activities.

Considering factories, these districts also are the key producers of iron and steel. They account for 97% of the crude steel capacity, 94% of the sponge iron capacity, and a majority of the iron ore mines, accounting for 99% of the production capacity. They also account for 100% of the aluminium (aluminium smelter) production capacity and 65% of the cement capacity (integrated plants).

Map 1: Hotspot districts



3. The energy transition can potentially impact about 9.3 lakh workers formally and informally engaged in the mining, electricity and manufacturing sectors.

The green energy transition will primarily have implications for coal mining, coal-based power, and at least 76% of all factories (those in the high-impact and medium-impact category) operating in Odisha.

About 9.3 lakh workers are formally and informally engaged by these industries. Besides, there are a large number of workers associated with the value chain. Therefore, a key aspect of the transition will be skilling and reskilling of the workforce for integration in the low-carbon economy.

D. Fostering Opportunities for Green Growth and Jobs

A key objective of just transition is to ensure green growth and social vitality of regions that will be impacted by the energy transition and enhance opportunities for green jobs for the impacted workforce and the local community.

1. Repurposing mining and industrial wasteland to develop green energy and green industry infrastructure can support the achievement of renewable energy targets while boosting local employment opportunities.

Repurposing mining lands in Odisha offers a strategic opportunity to develop green energy infrastructure and promote green industries, aligning with the state's RE and other decarbonisation targets. These broken-up land parcels can be repurposed for such activities as they already have the necessary infrastructure around them.

An assessment done by iFOREST shows that Odisha has 1,680 ha of mining wasteland and 3,990 ha of industrial wasteland. Besides, about 11,000 ha of coal mining land can be available for repurposing by 2030 following the scientific closure of mines.

Table 9: Availability of mining and industrial wasteland

Land type	Land available (ha)
Mining wasteland	1,680
Industrial wasteland	3,990
Total	**5,670**

Source: iFOREST analysis based on wasteland atlas of the Government of India and ISRO remote sensing data

The Government of India has also recognised the merits of repurposing mining land available to the coal industry. In April 2022, the Union Cabinet gave a nod to a set of policy guidelines allowing the development of certain coal and energy infrastructure and social infrastructure in land acquired under the Coal Bearing Areas (Acquisition and Development) Act of 1957. Recently in June 2024, the Ministry of Coal promulgated (draft) revised guidelines for coal mine closure, under which for the first time the repurposing of mining land has been specified in the context of 'just transformation' of the local communities.

2. Setting renewable energy targets for the mining sector can help to reduce direct and indirect emissions related to mining operations.

Mining operations use fossil fuels and electricity for activities like extraction, processing, material movement, and transportation. Switching to RE sources can help reduce Scope 1 and Scope 2 emissions from the sector.

Considering the expansive ongoing mining activities in the state and the foreseeable future, it will be important to set progressive RE adoption targets for the sector. Such targets will not only improve the sector's green performance but will also boost the confidence of financial institutions and investors, as RE-powered operations improve ESG (Environmental, Social, and Governance) ratings of industries, making companies more attractive to investors.

3. To decarbonise the steel sector, a phased approach of green hydrogen adoption by the industry will be essential.

Decarbonisation of the steel sector in Odisha will be essential for green industrial growth and overall reducing emission intensity of the state's economy. The government can mandate the establishment of greenfield 'hydrogen-ready steel plants' from 2025 onwards, and also retrofit the pre-existing ones.

Thereafter, a phased adoption of green hydrogen as energy can be mandated. This can be 10% hydrogen as energy by 2030, 25% by 2035, 50% by 2040, 75% by 2045 and 100% by 2050. This will complement Odisha's green hydrogen ambition. Essentially, by 2035, the focus should shift to green hydrogen-based steelmaking alongside the adoption of CCUS technologies as they become viable.

4. Promoting green growth will be crucial for enhancing jobs and economic opportunities.

As traditional industries associated with high carbon emissions will need to transition in the coming years, there will be chances of job losses and socio-economic disruptions if timely measures are not implemented. Boosting employment opportunities in green economic sectors will be crucial for retaining jobs and creating new employment opportunities.

The Industrial Policy Resolution (IPR, 2022), and the latest Economic Survey Report (2024), of the State Government have also emphasised certain sectors to support the state's industrial and economic growth and employment generation. These include green energy, green manufacturing, and electric mobility (e-mobility), among others. The Government has also emphasised the development of an industry-ready skilled workforce.

i. Green energy: Odisha has significant potential for green energy development and boosting employment opportunities in the RE sector. For example, considering the state's 11 GW RE target by 2030, the sector can generate at least 32,300 full-time employment (FTE).

Table 10: Employment opportunities in RE

Sector	Parameters	Total
Solar	Capacity target (GW)	7.5
	Estimated FTE	25,875
Wind	Capacity target (GW)	2
	Estimated FTE	2,540
Small hydro	Capacity target (GW)	0.19
	Estimated FTE	760
Large hydro	Capacity target (GW)	0.06
	Estimated FTE	Not estimated
Pumped Storage Plant	Capacity target (GW)	1.2
	Estimated FTE	3,000
Total RE	**Capacity target (GW)**	**10.95**
	Estimated FTE	**32,175**

Source: iFOREST job assessment based on Energy Department, Government of Odisha targets noted in September 2024 and using employment factor approach for each category.
The solar employment estimates are based on the employment factor for ground-mounted solar.

However, the overall potential of RE jobs is much higher considering the RE potential of the state that can be harnessed. An assessment of RE potential by iFOREST, considering the modest use of wasteland and reservoirs, shows that solar potential alone is about 170 GW.

Besides RE, the state also has set a target of achieving a production target of green ammonia at 5.8 MMTPA by 2030, along with 0.1 MMTPA green hydrogen and 0.5 MMTPA other derivatives. These will also be important for creating green jobs.

ii. Green metals and mining: Odisha, with its vast reserves of minerals such as iron ore, bauxite, and manganese, holds a central role in India's green transition by enabling the growth of green metals and sustainable mining practices. This transition presents significant opportunities for Odisha to diversify its mining sector, sustainable mining technologies, and mineral recycling, while simultaneously generating green jobs through responsible mineral extraction, beneficiation, and value-added processing.

iii. Green manufacturing: The manufacturing sector in Odisha remains crucial for the state's green growth and green jobs pathway with already a share of 54% of the industrial GSVA. To maintain a strong manufacturing sector, it will be essential to increase green manufacturing. The state can promote the manufacturing of electric vehicles (EVs), solar PV panels, and batteries for energy storage, which will not only drive the transition to clean energy but also boost domestic production of high-value products and create jobs.

iv. Green construction and green infrastructure: Odisha is experiencing rapid urbanisation with the urban population expected to reach 98.5 lakhs by 2031. Therefore, green construction will be crucial for the sector. This will involve material transformation and use in construction and infrastructure development. It will require the development of a workforce across the value chain, such as the use of sustainable building materials, energy efficiency of buildings, green utilities, and green certification, among others.

4. Strengthening the skilling ecosystem through government and industry engagement will be necessary to develop the future workforce.

To enable a just transition for workers from fossil fuel industries and prepare them for emerging opportunities, integrated skilling programs across sector-specific value chains are essential. Both government and industry investments in skilling and reskilling will be critical to help workers adapt to new roles in green sectors and remain agile in a dynamic job market.

The State Government has taken significant initiatives in recent years to expand the skilling ecosystem in the state. Some of the relevant key schemes are Nutana Unnata Abhilasha (NUA) Odisha, the Placement-linked

Training Programmes (PLTP), the Nanu Unicorn scheme, and Swakalpa. A state-of-the-art skilling institute, the World Skill Centre (WSC), augments the skilling infrastructure and resources besides the Industrial Training Institutes (ITIs) and polytechnics.

However, the current skilling ecosystem does not yet adequately address the growing demand for jobs in various renewable energy segments, and other emerging green and high-tech industrial sectors.

To meet the rising demand, the green skills ecosystem needs further strengthening. Initiatives like the WSC and flagship schemes such as NUA Odisha, with their emphasis on advanced technology and digital skills are well-positioned to accommodate the need for workforce development for renewables, green manufacturing, and green construction. The courses and training modules need to be further strengthened based on in-depth skill gap assessment, potential demands, and market outlook. The PLTP, which has one of the highest placement rates, should also modify the courses and training modules to incorporate emerging green sectors to leverage its outreach and employability focus.

Industry involvement is equally crucial in workforce transition efforts. Subsidiaries of Coal India Limited (CIL), including Mahanadi Coalfields Limited (MCL), have established just transition cells to support the transition of coal mines and local communities. Similar industry-led initiatives will play a vital role in workforce transition within other sectors such as power, steel, and aluminium.

These collaborative efforts will ensure that workers are not only equipped to meet current demands but are also prepared to thrive in a sustainable economy.

E. Policy Support

Having well-designed policies, plans and institutional mechanisms will be important to support a well-planned and well-managed just energy transition.

1. The development of a State Just Transition Policy will be necessary to ensure a just and inclusive energy transition.

Considering the scale of impact and the diversity of sectors involved, a comprehensive State Just Transition Policy will be required to ensure a well-planned and well-managed transition in Odisha. The policy will be important to guide the following aspects:

i. **Economic diversification and innovation:** Will be essential to support the economic vitality and development of regions impacted by the transition.

ii. **Fostering an ecosystem for green investments:** This will be important for accelerating the transition to green energy and green industries, with a focus on districts where fossil fuel industries are concentrated.

iii. **Workforce transition and human resource development:** Will be required to ensure adequate job security, payments at the time of retrenchment (severance pay), and compensations for all workers engaged in industries that the transition will impact.

iv. **Social welfare:** Will be required to provide timebound support to informal workers, widows, marginalised communities in the fossil fuel areas to be impacted by the transition, and to safeguard against immediate transition shocks.

v. **Augmenting social and physical infrastructure development:** Will help to improve social capital and attract businesses and investors to ensure economic vitality.

vi. **Mobilising financing:** A well-designed policy will be essential for mobilising public and private finances to support a just transition.

vii. **Institutional structure:** The policy will provide the necessary guidance to develop a dedicated institutional structure and mechanisms for supporting a just energy transition.

2. Development of regional just transition plans will help to support inclusive growth.

Given the regional concentration of various industrial activities, regional just transition plans will be necessary to strengthen opportunities for inclusive growth. These plans will also help to attract green investments and ensure economic stability and job preservation in these areas. They will also be crucial for addressing the needs of informal and migrant workers. These workers often move between regions and industries based on available opportunities.

The regional just transition plans could be structured around a 10-year transition strategy, providing a framework for crafting just transition measures at the regional and district levels.

The priority clusters for the development of regional just transition plans are the Angul-Dhenkanal cluster, the Sundargarh-Sambalpur cluster, and the Jharsuguda cluster. These are going to witness the impacts of green energy transition within the next 10 years.

3. Utilisation of coal cess and repurposing of District Mineral Foundation funds can support just transition in coal districts.

As Odisha plans for a just energy transition, it is essential to allocate social welfare funds toward sustainable livelihoods, skilling and reskilling, and strengthening resilient social infrastructure. The District Mineral Foundation (DMF) funds and coal cess represent the most critical public financing sources for supporting localised transition measures. These funds align with broader goals of environmental sustainability, clean energy promotion, and public welfare.

Odisha has the maximum DMF accrual in India amounting to over ₹25,858 crore (₹258.58 billion) which is nearly 30% of India's total. Further a long-term assessment of DMF contributions over the next four decades estimates that ongoing and planned coal mining expansions (excluding allocated coal blocks) could generate over ₹39,764 crore (₹397.64 billion) by 2060. Additionally, DMF funds from the extraction of other major minerals will be instrumental in supporting just transition efforts in key mining districts such as Sundargarh, Kendujhar, Jharsuguda, and others that are essential to the industrial supply chain.

The coal cess, currently integrated into the GST compensation cess, is another significant financing tool. With a levy of ₹400 per tonne of coal production and imports, it is estimated that ₹3,52,592 crore (₹3.53 trillion) could be generated. This provides a substantial pool of resources to fund just energy transition initiatives across the state. Odisha and other coal-producing states should work with the central government to meaningfully utilise coal cess for green growth and just energy transition.

Overall, effective management of these funds will be crucial for enabling a smooth transition, ensuring both economic growth and social welfare in Odisha's key industrial and mining regions.

Notes

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