Summary for Stakeholders

JUST ENERGY TRANSITION IN MAHARASHTRA

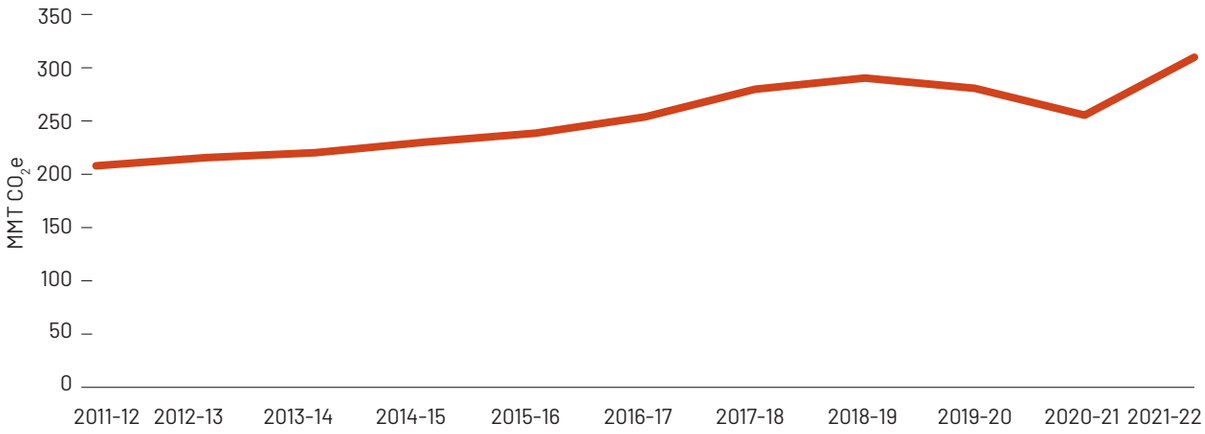
An Opportunity for Green Growth and Green Jobs

iFOREST
INTERNATIONAL FORUM FOR ENVIRONMENT, SUSTAINABILITY & TECHNOLOGY

Summary for Stakeholders

Maharashtra, as a key industrial state, is crucial in steering the country towards an accelerated and just energy transition, establishing the groundwork for a net zero emissions economy. The emission of the state has increased at a compound annual growth rate (CAGR) of 4.1% over the last decade, with the state currently accounting for 10% of India's GHG emissions (310 million metric tonnes of CO_2e). About two-thirds of the emission comes from five key sectors - thermal power plants (TPPs), road transport, iron and steel, cement, and brick. With the third-largest number of factories in the country, including the largest automobile industry, the state needs a comprehensive cross-sectoral approach to decarbonise its economy, augment opportunities for green jobs, and ensure green growth.

Figure 1: GHG emissions in Maharashtra



Source: iFOREST analysis

A. Just Transition Landscape: Sectors, Geographies and Dependency

1. Coal Transition

Over the next decade, the state is set to undergo a gradual reduction of coal mining activities, highlighting the necessity for a just transition strategy that safeguards economic development and employment in the impacted regions and communities.

COAL MINING

Maharashtra is India's sixth-largest coal-producing state, accounting for over 7% of the country's coal production. The state has a coal production capacity of 87 million metric tonnes per annum (MMTPA) and produced about 63 MMT of coal in 2022-23. The sector supports over 89,000 formal and informal jobs (29,087 formal jobs and at least twice informal) in the three mining districts—Chandrapur, Nagpur, and Yavatmal.

Coal mining is facing challenges of economic unviability, resources exhaustion and closures.

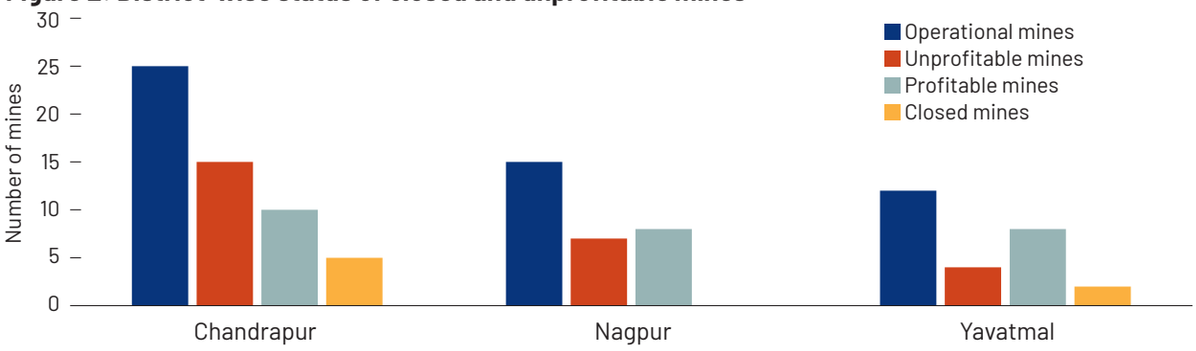
Table 1: Status of operational mines

Mine type	Number of mines	Production capacity (MMTPA)	Formal workforce
Opencast*	37	83.6	21,757
Underground	15	3.3	7,330
Total	52	86.9	29,087

Source: Western Coalfields Limited, April, 2023; Latest environmental clearance letters of mines. *Includes two mixed mines.

The coal sector is facing challenges of economic unviability, resource exhaustion (old mines), and closures. At least half of the operational coal mines in the state are unprofitable, and one-fourth will soon exhaust their resources. Consequently, there are a significant number of mines that are already closed. Further, over 60% of the currently operational mines will close in the next 10 years due to such reasons.

Figure 2: District-wise status of closed and unprofitable mines



Source: iFOREST analysis based on information obtained from Western Coalfields Limited, April, 2023. Financial status of mines provided for 46 mines out of 52. Mines for which financial details were not shared have been considered as profitable.

A just transition planning is urgently needed for unprofitable and end-of-life mines.

The unprofitable and old mines, however, have high income dependence considering formal and informal workers and the induced economy in mining areas. For example, the unprofitable mines collectively account for about half of the formal workforce (about 15,000 workers) of the Western Coalfields Limited (WCL), the public sector undertaking (PSU) operating in Maharashtra.

Therefore, planning a just transition of the unprofitable and end-of-life mines is urgently required in Maharashtra. Overall, transition planning will be necessary for at least 32 mines (with a total capacity of over 40 MMT) through intervention by the coal company, as well as the state government.

COAL-BASED THERMAL POWER

Maharashtra has the largest coal-based thermal power capacity in India which is 11.3% of the country's total. The total capacity of utility-scale coal-based TPPs is about 24 gigawatts (GW). Besides, the state also has a significant captive power capacity of 3GW, which accounts for about 7.4% of India's total captive power capacity.

Coal power plants are the single-largest source of GHG emissions accounting for 42% of the total state emissions.

The sector formally employs about 45,570 people, out of which over 95% are with the utility plants. The informal jobs are likely to be much higher.

Table 2: Coal-based thermal power planst

Type	Capacity (MW)	Formal workforce
Utility	23,856	43,561
Non-utility (captive)	3,332	2,099
Total	27,188	45,570

Source: Capacity data based on report of Central Electricity Authority, 2023. Worker numbers as provided for NTPC plants, Chandrapur STPS, and MAHAGENCO operated plants by respective companies, for others, estimated as per CEA thumb rule of 0.63 persons per MW of installed capacity.

While Maharashtra has a relatively younger coal power fleet, about 20% of the units are over the age of 25 years. Many of these units are also inefficient with low plant load factor (PLF below 60%). There are also challenges to environmental compliance with the old units as most of them do not have Flue Gas Desulphurisation (FGD) systems. In the next 10 years, therefore, about one-fourth of the capacity will likely be decommissioned due to techno-economic and environmental factors.

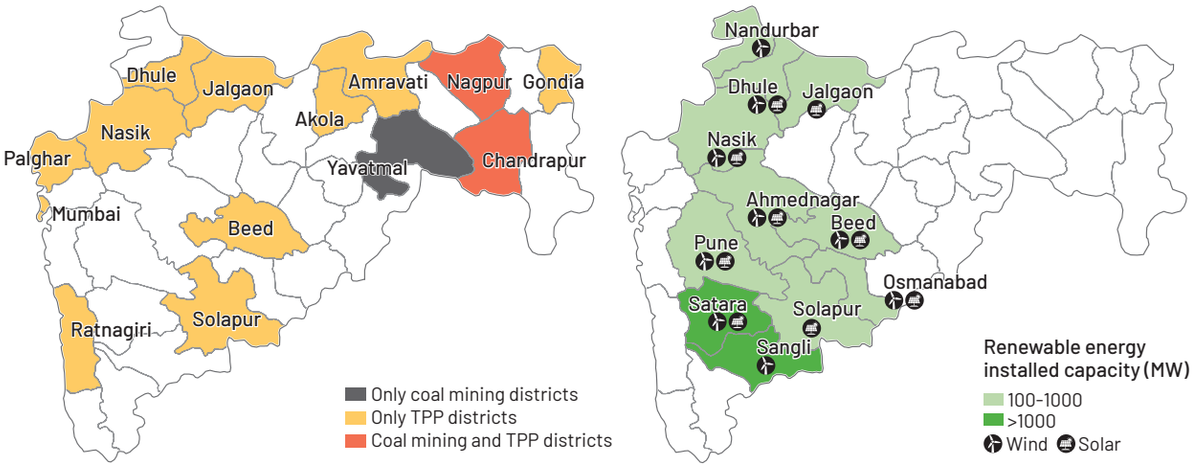
25% of the coal-based capacity is likely to be decommissioned in the next 10 years.

Transition hotspots, challenges and opportunities

Hotspot: The districts of Chandrapur, Nagpur, and Yavatmal are most vulnerable to coal transition due to the concentration of old, economically unviable, and closed mines in these districts. Furthermore, most of the old TPPs are in Chandrapur and Nagpur districts.

Challenges: There is a regional imbalance in the growth of renewable energy (RE) in Maharashtra. RE is growing in the Southern and Central districts, while coal transition districts are mainly in the Northern and Eastern parts.

Figure 3: Renewable energy disparity



Source: iFOREST analysis

Opportunities: There are two key opportunities for just transition in the coal districts. These include repurposing of land available with coal mines, and repurposing of the retired thermal power units.

i. Repurposing of land available with coal mines provides a crucial opportunity for economic diversification, green growth, and green jobs in the coal districts.

Over 42,000 hectares (ha) of land is currently available with operational and closed coal mines in Maharashtra. Besides, over 13,000 ha of land is available with the TPPs. A large proportion of this land (about 50%) is available in the blocks that need to start addressing transition challenges starting this decade.

An immediate opportunity lies in repurposing the land that is available with the unprofitable mines after their scientific closure and reclamation. This land is prime for local economic diversification, RE development, green industry development, and job creation.

About 20,000 ha of land is available with the opencast and underground mines that are likely to be closed by 2030.

Table 3: Land with unprofitable coal mines

District	Total number of operational mines	Unprofitable mines			Available land (ha)		
		Total	UG	OC	Total	UG	OC
Chandrapur	25	15	8	7	11,016	5,210	5,806
Nagpur	15	7	6	1	4,329	3,981	348
Yavatmal	12	4	1	3	5,224	1,697	3,528
Total	52	26	15	11	20,569	10,888	9,682

Source: iFOREST analysis based on information obtained from WCL, 2023, and environmental clearance letters of mines.

ii. Repurposing the retired thermal power units can support green energy and green industry development in coal areas.

Maharashtra also has 14 TPP units with a cumulative capacity of 2.7 GW that were retired between 2016 and 2021 for techno-economic reasons. Besides, 4.4 GW (involving 15 units) of the coal fleet is likely to retire in the next 10 years.

Repurposing the retired units into industrial parks, green hydrogen plants, and RE development provides significant opportunities for supporting green energy and industry development, creating jobs, and strengthening state-level climate action.

Overall, Maharashtra will require a comprehensive strategy urgently to deal with the coal transition in the next 10 years.

2. Oil and Gas Transition

The transition to electric vehicles and innovation in non-conventional fuels are some of the early triggers to plan for the transition of the oil and gas sector.

Maharashtra is the second largest consumer of petroleum products, accounting for 10.5% of India's consumption. The state is also the second largest consumer of petrol and diesel, accounting for 10.9% and 10.8% of the country's total consumption, respectively.

Maharashtra is the second largest petrol and diesel consuming state in India.

The state has two refineries with 21.5 MMTPA oil refining capacity which account for 8.6% of the country's refining capacity. Besides the state has about 7,256 petrol pumps which is over 9% of India's total.

For the natural gas sector, the distribution segment involving the supply of compressed natural gas (CNG), piped natural gas (PNG), and liquefied petroleum gas (LPG) has significance from a just transition perspective. There are at least 802 CNG stations in the state which is 13.2% of India's total. For PNG, there are a total of 3.1 million connections, accounting for 26% of India's total. Concerning LPG, there are over 2,231 distributors, reflecting a share of 9% of the country's total.

Combining the oil refineries, retail, and LPG distributors, the oil and gas sector provides at least 158,259 formal employment in the state. Besides there are workers associated with CNG stations, and also with PNG supply.

Table 4: Downstream segment of the oil and gas sector

	Facilities	Production capacity	Formal employment
Oil refinery	2 refineries	21.5 MMTPA refining capacity	33,239
Oil retail	7,256 petrol pumps		116,096
LPG distribution	2,231 LPG distributors		8,924
CNG	802 CNG stations		
Total			158,259

Transition hotspots, challenges and opportunities

Hotspots: The hotspots for the oil and gas sector include districts where the oil refineries are located (and thus have direct employment dependence), and also the locations of retail shops (petrol pumps), LPG distributors, and CNG stations. While the oil refineries are located in Mumbai, considering the distribution of oil retailers, LPG distributors, and CNG stations in various districts of the states, the transition geography is all across Maharashtra.

Challenges and opportunities: The key transition challenge for the oil and gas sector is the shift to Electric Vehicles (EVs). However, the impact of the transition is likely to happen only in the next decade, as EVs are likely to become dominant only after 2030. Therefore, in addition to developing new infrastructure for EVs, the state should also start planning for repurposing the existing oil retail infrastructure to support EVs.

3. Just Energy Transition in Industry

With a share of over 14.5% of the state's GVA and more than 2 million formal employment, a just transition of industry will be a central agenda for greening Maharashtra's economy and boosting green job opportunities.

Maharashtra is the third largest state in India in terms of both the number of factories (25,610) and those in operation (19,462). About 9.8% of all operational factories in India are located in the state. The economic output of factories is the second largest in India, about 13.8%, and it accounts for 14.5% of the gross value added (GVA). The factories provide formal employment to about 2.04 million people.

Industries in Maharashtra 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, cement, bricks and refractories, automobile and automobile components, basic chemicals, nitrogen fertilizer, coke oven and refined petroleum products, electric motors, generators, batteries, and appliances, will be highly impacted.

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

Low impact: Sectors including food processing, apparel and footwear, wood-processing and product industries, fabricated and structural metal products, computers and electronics, consumer goods, machineries, etc., will be less impacted due to energy transition.

High impact

Approximately 5,500 operational factories, making up about 27% of Maharashtra's total, will be highly impacted by the energy transition. These factories are highly significant for the economy for the following reasons:

- They account for 44% of the total output and 39% of the Gross Value Added (GVA) from all factories.
- Provide 43.3% of total factory employment and engage 33% of all factory workers.
- A notable characteristic is their higher ratio of contractual workers. Approximately 55% of employees in these sectors are contractor-based, in contrast to 43% in the low impact sectors.
- These are highly energy-intensive and are responsible for around 60% of the total industrial energy consumption.

Overall, about 41% of the factories in Maharashtra, employing about half of the formal workers, will be highly or moderately impacted by the energy transition.

Moderate impact

Approximately 2,485 operational factories, making up 13% of the state's total, will be moderately impacted by the energy transition. These factories account for the following:

- They account for about 8.7% of the total output and 13.6% of the total GVA.
- These sectors employ about 15% of the workforce.
- They consume about 14% of the total energy used by all factories and exhibit moderate energy intensity.

Low impact

Approximately 11,478 operational factories, making up 60% of the state's total, will be moderately impacted by the energy transition. These factories account for the following:

- They account for approximately 48% of both the total output and GVA.
- They provide 52% of total factory employment and engage 51% of the workers.
- Notably, nearly 80% of all directly-employed female workers are in these sectors.
- These have low energy consumption and responsible for about 26% of the total energy usage.

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

Characteristics	All factories	Low impact sectors		Moderate impact sectors		High impact sectors	
	Value	Value	Share of total (%)	Value	Share of total (%)	Value	Share of total (%)
1. Number of factories	25,610	15,301	59.7	3,373	13.2	6,941	27.1
a. Number of factories in operation	19,462	11,478	59	2,485	12.8	5,505	28.3
2. Total output (₹ Lakh)	12,39,76,857	5,83,38,486	47.1	1,08,45,093	8.7	5,47,93,277	44.2
3. Gross Value Added (GVA) (₹ Lakh)	2,15,86,010	1,02,69,044	47.6	29,28,914	13.6	83,88,050	38.9
4. Number of persons engaged	20,38,255	10,61,126	52.1	3,04,463	14.9	6,72,670	33
5. Total number of workers	14,54,788	7,40,883	50.9	2,17,001	14.9	4,96,905	34.2
a. Percentage of workers employed through contractors (%)	48	42.8		48.8		55.5	
b. Number of directly employed women workers	90,884	70,637	77.7	10,293	11.3	9,960	11
6. Total energy use (as per cost in ₹ Lakh)	44,70,441	11,66,768	26.1	6,23,454	13.9	26,80,220	60

Source: iFOREST Analysis based on Annual Survey of Industries 2019-20

IRON AND STEEL

Maharashtra currently has about 12 MMTPA of crude steel production capacity which is about 7.4% of India's total. Crude steel production has grown by 34% in the last five years, from 8.5 MMT in 2017-18 to 11.4 MMT in 2021-2022.

With a CAGR of over 5%, GHG emissions from the steel sector has increased significantly due to growing steel demand.

Simultaneously, emissions from the steel sector have increased at a CAGR of 8.9% over the corresponding time period. It is the highest GHG emitter among industrial sectors, with estimated emissions of 21.2 MMT CO_2e in 2021-22.

Iron making in the state is largely based on the Direct Reduction process using coal and natural gas. Electric arc furnace and induction furnace are used for steel making.

The state also has a large number of foundries, accounting for about 15% of the foundry units in the country. A large number of foundries are involved in casting of automobile components. About 90% of these units belong to the micro, medium and small industries (MSME) category.

The iron and steel sector, including foundry, employ a large number of people. An estimated 86,150 workers are formally employed by these units. The overall employment dependence is much higher considering high proportion of informal engagement in manufacturing sectors.

Table 6: Iron and steel sector

Type of units	No. of units	Production capacity (MMTPA)	Formal workforce
Iron making units	9	7.7	13,107
Crude steel	57	11.99	18,043
Total iron and steel	66	19.69	31,150
Foundry	409		55,000
Total			86,150

Source: iFOREST analysis based on Joint Plant Committee, Indian Iron and Steel database-2019-20, MIS data obtained from Indian Institute of Foundrymen, 2023,and Company-specific Annual Reports and Accounts, 2022-23.

Transition hotspots, challenges and opportunities

Hotspots: Nagpur and Jalna have the largest capacity of iron and steel-making, whereas Pune and Kolhapur host the largest numbers of foundries.

Challenges: The key transition challenge with the iron and steel sector is the transition of the MSMEs, essentially the small induction furnaces and foundries. The foundry sector will experience technological changes due to shift to EVs.

Opportunities: With a steady growth in crude steel production in the state, and anticipated steel demand, a just energy transition of the sector is crucial for reducing industrial emissions. The iron and steel sector will witness technological shift in iron making from coal and natural gas to hydrogen in the future. Steel making in Maharashtra is already based on electricity and hence no major disruptions are expected.

CEMENT

Maharashtra is one of the key cement producers in Western India. With a total of 18 integrated plants and grinding units, the state's current production capacity stands at over 49 MMTPA.

The cement sector remains the second largest source of industrial process emissions after steel.

Cement production in the state has steadily increased over the past decade, from 10.2 MMT in 2011-12 to 14.7 MMT in 2021-22, driven by construction demand. Correspondingly, GHG emissions from the sector has also increased exhibiting a CAGR of 3.7%, with estimated emissions in 2021-2022 being 14.7 MMT CO_2e.

While the sector's employment dependence is less than the steel sector, it still remains significant. Overall, the formal workforce associated with integrated plants and grinding units is about 14,470. Further, the sector is estimated to employ about 20,000 people downstream for every million tonnes of cement produced.

Table 7: Status of integrated cement plants and grinding units

Type of unit	No. of units	Production capacity (MMTPA)	Formal workforce
Integrated plant	6	27.35	10,591
Grinding unit	12	21.75	3,879
Total	18	49.10	14,470

Source: iFOREST analysis based on IBM Cement Yearbook, September 2023; Directorate of Industrial Safety and Health, Government of Maharashtra, 2023; Company-specific Annual Reports and Accounts, 2022-23

Transition hotspots, challenges and opportunities

Hotspots: While cement plants and grinding units are located in 10 districts of Maharashtra, Chandrapur alone accounts for 48% of the total capacity. Five out of the six integrated plants are located in the district (the only other being in Yavatmal).

Challenges: Despite adopting commendable energy efficiency measures, a critical issue of energy transition for the cement sector remains 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.

BRICK

Maharashtra is estimated to have nearly 17,000 brick manufacturing units producing about 28 billion bricks annually. The sector is a major source of employment in rural and peri-urban areas of the various districts where the brick-making units are clustered. There are primarily five clusters which include Sangli, Pune, Mumbai-Thane, Nashik-Ahmednagar, and Nagpur.

The brick sector employs about 0.25 million people in rural and peri-urban areas of Maharashtra.

The use of coal as the most predominant fuel by the brick kilns, and the use of inefficient clamps for brick-making in most clusters, adds to the sector's pollution and emission burden. The overall coal consumption for producing burnt clay bricks in the state is estimated to be 2.3 MMT per year. The sector's CO_2 emissions per year is about 6 MMT.

Table 8: Brick production

No. of units	Production (number)	Workforce
17,000	28 billion bricks annually	248,000 (largely informal)

Source: iFOREST analysis based on other scholarly studies and on-ground interactions

Transition hotspots, challenges and opportunities

Hotspots: Sangli, Nagpur, and Mumbai-Thane clusters are the major producers of burnt clay bricks, using clamp technology. Coal is the main fuel used in brick-making in these clusters. To reduce pollution and GHG emissions, the transition of brick-making process and fuel use is essential in these clusters.

Challenges: The key energy transition issue for the brick sector is the shift towards cleaner technologies and resource efficient ways for producing bricks. At the same time, there is large-scale income dependence on the sector among low-income people and informal workers. This makes the sector highly sensitive to any unplanned transition.

Opportunities: A key opportunity for the brick sector is changing brick-making technology that is already viable and widely used in India. This includes changing traditional kilns like clamps and Fixed Chimney Bull Trench Kilns (FCBTK) to Vertical Shaft Brick Kiln (VSBK) and Zigzag technologies. For example, most brick kilns in the states of the Indo-Gangetic region have already moved to Zigzag technology. These kilns can be run with biomass to reduce coal dependence.

There is also an opportunity to move to alternative walling materials, such as AAC blocks, fly ash bricks, hollow and perforated bricks, compressed soil bricks, to improve resource efficiency in the brick sector.

AUTOMOBILE

Maharashtra's automobile sector is the largest in the country and remains a cornerstone for the state's economy. The sector's contribution to the gross state domestic product (GSDP) is about 7%, which is highest among all manufacturing sectors and 15.3% of industrial GSDP.

The automobile sector has a share of over 15% in Maharashtra's industrial GSDP.

Overall, the state's automobile industry accounts for 20% of the vehicle production, 21% of parts and accessories and 24% of other transport equipment produced in India.

The state is also a front-runner in the transition to EVs. In 2023, Maharashtra accounted for 12.6% of the country's EV sales. The penetration of EVs in the state has increased from 0.4% in 2020 to 7.6% in 2023, surpassing India's average of 6.5%.

There are at least 16,602 enterprises involved in the manufacturing of automobiles and automobile components. This includes 26 Original Equipment Manufacturers (OEMs) and 16,576 Auto Component Manufacturers (ACMs). Overall, micro and small enterprises dominate the manufacturing segment, with 97% of all automobile enterprises belonging to these categories.

The OEMs and ACMs collectively account for the direct employment of at least 0.34 million people in the state. Besides, there are a significant number of informal workers associated with the sector, particularly in the MSMEs.

Table 9: Distribution of automobile enterprises

Type of enterprise	Sub-type	No. of units	Workforce
OEMs		26	95,201
ACMs	Micro enterprises	13,174	71,114
	Small enterprises	2,950	74,845
	Medium enterprises	352	50,633
	Large enterprises	100	43,444
Total ACMs		16,576	240,036
Total automobile enterprises		16,602	335,237

Source: iFOREST analysis, based on information obtained from the Directorate of Industries, Government of Maharashtra, 2023

The growth in EVs makes the sector a key one for developing a strategic roadmap for supporting a just energy transition in the sector. With increasing investments in electric mobility and the steep penetration of EVs in the state, the automobile sector is already experiencing a transition. While the impact on the business and workforce is not likely to be immediately apparent for the next few years, some sections of the industry will start experiencing transitional challenges by 2030. While four-wheelers are expected to transition slowly, in a phased manner, two and three-wheelers are likely to transition rapidly and thereby cause significant market disruption. Therefore, developing a strategic roadmap and a plan for just transition of the sector is essential.

Transition hotspots, challenges and opportunities

Hotspots: While all districts in Maharashtra have automobile-related enterprises, about 26% are concentrated in Pune (a total of 4,250). About 0.18 million are formally employed by the automobile manufacturing industry in the district. Overall, just five districts, Pune, Kolhapur, Aurangabad, Thane, and Mumbai Suburban account for 60% of the automobile enterprises.

Challenges: The EV transition will have an impact across the auto value chain, including ACMs, OEMs, and service centers. The ACMs who are involved in the manufacturing of various powertrain components required by internal combustion engine (ICE) vehicles will face challenges of equipment redundancy. Besides, the shift from producing components for mechanical power-based vehicles to components for EVs will require different skill sets, which will impact many existing workers of the ACMs.

The transition to EVs is also anticipated to bring about significant changes to the business structures of OEMs, including changes in product mix and supply chains of various parts. Besides, the OEMs will also need a skilled workforce capable of handling the unique aspects of EV technology. A crucial aspect of the EV transition will be the altered nature of maintenance and repair work which will have a differential impact on both established and informal service centres.

Opportunities: While the transition to EVs is already well underway, the impact on the businesses and workforce is not likely to be immediately apparent for the next few years. Therefore, there is time to strategise and plan for the transition.

The automobile industry in Maharashtra, with many leading private players, is also well-positioned to support a well-planned and well-managed transition by enterprise-level intervention, and government engagement. A key

requirement will be investments in skilling and re-skilling programmes, support for the reorientation of enterprises involved in ICE component manufacturing towards EV components, and develop a 'Right to Repair and Servicing' policy to enable EV manufacturers to involve local service centers in repair and servicing, among others.

FERTILIZER

Maharashtra contributed to about 7.7% of India's total urea production in 2022-23 (2.2 MMT). The state has two urea fertilizer plants with a combined annual production capacity of slightly over 2 MMT.

The annual combined GHG emissions from the two plants is estimated to be 1.7-1.8 MMT CO_2e.

Use of green hydrogen in the production process will be a crucial step for a transition of the fertilizer sector.

Table 10: Production of urea fertilizer

Number of plants	Production capacity (MMTPA)	Formal workforce
2	2.04	3,812

Source: Rashtriya Chemicals and Fertilizers Limited Annual Reports, 2021-22 and 2022-23

Transition hotspots, challenges and opportunities

Hotspots: The urea fertilizer producing units in the state are located in two districts, Raigad and Mumbai Suburban.

Challenges and opportunities: A significant share of CO_2 emissions from urea production is a result of the use of natural gas as feedstock to produce hydrogen. Therefore, a key issue for the sector's energy transition is moving to less carbon-intensive methods to produce hydrogen to reduce the process-related emissions from urea production. The opportunity lies in utilizing green hydrogen (hydrogen production via water electrolysis powered by renewable energy) as a feedstock in the production process.

In fact, electrolysis was a common means of producing hydrogen in areas with cheap power before hydrocarbon-based processes took over. Fertilizer Corporation of India's Nangal plant employed electrolysis to produce hydrogen until it switched to hydrocarbons (then LSHS and fuel oil) in the 1970s due to shortage of power in the Bhakra grid. The Green Hydrogen/ Green Ammonia Policy (2022) of the Government of India also provides the necessary impetus.

OTHER INDUSTRIES – BOILERS

Other industrial sectors depend on the direct use of fossil fuels for generating process heat and electricity through boilers. Maharashtra has 5,988 registered boilers across diverse industrial sectors. The sectors with the maximum number of boilers include food/agriculture, textile, chemical, sugar, and pharmaceutical/healthcare, collectively accounting for over 70% of the total.

About 44% of the boilers are based on fossil fuels.

The boilers used by various industrial units are primarily of small capacity. The analysis of the inspected boilers in the state last year (1,543), shows that over 73% fall within 1-10 tonnes per hour (tph) capacity range.

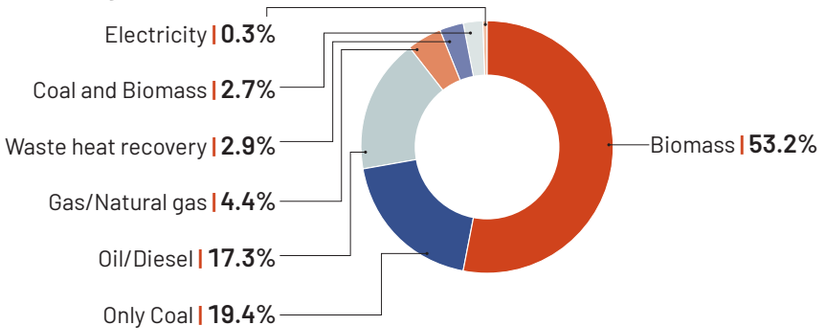
Table 11: Status of boilers

Number of boilers	Estimated workforce
5,988	18,000 workers directly engaged in just operating the boilers

Source: Directorate of Steam Boilers, Government of Maharashtra, 2023

More than half of the boilers in the state are based on biomass. About 44% of the boilers use fossil fuels.

Figure 4: Fuel use by boilers



Source: iFOREST analysis based on information of Directorate of Steam Boilers, Government of Maharashtra, 2023

Transition hotspots, challenges and opportunities

Hotspots: Pune has the highest number of boilers followed by Thane, Raigad, Kolhapur, Nashik and Nagpur districts. These five districts collectively account for over 52% of the registered boilers in the state. The key sectors using boilers in these districts include food and agriculture, textile, chemical, pharmaceutical and healthcare and manufacturing/automobile.

Challenges and opportunities: Maharashtra have an opportunity to decarbonise the boilers through biomass and electricity. Already more than half the boilers are based on biomass. In addition, most of the boilers are of less than 10 tph capacity. These small-capacity boilers, which are dependent on coal, oil and natural gas, can be shifted to electric boilers. Therefore, adoption of electric boilers by industrial units, particularly those in food processing, textiles, pharmaceutical, etc., is a crucial opportunity to reduce fossil fuel dependence.

B. Overall Outlook

The energy transition unfolding in the coming years will impact a large number of workers across various sectors and districts in Maharashtra.

1. The energy transition will impact about 50% of the workforce involved in mining and manufacturing, excluding construction.

The green energy transition will affect coal mining, thermal power, refineries, and 41% of all factories operating in Maharashtra. They collectively employ more than a million formal workers. It will also impact the brick sector, which employs about 0.25 million informal workers. Overall, close to half of the workforce involved in mining and manufacturing, excluding construction, will be impacted.

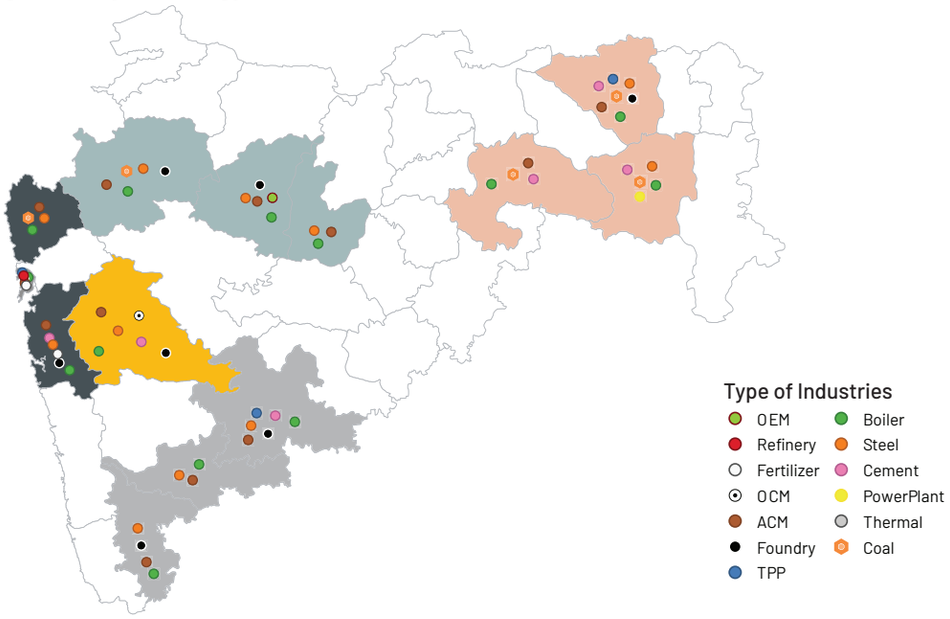
2. Fourteen districts, including the Chandrapur-Nagpur-Yavatmal coal and industrial region, and the Pune industrial region, remain hotspots for just energy transition.

Overall, 14 districts remain highly significant from an energy transition perspective. These include Nagpur, Chandrapur, Yavatmal, Pune, Nashik, Aurangabad, Ahmednagar, Kolhapur, Sangli, Solapur, Palghar, Raigad, Thane and Mumbai Suburban (including Mumbai city). These districts will require priority intervention to ensure net-positive environmental and socio-economic outcomes.

These districts account for 100% of the coal mines, oil refineries, and fertilizer plants. Besides, they are home to 65% of the coal-based TPP units (and over 60% of the capacity), 77% of the iron and steel units (and 93% of the foundries) and 78% of steel capacity, over 60% of the cement units (combining integrated plants and grinding units) and 74% of the capacity, 75% of the automobile enterprises (combining ACMs and OEMs), and about 78% of the boilers. Besides, these districts also cover all five brick-making clusters.

The districts overall employ 0.4 million people formally and many more informally across the value chain of various sectors, including, 0.25 million brick workers.

Map 1: Hotspot regions for just energy transition



Source: iFOREST analysis

C. Fostering of Green Growth and Green Jobs

A key objective of just transition is to ensure economic continuity 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. Fostering green growth and green jobs in the transition regions will require the development of policies and plans, boosting opportunities for green investments, and mobilising financial resources.

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. The policy should include the following components:

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

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

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

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

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 priority clusters for the development of regional just transition plans are the Chandrapur-Nagpur-Yavatmal cluster and Pune. These two are going to witness the impacts of green energy transition within the next 10 years.

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

3. Balanced development of green energy and green industries will be required to improve clean energy access and prospects of green jobs.

There is a clear regional disparity between the transition geography of the coal districts and where RE investments are happening.

To address this, the State Government should create enabling environments for RE investments in the coal districts and address the regional imbalance in RE growth in the state. The state may provide fiscal and non-fiscal incentives to support RE investments in these regions. At the same time, the government can work along with Western Coalfields Limited (WCL) to repurpose the coal mining land for RE development, besides leveraging other opportunities for economic diversification and job creation.

4. Repurposing of land and infrastructure will be crucial for economic diversification, development of green industries, and green energy infrastructure, in the coal regions.

Repurposing the land and infrastructure available with coal mines and power plants provides a huge opportunity for undertaking various economic activities once the mines are closed. For this, the government, industry, financial institutions, and investors need to engage collectively.

Maximising land repurposing potential will also require the reform of land-related laws and the development of necessary guidelines, to ensure the transfer of land to the State Government by the industry (such as coal mining land after mines are closed) for supporting diverse economic activities that can enhance income and livelihood opportunities of the local community.

5. Reskilling and skilling the workforce for the transition to low-carbon economy will be crucial for retaining jobs and creating a future-ready workforce.

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. Investments in skilling and reskilling programmes for the workforce, both by the government and the industries will be essential to minimize job loss, help workers adapt to new roles within emerging green sectors, and make them more adaptable to the changing job market. Besides, skilling will be essential to develop a future-ready workforce, as the skills required for jobs in a low-carbon economy will in many ways be different from those in the existing enterprises.

The current skill development programmes and schemes in Maharashtra focus majorly on information technology (IT), automobile, accounting, construction, and healthcare. There are a handful of solar energy and auto (EV) transition-related skill development programmes implemented by both the government and the industry.

To support a just transition of the workforce, integrated skilling programmes across sector-specific value chains will be required. Considering future job prospects, workforce development for the following five sectors will be important.

i. **Green construction and green infrastructure:** This will involve material transformation and use in construction and infrastructure development. It will require the skilling of the workforce across the value chain in brick manufacturing, cement manufacturing, green steel making, etc., use of sustainable building materials, life cycle assessment, green certification,
ii. **Green mobility:** Developing skilling and reskilling programmes across the auto value chain, including OEMs, ACMs, servicing, research and development (R&D), and charging stations, is a necessity across Maharashtra. The industry is already planning skilling for EV transition, and the government must support these steps by planning courses that are designed according to the needs and demands of the auto industry.
iii. **Green energy:** Transitioning the workforce toward green energy will require a combination of technical, analytical, and practical skills. Skilling will be required for the design, installation, and maintenance of RE systems, smart grid technologies, energy storage, green hydrogen use, transportation, and operation, among others.
iv. **Repurposing and decommissioning:** Design skilling courses and programmes aligned to support skilling for decommissioning and repurposing of fossil fuel-related infrastructure and energy assets. This will involve skilling for impact evaluation, risk assessment and management, waste disposal and management, remediation, etc.

v. **Green industry:** A key aspect of industrial transition will be the use of electric boilers by various industries in the future. This will require the development of a workforce for handling electric boilers in the green industry, including, installation and commissioning, handling of control system, operation, and maintenance, among others.

6. The creation of a dedicated Just Transition Fund from state, national, and international sources will be necessary.

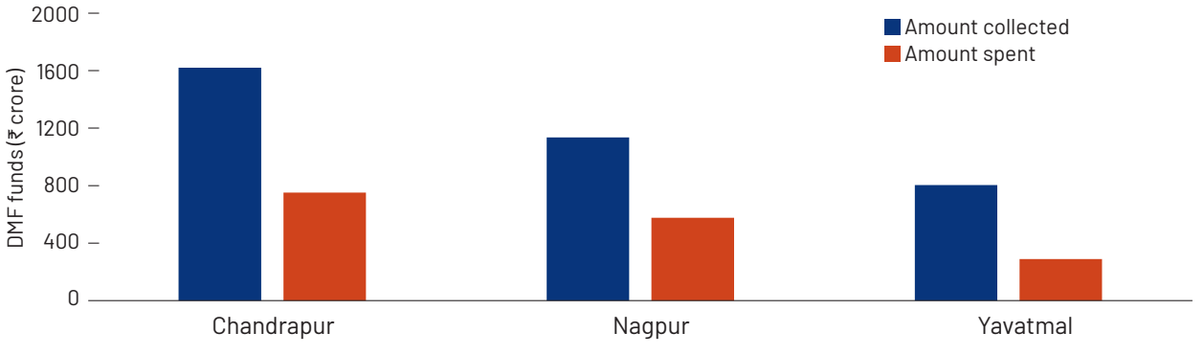
A dedicated fund for just transition needs to be created at the state level to allow interventions outside the planned investments, especially to provide income and welfare support and protection to the informal workers and vulnerable groups in the induced economy during the transition.

7. Repurposing of District Mineral Foundation funds can support just transition in coal districts.

District Mineral Foundation (DMF) funds provide an important opportunity to support just transition of the local communities in the coal districts. The objective of the DMF and priority issues towards which the funds should be used are well aligned with key intervention areas of just transition. These include investments in sustainable livelihood and income generation activities, skilling, education, social infrastructure development, improving clean energy access, etc. All these are important for improving income opportunities and building community resilience.

So far, over ₹4,841 crores has been accrued to DMFs in Maharashtra, out of which the three coal districts have a share of about 74% (₹3,559 crores). Only about 45% of the accrued amount has been spent so far. Moreover, DMFs in these districts are expected to receive about ₹150 crore per year, at least in the coming 10 years.

Figure 5: DMF fund accrual and expenditure in coal districts



Source: iFOREST analysis based on information of the Ministry of Mines and district DMFs, 2024

DMF funds, therefore, can be crucial seed money and provide an opportune window. The State Government can provide the necessary direction for using DMF funds to support just transition-aligned investments in these districts, particularly in blocks where mines are likely to close in the near future due to resource exhaustion and economic unviability.