# Just Transition: Understanding the implications of moving away from coal

## Impact on MSME workforce in selected coal consuming sectors


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# FOREWORD

Coal has been, and will continue to be, a critical driver of India's economic growth. Coal accounts for 55% of India's total energy consumption and is used in many industrial sectors as well as in myriad micro, small and medium scale enterprises (MSMEs). These coal-based industries and allied enterprises provide employment and entrepreneurial opportunities for tens of millions of people, in the coal-rich regions of eastern India as well as far beyond.

The MSME sector, a core sector pivotal to the nation's economic growth, is a major consumer of coal. The sector significantly contributes to India's gross domestic product (GDP) and generates substantial employment. The sector is heterogeneous, comprising a mix of few progressive large/medium-scale plants and numerous micro and small units, which complicates the adoption of low carbon technologies aimed at achieving net-zero emissions. Coal has historically played a crucial role in the socio-economic development of steel-producing regions, particularly in Eastern India. However, drastic and abrupt measures to phase-down coal could imperil large number of people whose livelihoods depend on the coal value chain. It is important to keep the rights and welfare of the affected people in focus while planning for and undertaking the energy transition.

Under the project, a Just transition framework has been prepared for MSME sectors. Field studies and stakeholder interactions were conducted by TERI to examine the techno-social implications of the energy transition in six major coal-consuming industrial sectors which are predominately in MSME sector—direct reduced iron (DRI), steel re-rolling mills (SRRM), foundry, brick, pulp & paper and textile. A deep dive study to examine the socio-economic implication of the transition was conducted in three major secondary steel clusters—Durgapur in the state of West Bengal; Giridih in the state of Jharkhand; and Raipur in the state of Chhattisgarh.

Working with coal-based MSMEs in different clusters was not easy. The project team at TERI was able to connect with the stakeholders in various clusters because of several years of technical assistance provided to MSMEs in the targeted sectors. This helped TERI to gain the trust of the entrepreneurs as well as the workforce and establish a rapport with them. It is important to continue the dialogue on Just transition with government representatives, industry and other stakeholders, to implement innovative policies for the benefit of the MSME workforce.

**Vibha Dhawan**

**Director General**

**TERI**



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TERI team



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# ABBREVIATIONS

| | |
|---|---|
| AAC | Autoclave Aerated Concrete |
| AIIMS | All India Institute of Medical Sciences |
| BATs | Best Available Technologies |
| BF-BOF | Blast Furnace-Basic Oxygen Furnace |
| BTK | Bull's Trench Kiln |
| CAPEX | Capital Expenditure |
| CCUS | Carbon Capture, Utilization and Storage |
| CHP | Combined Heat and Power |
| COP | Conference of the Parties |
| DBC | Divided Blast Cupola |
| DFO | Development and Facilitation Office |
| DIC | District Industries Centre |
| DISCOMs | Distribution Companies |
| DPR | Detailed Project Report |
| DRI | Direct Reduced Iron |
| EAF | Electric Arc Furnace |
| EIF | Electric Induction Furnace |
| ESI | Employees' State Insurance |
| ETC | Energy Transition Centre |
| FDGs | Focus Group Discussions |
| GCF | Green Climate Fund |
| GCV | Gross Calorific Value |
| GDP | Gross Domestic Product |
| GEF | Global Environment Facility |
| GHG | Greenhouse Gas |
| HYBRIT | Hydrogen Breakthrough Ironmaking Technology |
| IEDS | Indian Enterprises Development Service |
| IPCC | Intergovernmental Panel on Climate Change |
| IPCEI | Important Projects of Common European Interest |
| IPP | Integrated Policy Package |
| IRENA | International Renewable Energy Agency |
| ITI | Industrial Training Institutes |
| JT | Just Transition |



| | |
|---|---|
| kWh | Kilowatt hours |
| kWhe | Kilowatt Hours Equivalent |
| LKAB | Luossavaara-Kiirunavaara Aktiebolag |
| MPP | Master of Public Policy |
| MS | Mild Steel |
| MSME | Micro, Small and Medium Enterprises |
| MT | Million Tonnes |
| MTOE | Million Tonnes of Oil Equivalent |
| MWh | Megawatt hours |
| NCV | Net Calorific Value |
| NGOs | Non-Governmental Organizations |
| O&M | Operations and Maintenance |
| OPEX | Operating Expenditure |
| OSH | Occupational Safety and Health |
| PF | Provident Fund |
| PV | Photovoltaics |
| RE | Renewable Energy |
| SHGs | Self-help Groups |
| SMS | Steel Melting Shop |
| SOEs | State-Owned Enterprises |
| SOPs | Standard Operating Practices |
| SPPA | School of Public Policy and Administration |
| SRRMs | Steel Re-Rolling Mills |
| SSAB | Svenskt Stål AB |
| TMT | Thermo Mechanically Treated |
| TPD | Tonnes per day |
| TPH | Tonnes per hour |
| WBREDA | West Bengal Renewable Energy Development Agency |

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# INTRODUCTION

## 1.1 Backdrop

Coal has been, and will continue to be, a critical driver of India's economic growth. Coal accounted for about 58% of India's total primary energy consumption of 840 million tonnes of oil equivalent (MTOE) in the year 2023 (MOSPI, 2024). India has the world's fifth largest reserves of coal and ranks second in the world in coal production after China.

About 70% of India's electricity generation comes from coal-fired power plants. Coal is also used in many core industrial sectors such as cement and iron & steel, as well as in myriad small and medium-scale industries. These coal-based industries and allied enterprises provide employment and entrepreneurial opportunities for tens of millions of people, in the coal-rich regions of eastern India as well as far beyond. As the Indian economy continues to grow, the demand for coal is also increasing, from the power sector and from industry. The coal demand is met by indigenous coal mines as well as imports. The overall production of raw coal in India during 2022–23 was about 893 million tonnes (Mt) (10.3% of the world's total) compared to 778 Mt in the previous year (a growth rate of 14.8%) (Ministry of Coal, 2024) (Ministry of Finance, 2022). India imported 238 Mt of coal during 2022–23, out of which about 56 Mt was coking coal.

Not surprisingly, India is currently also a significant contributor of annual global emissions, accounting for about 2310 Mt of $CO_2$ emissions in 2019, equivalent to about 7% of the world's total $CO_2$ emissions during that year (IEA, 2019). However, as a developing nation, India has contributed only a miniscule share to the cumulative global carbon emissions. Under the circumstances, India can refrain from drastic and abrupt measures that could imperil millions of people whose livelihoods are involved with the coal value chain. It is critically important for the country to keep the rights and welfare of all affected people in central focus while planning for and undertaking the energy transition away from coal.

At the COP26 conference in Glasgow, India announced a five-point agenda, called *Panchamrit*, towards reducing emission levels in a time-bound manner *(Box 1)*.

**Box 1. Panchamrit: India's emissions reduction targets**

1. Reduce emissions intensity of its GDP by 45% by 2030, from 2005 level
2. Achieve non-fossil fuel energy capacity of 500 GW by 2030
3. Achieve about 50% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030
4. Reduce projected carbon emissions by one billion tonnes by 2030
5. Achieve net-zero emission levels by 2070

## 1.2 Just Transition

Even as nations across the world strengthen their commitments and actions to cut down greenhouse gas emissions by transitioning away from fossil fuels to low/zero-carbon energy options such as clean electricity produced from renewable energy (RE) and green hydrogen, there is growing recognition that such a large-scale energy transition away from fossil fuels will bring about massive societal disturbances. This is because there are countless millions of people who now depend for their livelihoods, directly or

indirectly, on the extraction, processing, transport and usage of fossil fuels. Energy transition will be an extremely disruptive force in their lives; indeed, the impacts of the transition could potentially be far more immediate and devastating for them than the looming impacts of climate change.

> *"Energy transition is about more than reaching a carbon neutral society. It is also about ensuring that all groups in society can equally benefit from the transition, and especially, that it does not come at the expense of certain groups..."*
>
> *—University of Leiden*
>
> *'Just Energy Transition'. Livable Planet Programme [https://www.universiteitleiden.nl/en/liveable-planet/case-studies/just-energy-transition]*

Hence, all nations must strive to achieve energy transition through 'just' pathways that protect the rights and interests, and enhance the economic and social well-being, of all people whose lives will be adversely affected, directly or otherwise, by the transition.

> *"Coal will remain the bulwark of India's energy system for decades. It is no doubt the dirtiest of fuels, but it remains amongst, if not the cheapest, source of energy. Plus, hundreds of thousands depend on the coal ecosystem for their livelihood. The option of phasing out coal whilst environmentally compelling is not yet a macroeconomic or social possibility."*
>
> *Vikram S Mehta*
>
> *Chairman and Distinguished Fellow, Centre for Social and Economic Progress*
>
> *[https://indianexpress.com/article/opinion/columns/decarbonisation-path-russia-ukraine-conflict-8355563/]*

The importance of ensuring justice in energy transition has found clear expression in recent international discussions and agreements on climate change. For instance, the COP27 summit held in Sharm El-Sheikh in November 2022 called for *"accelerating efforts towards the phasedown of unabated coal power and phase-out of inefficient fossil fuel subsidies, while providing targeted support to the poorest and most vulnerable in line with national circumstances and recognizing the need for support towards a just transition."* (UNFCCC, 2022)

## 1.3 The project

While just energy transition now features prominently in the global discourse on climate change, so far, the focus has tended to be on the points of fossil fuel extraction—specifically, on coal mines and the workers and communities that directly depend on coal mining. However, in countries such as India that are rich in coal deposits as well as heavily dependent on coal for generating electricity and for meeting



thermal energy requirements in industry and other sectors, the transition away from coal towards alternative (green) energy options will bring huge and snowballing economic and social impacts: not only among those directly dependent on coal mining, but also down the entire coal value chain to sweep across the much wider communities whose lives are centred around and sustained by the usage of coal, directly or indirectly.

> *Look beyond coal mines!*
>
> *India's vast MSME sector includes tens of thousands of traditional small-scale industries that are based on coal, which is often locally available and the cheapest source of energy. Examples are brick kilns, direct reduced iron (DRI)/ sponge iron-based steel units, steel re-rolling mills having reheating furnaces, cupola-route foundries, textile dyeing industries having coal-fired boilers, and many others. These industries provide direct and indirect livelihoods to millions of people and will be severely impacted by the transition away from coal. Many will face closure, putting at risk not only the livelihoods of millions of workers but also adversely impacting the local/ regional economies*

It is hence essential to expand the discussions, studies and strategizing on energy transition beyond coal mines, to cover the much larger socio-economic ecosystems that will be as seriously affected by the contemplated transition away from coal.

> *"Just transition is not a fixed set of rules, but a vision and a process based on dialogue and an agenda shared by workers, industry, and governments that need to be negotiated and implemented in their geographical, political, cultural, and social contexts. "*
>
> *—International Institute for Sustainable Development*
>
> *['Just Transition'; https://www.iisd.org/topics/just-transition]*

Recognizing the enormous potential for bringing about just energy transition among coal-based micro, small and medium enterprises (MSMEs) in India, TERI, with support from MacArthur Foundation, undertook the current project to study and assess, in more detail:

- Identification of priority sub-sectors for transition;
- Evolution of a comprehensive transition framework;
- Assessing the effectiveness of the framework and modifications for reskilling;
- Human and institutional development.

In the study, TERI explored concrete ways in which to make green industrial transformation without exacerbating socio-economic and environmental disparities. In-depth information was collected through primary surveys in selected MSME clusters through a local survey agency. Methods include surveys,

focus group discussions (FDGs), and interviews with key informants such as formal/informal industrial workers, supervisors/technicians, executives/engineers, industrialist/factory owners, local NGOs/ community groups/SHGs, and representatives (DIC, MSME-DFO, etc.).

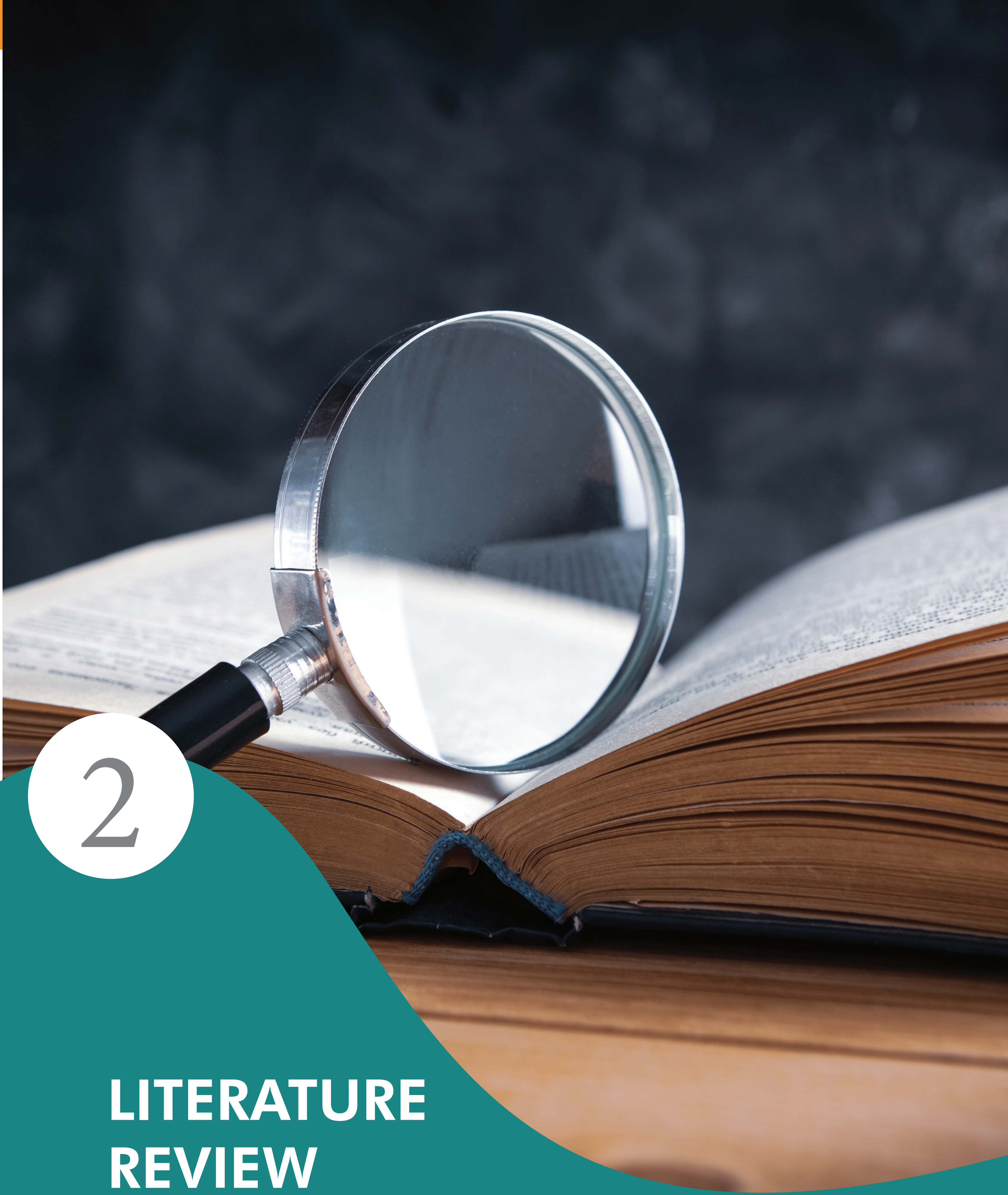
Through its extensive field work, the project team was able to understand the socio-economic status and impacts of energy transition and identify a host of policy recommendations. A few key findings:

- India's efforts towards net zero must be attuned to the needs of coal-based MSME clusters.
- The energy transition must not exacerbate existing regional inequities.
- Just transition must involve reskilling/upskilling of the MSME workers.
- A robust policy framework is needed to help upskill and reskill workers who are at risk of losing their jobs.

Support is required to cultivate alternative economic opportunities within the MSME clusters

This report covers the literature review, research approach and study area, studies in selected sub-sectors and prepared framework for Just Transition in MSME sector.





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# LITERATURE REVIEW

The world is facing a climate crisis. The past decade witnessed the largest decadal emissions in history. Recent reports released by the Intergovernmental Panel on Climate Change (IPCC) shows that unless there is deep, immediate greenhouse gas (GHG) reduction across regions and sectors, limiting warming to 1.5°C is out of reach. All countries, both developed and developing, need to shift their development pathways towards sustainability. To achieve this, all countries must shift from coal to renewable energy as soon as possible.

Considered as the engine to growth, coal forms the backbone of various industrial activities, especially where it is consumed. Coal has been playing an important role in generating employment and entrepreneurial opportunities for decades, bringing in all-around development in coal-dependent regions and industries. Any transition from fossil-fuel dependence to alternative cleaner options would destabilize the existing ecosystem and the intent of the proposed project is to ensure a responsible and humane transition and infusing greater vibrancy. Millions of workers are employed not just in the upstream sector, i.e., the coal mining sector, but also in an equally large number of industries especially the MSMEs, which use coal in large quantities and provide a livelihood to the workers engaged in utilization of coal in furnaces, boilers, and other processes.

As one of the world's largest producers and consumers of coal, India relies heavily on this fossil fuel to meet its growing energy demands, despite increasing global trends towards renewable energy sources. The coal industry in India not only drives economic growth but also poses significant environmental and social challenges, shaping national policies and global energy dynamics in the process.

No doubt, addressing global warming is important. But, it is equally important for developing countries to ensure that there is adequate and affordable energy available for powering economic growth (ET, 2023). Balancing environmental stewardship with economic development remains a pressing challenge for nations worldwide. As India strives for sustainability, the country must innovate and invest in clean technologies while respecting the energy needs of its burgeoning economy.

## 2.1 Coal reserves and production

India's proven coal reserves is estimated to be about 200 billion tonnes. Four states in eastern India – Odisha, Jharkhand, Chhattisgarh, and West Bengal – account for about 70% of the country's coal reserves. Madhya Pradesh, Telangana and Maharashtra are the other major coal-producing states.

The Ministry of Coal is the nodal Ministry responsible for making policies and strategies for exploration of the coal in India. State-owned enterprises (SOEs) account for 95% of the total coal produced in the country. Coal India Limited is the largest state-owned company, contributing to about 80% of the total coal production followed by Neyveli Lignite Corporation India Limited and Singareni Collieries Company Limited. The share of coal production of SOEs and private enterprises is shown in Table 1.

**Table 1:** Coal production share (2022–23)

| Sector | Coking coal | Non-coking coal |
|---|---|---|
| Public | 91% | 96% |
| Private | 9% | 4% |

*Source: Based on Coal Directory of India, 2022–23*

The major coal producing states in India are shown in Figure 1. During 2022–23, Odisha ranked highest in coal production, followed by Chhattisgarh, Jharkhand, and Madhya Pradesh. Most of the coking coal came from Jharkhand.

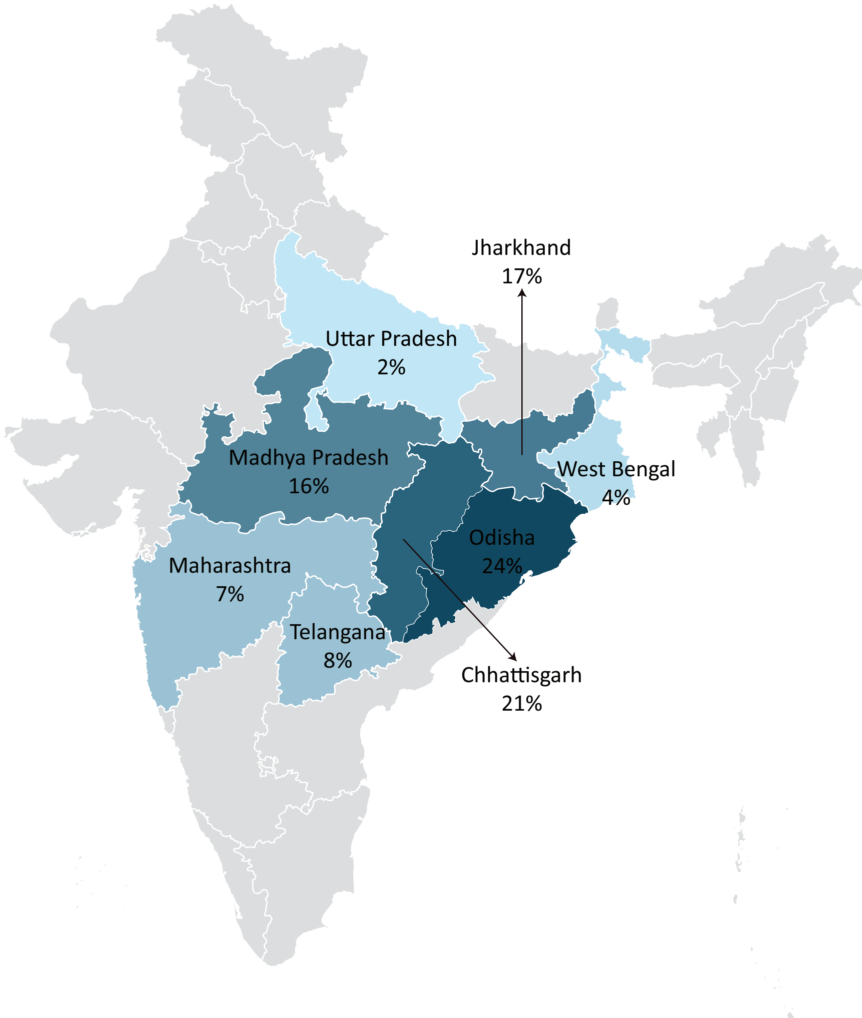



**Figure 1:** Major coal producing states in India

## 2.2 Coal consumption

India accounts for about 12% (1155 Mt) of the world's total coal consumption (ICED, 2024). The thermal power plants are estimated to account for about 66% of the total coal consumption in the country. The balance of coal is consumed by large-scale as well as MSME energy-intensive industries such as iron & steel, cement, brick, and pulp & paper.

Industry accounted for about 8.7 Gt of $CO_2$ emission, which is 26% of the world's total $CO_2$ emissions, in 2020 (IEA, 2021). In India, the industry sector accounted for about 1,500 Mt of $CO_2$ emission, which is 53% of the total $CO_2$ emissions of the country (TERI, 2024). Emissions of some of the industries in India are given in Table 2. The anticipated economic growth of the Indian economy will lead to a significant increase in the use of fossil fuels. For example, the energy consumption in iron & steel industries, and hence the corresponding GHG emissions are estimated to rise from about 300 Mt in 2019 to 800 Mt by 2050 (TERI, 2020). Since use of coal will continue to be the major source of energy, strategies such as adoption of green technologies (RE and electrification) and improvements in efficiency of utilization will be essential.



**Table 2:** GHG emissions per annum of few industrial sectors in India

| Sector | Coal consumption, Mt | Emissions, Mt $CO_2$ |
|---|---|---|
| Iron & steel | 150 | 272 |
| Cement | 135 | 245 |
| Pulp & paper | 19 | 34 |

*Source: TERI estimates*

India is in a transition phase of economic liberalization. Many developed countries are making very successful attempts to transfer industrial technologies and developing innovative capabilities over time. India on the other hand had a mixed experience of successful technology transfer and its diffusion.

At the same time, MSMEs in these and other sectors account for a significant share of coal consumption in the country. MSMEs in sectors like sponge iron/direct reduced iron (DRI), red clay bricks, steel re-rolling mills (SRRMs), textile dyeing, foundries and pulp & paper and so on are also large consumers of coal. For example, six MSME sectors consume about 120.5 Mt of coal per annum (~ 38% of total coal consumption (Figure 2).

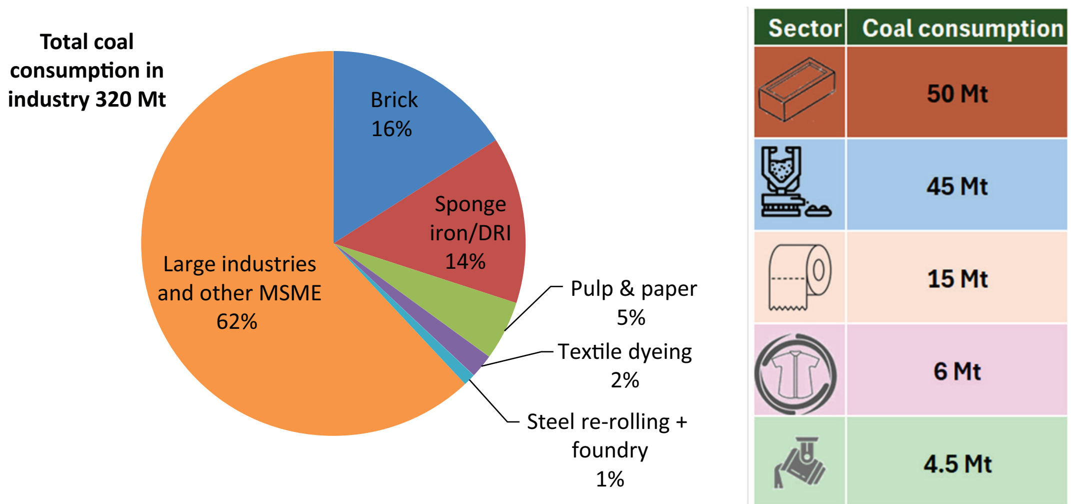



**Figure 2:** Major coal consuming MSME sectors

*Source: TERI estimates*

The details of coal consumption, conventional and new low-carbon technologies, challenges for energy transition and socio-economic perspectives of the six coal-based MSME sectors are discussed in subsequent chapters.

## 2.3 Phase-out of coal and Just Transition

Any policies aimed at phase-out of coal in the future will impact the large industries as well as MSMEs and their workers. However, the MSME sector is likely to be much more impacted as the sector has limited capacity to access modern technologies and capital. Hence 'one size fits all' policies cannot be taken for all industries. The MSMEs and workers in them need to be given special assistance for them to be able to cope with the new rules.

The preparedness of major coal consuming MSMEs like sponge iron/DRI, brick, textile dyeing, foundry, steel re-rolling and so on to meet its phasing out needs to be evaluated. Incidentally, some of these sectors are also large employment providers. This necessitates adopting a Just Transition (JT) framework for coal that addresses mitigating climate change while ensuring workers, communities and businesses are protected, and economic gains are made.

There are large differences among the states in India in the level of socio-economic development achieved and dependence on coal. Incidentally, the eastern states of Jharkhand, Chhattisgarh, Odisha and West Bengal meet not only the country's coal requirement but also host several coal-based enterprises. Incidentally, some of these aforementioned states are also low performing on the human development indices. This has wide implications for the transition to non-fossil fuels in the context of climate change, as some states will have a stronger path dependency to manage the transition to cleaner technologies than others. Since climate change is not a priority for most MSMEs, it is important that strategies for implementation and diffusion of green technologies among them are in tandem with their developmental priorities. Another challenge faced in energy transition of the sector is to bring together and involve a diversity of stakeholders like central and state government ministries and departments, local administrative set-ups, sectoral organizations, NGOs (non-governmental organizations), and private-sector enterprises in each of the sectors to a common agenda.

The energy concerns of the MSME sector is not new and there have been some successful cases of transfer of green technologies among them. Some MSMEs have prioritized their actions in the context of climate change to some extent. However, there is a need to develop an integrated programme endorsed by the national/state government, industry associations and workforce to promote widespread adoption and diffusion of green technologies among MSMEs.

The framework proposed in the last chapter of this report takes into consideration this wide socio-economic disparity between states in India and their varied needs. The role of respective state and central governments has been emphasized in the framework to address the state-specific issues.



3

# MSME SECTORS IN IRON & STEEL INDUSTRY

# 3.1 DRI

## 3.1.1 Background

India is the largest producer of sponge iron, also called direct reduced iron (DRI), in the world. Sponge iron, an intermediate product in steel industry, is made from iron ore. There are about 300 sponge iron plants in the country and their total production was 43.5 Mt in 2022–23 (SIMA, 2023). In India, 80% of the sponge iron is produced by coal-based route. Majority of the coal-based DRI units are located in Chhattisgarh, Odisha, West Bengal, and Jharkhand. Some of the major DRI clusters are Raipur in Chhattisgarh; Jharsuguda, Sambalpur, and Sundergarh in Odisha; Giridih and Chandil in Jharkhand; and Durgapur and Jamuria in West Bengal (Figure 3).

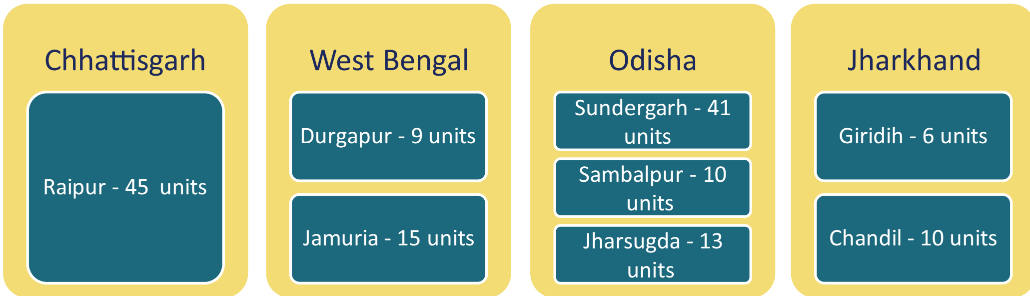



**Figure 3:** Sponge iron clusters in India

## 3.1.2 Coal consumption

Unlike in industrialized countries where natural gas is used, coal is primarily used to produce sponge iron in India. The specific coal consumption in DRI process ranges between 1.0 and 1.5 t/t of DRI (about 5.2–7.8 GCal/t). The total quantity of coal consumption of the sector is about 45 Mt per annum. The equivalent carbon emissions is estimated to be 64.9 $MtCO_2$ per annum.

## 3.1.3 Present coal-based technology

Coal-based sponge iron production uses horizontal rotary kiln technology (Figure 4). The rotary kiln is a refractory lined vessel on which several blowers are mounted. From the blowers, air pipes go through the shell and refractory, vertically and deliver the required amount of air for the process axially. The kiln is placed on a slope (of 2.5°) from feed end and the kiln rotates at a speed of about 1–3 rpm. Iron ore, coal, dolomite (or limestone) is fed in the required quantities. Temperature ranging between 1000 and 1100°C is maintained in about 70% of the kiln length (towards discharge end) for the required reaction.

**Figure 4:** Horizontal kiln in a DRI plant

A typical DRI unit (2 x 100 tpd) employs around 200 people. The number of workers deployed in different sections is shown in Table 3.

**Table 3:** Area-wise deployment of workers (DRI)

| Sections/Area | No. of workers |
|---|---|
| Raw material (dolomite, iron ore) processing | 25 |
| Coal processing/handling | 20 |
| Process control | 25 |
| Mechanical & electrical maintenance | 40 |
| Quality control (lab) | 15 |
| Administration | 25 |
| Other support staff | 50 |
| Total | 200 |

## 3.1.4 Alternate technology

Hydrogen ($H_2$)-based DRI technology is emerging as an alternative method for production of sponge iron. The gas-based DRI technology employs vertical shaft furnaces. Some of the production routes for hydrogen based DRI production is given below.

### (i) $H_2$ Green Steel

The $H_2$ Green Steel project near Boden, in northern Sweden, will be the world's first renewable hydrogen-based integrated steel mill. It is expected to start production in 2025. The project is a consortium of SMS group, Paul Wurth and Midrex, and consists of $H_2$-DRI plant, EAF, and advanced cold rolling and processing to manufacture high strength steel and automotive steel grades. All electricity requirements of $H_2$ Green Steel will be covered by renewables. It is expected to have 95% lower carbon footprint compared to traditional steelmaking.

### (ii) HYBRIT

The HYBRIT (Hydrogen Breakthrough Ironmaking Technology) project is a part of the European IPCEI project Hy2Use (Hydrogen), which includes a total of 35 projects from 12 countries to support the rapid



transition and increase the competitiveness of the European industrial sector. The HYBRIT initiative was launched in 2016 by a consortium of SSAB, LKAB and Vattenfall aiming to replace coal with hydrogen in the steelmaking process (SEI, 2024). An amount of EUR 143 million was awarded by EU Innovation Fund. The pilot plant for test production of sponge iron in Luleå, Sweden became operational in August, 2020 (S&P, 2021). In August 2021, SSAB produced and delivered the world's first fossil-free steel made with HYBRIT technology to a customer. In March 2021, Gällivare was chosen as the site of the planned demonstration plant for the production of fossil-free sponge iron on an industrial scale. There are plans to include a new apatite plant to extract phosphorus and rare earth metals from the waste streams in the proposed demonstration plant in Gällivare.

## 3.1.5 Barriers and remedial measures

There are several barriers limiting the transition of existing coal-based DRI plants to cleaner $H_2$-based routes. These barriers are discussed below.

### (i) High CAPEX requirements

The high capital expenditure requirement associated with vertical shaft furnace technology for DRI production serves as a significant barrier to its widespread adoption. This technology, despite its efficiency and lower operational emissions, demands substantial initial investment in infrastructure, advanced equipment and specialized engineering expertise. The high upfront capex requirement is a barrier for large number of small and medium-sized DRI plants in India from transitioning. Addressing these economic challenges would require substantial government incentives and innovative financing solutions for widespread adoption of $H_2$-DRI production.

### (ii) High OPEX cost

The OPEX cost of DRI production significantly impacts the viability of the technology. For $H_2$-DRI production to be cost effective, hydrogen should be available between USD 1 and 2/kg. Substantial policy backing and investment is needed to make hydrogen-based technologies viable against coal-based counterparts.

### (iii) Infrastructural bottlenecks

The expansion of piped hydrogen supply faces significant infrastructural bottlenecks that hinders its widespread adoption in steel making clusters in Eastern and Central India. Moreover, regulatory hurdles and complex approval processes may delay the expansion of piped gas networks, complicating efforts to integrate this clean energy source. Addressing these infrastructural bottlenecks through coordinated investment, regulatory reform and strategic planning is crucial in realizing the full environmental and economic benefits of piped hydrogen supply.

### (iv) Low awareness of new technologies

Low awareness of new technologies among DRI units pose significant challenges, impacting operational efficiency, worker safety, and environmental sustainability. There is a need to invest in regular training and awareness programmes. Preparation of feasibility studies/DPRs on adoption of hydrogen-based technologies is the first step towards market transformation. Conducting awareness programmes at regular intervals can also drive the integration of new technologies. By enhancing technological awareness, coal-based DRI units can be motivated to reduce their environmental footprint.

### (v) RD&D of new technologies

Unlike coal-based technology, there are no local suppliers of $H_2$-DRI technology at present. To address this gap, RD&D programmes, jointly with international technology providers, will play a crucial role in building local capabilities and prove the techno-economic viability of $H_2$-DRI processes. Establishing these demonstration plants in major industrial clusters will create effective role models, foster regional adoption and showcase the benefits of the technology. Public support, both at domestic and international levels, is essential for such initiatives.

### (vi) Re-skilling and training

For adopting new technology, re-skilling and training of plant-level will play a significant role in energy transition. Limited avenues for hands-on training courses and instructors, especially in the focused clusters, is a challenge. To tackle these challenges, comprehensive training packages need to be developed for engineers and plant operators. Bridging the skill gap through training builds the confidence of the plant personnel. Government, as well as international bilateral/multilateral organizations, need to invest in skill development.

## 3.1.6 Socio-economic dimensions

The socio-economic dimension of the DRI sector is multifaceted. A study was conducted by TERI, jointly with a local NGO, on the socio economics dimensions of the sector. Some of the key findings from the study are summarized below.

- The workforce in sponge iron units include both local and migrant workers who are often employed on short-term contracts or performing labour-intensive tasks.
- Over time, the proportion of contract workers has increased compared to permanent workers, leading to significant migration, particularly from Jharkhand, Bihar, Odisha, and West Bengal, due to job opportunities in DRI clusters.
- Compliance with labour laws, such as the Minimum Wages Act, Contract Labour Act, Factories Act, and Industrial Disputes Act, is often inconsistent across DRI units. This inconsistency results in inadequate wages, poor working conditions, and insufficient job security, especially for contract and migrant workers.
- Disparities in wages for similar labour work is common due to the varied culture of hiring contractual workers, with some portion of wages retained by contractors.
- The delayed payment process is used to bind workers, and the principle of "no work, no pay" is often enforced.
- There is a lack of robust social security measures, with many workers, particularly those on short-term contracts, lacking access to essential benefits such as provident fund (PF), employees' state insurance (ESI), health insurance and medical benefits in case of accidents.
- Classified under the 'Red Category' for hazardous industries, DRI units expose employees to high temperatures and potentially harmful gases, increasing the risk of occupational health issues.
- Pollution from DRI units significantly impacts nearby areas, with dust settling on roofs and grounds, leading to infertile agricultural land and polluted groundwater. The resulting pollution has reduced life expectancy and increased the prevalence of diseases, particularly respiratory and lung diseases.
- Due to limited economic opportunities, workers find it challenging to shift to new jobs and often remain in their current roles for extended periods, bound by contractor or employer conditions.

This analysis underscores the need for improved labour law enforcement, better working conditions, enhanced social security measures, and environmental protection to mitigate the adverse socio-economic impacts of energy transition for the DRI sector.

## 3.2 Steel re-rolling

### 3.2.1 Background

The iron & steel sector is one of the most important sectors for the Indian economy, contributing to about 2% to the country's GDP and employing around 2.6 million people in steel and allied sectors (JSW, 2024).

Steel is made through three routes in India mainly by blast furnace-basic oxygen furnace (BF-BOF), electric arc furnace (EAF) and electric induction furnace (EIF). The 'crude steel' is the steel in its first solid form after casting from a BF or EAF/EIF. Liquid steel is commonly cast into slabs (flat products), billets and blooms (square cross section). These semi-finished steel products are transported to other sites for further processing like rolling.

The steel re-rolling operation contributes to a major share of finished steel production. The major products manufactured in steel re-rolling mills (SRRMs) are bars, angles and strips. The final products of the SRRMs are majorly used in construction, buildings and other infrastructure sector.

There are an estimated 3000 SRRMs in India. The estimated production of the sector is about 63 million tonnes (Mt) per annum. Most of the SRRMs are in the MSME sector and are in clusters. Some of the prominent SRRM clusters are Howrah, Durgapur and Jamuria in West Bengal, Mandi Gobindgarh in Punjab, Raipur in Chhattisgarh, Giridih in Jharkhand and Bhavnagar in Gujarat (Figure 5).

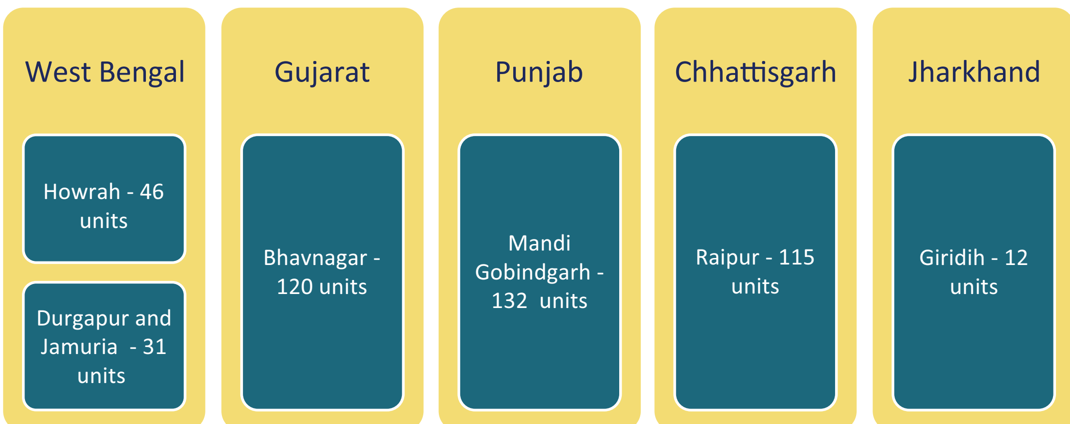



**Figure 5:** Steel re-rolling cluster in India

### 3.2.2 Coal consumption

Small and medium-scale rolling mills typically purchase billets or ingots from larger steel plants and rely on coal-based reheating furnaces to heat the metal for rolling. These furnaces are essential for heating the steel to the necessary temperature before it can be shaped into final product. On the other hand, larger rolling mills often have in-house melting (EIF/EAF) and continuous casting and rolling machines.

Considering small and medium-scale rolling mills account for about 50% of the total production in the sector, the coal consumed in reheating is substantial. Assuming a specific coal consumption of 125 kg/t of product in reheating, approximately 3.75 Mt of coal is consumed per annum in the sector. This translates to carbon emissions of around 6.8 $MtCO_2$ per annum.

A typical SRRM unit employs around 100 people for a typical 10 TPH reheating furnace. The number of workers deployed in different sections is shown in Table 4.

**Table 4:** Area-wise deployment of workers (steel re-rolling)

| Sections/Area | No. of workers |
|---|---|
| Raw material (billet cutting and loading) | 5 |
| Coal processing/handling | 5 |
| Reheating furnace operators | 5 |
| Rolling mill section | 15 |
| Finishing section | 15 |
| Mechanical & electrical maintenance | 6 |
| Quality control (lab) | 2 |
| Finished product dispatch/loading | 10 |
| Administration | 7 |
| Other support staff | 30 |
| Total | 100 |

## 3.3.3 Coal-based technology

Coal-based reheating furnaces in steel rerolling plants are used to reheat the billets for further deforming its shape and size. These reheating furnaces (Figure 6) are designed to heat steel billets or ingots to temperatures suitable for rolling, typically ranging from 1,100 to 1,300°C. In a typical coal-based reheating furnace, the combustion of coal generates the necessary heat, which is then transferred to the steel through radiation and convection. The efficiency of these furnaces is another concern, as conventional designed furnaces result in substantial energy losses through flue gases and unburnt coal residues. Recent advancements aim to address these issues by improving furnace insulation, optimizing combustion processes, and implementing better control systems to enhance thermal efficiency and reduce emissions.

**Figure 6:** Reheating furnace



## 3.3.4 Alternate technology

### Electric billet heater

Electric billet heater is a cleaner alternative to coal based reheating furnace (Figure 7). The electric heater has several coil zones. The temperature profile of each individual heating zone can be controlled to meet the specific requirements of the rolling mill.

**Figure 7:** Electric billet heater

It is possible to replace the existing reheating furnace with new electric billet heater technology. Adoption of electric billet heater will reduce GHG emissions, increase production, improve quality, decrease operating cost and extend the life of the equipment.

Typically, specific energy consumption of electric heating furnace ranges between 360 and 380 kWh/tonne. If all the re-rolling product produced by pulverized coal reheating furnace route (~30 Mt) is converted to electric induction reheating furnace, the carbon emissions will be 8.1 $MtCO_2$ (Grid Emission Factor of about 0.71 $tCO_2$ /MWh). However, the carbon emissions will reduce to 6.8 $MtCO_2$ by 2030 and 1.14 $MtCO_2$ by 2050 assuming that the grid emission factor will reduce to 0.6 $tCO_2$ /MWh and 0.1 $tCO_2$ /MWh by 2030 and 2050, respectively. If green electricity produced through renewable energy sources is used to meet the electricity consumption, then the SRRM industry can be completely decarbonized.

## 3.2.5 Barriers and remedial measures

There are several barriers which are limiting the rate of electrification of reheating furnaces in SRRM. These barriers are discussed below.

### (i) High capital and cost of power supply augmentation

Electric heating furnace need higher capital cost and enhanced power infrastructure including equipment like transformer and control panel. The high capital cost is a challenge, especially for MSMEs, as they often struggle with limited capital and restricted access to commercial financing. To facilitate the adoption of these greener technologies, several remedial measures can be implemented. Firstly, offering soft loans with favourable terms can ease the financial burden on MSMEs, making the high upfront costs more manageable. Secondly, reducing the cost of power delivery through subsidies or incentives for renewable energy can lower ongoing operational expenses. Lastly, simplifying the loan approval process for green technologies by streamlining procedures and expediting approvals can make financing more accessible for these enterprises. These steps can collectively make the transition to electric induction reheating furnaces more feasible and attractive.

### (ii) High price of electricity for industrial consumers

The high cost of electricity is significant for MSMEs, impeding their growth and modernization efforts. Electrification is financially unviable for many SRRM units, especially when the price of electricity is high. The challenge is particularly pronounced when MSMEs consider adopting advanced technologies, such as electric heaters, which despite having better efficiency and environmental benefits, require a consistent and affordable power supply. The high electricity prices discourage investments in such technologies. To mitigate this barrier, there is a critical need for policy interventions, such as subsidized electricity rates and incentives for the use of renewable energy. By addressing the high cost of electricity, MSMEs can be empowered to innovate, improve their operational efficiency and contribute to a cleaner industrial ecosystem.

### (iii) Additional land requirements

MSMEs generally have limited land area. Incorporation of electric reheater requires additional land and major changes in existing layout. The additional land area needed for the new set-up is generally a constraint among MSMEs, particularly when considering the adoption of modern, space-demanding technologies. Technologies such as electric heating furnaces necessitate the installation of supplementary equipment like transformers, control panel and cooling system, which often require more space than traditional set-ups. This additional land requirement can be a major hurdle for MSMEs, which typically operate in constrained spaces with limited expansion opportunities. Acquiring extra land or restructuring existing facilities to accommodate new equipment is not only costly but also logistically challenging, especially in densely populated or industrially congested areas. Addressing this barrier may involve providing support for proper planning, offering incentives for technology or facilitating access to larger industrial zones where expansion is feasible.

### (iv) Trained manpower

Implementing modern machinery, such as electric heating furnace, requires specialized knowledge and technical expertise that many MSMEs lack. These enterprises often struggle to find and retain skilled workers who are proficient in operating, maintaining, and troubleshooting sophisticated equipment. This skills gap is further exacerbated by limited access to quality training programmes. As a result, MSMEs may be reluctant to invest in new technologies due to concerns over operational disruptions and increased training expenses. Without the necessary skilled workforce, these businesses are unable to leverage the full benefits of technological advancements, which can lead to inefficiencies and a competitive disadvantage in the market. To overcome this barrier, there is a critical need for targeted training initiatives, partnerships with technical institutions and government-supported programmes that provide MSMEs with access to the requisite expertise and resources to upskill their workforce. Proper training through various training programmes should be facilitated to provide skilled manpower to the industry. Apart from that, industry-specific courses should also be introduced in technical institutions to train manpower for these industries. By addressing the gap in trained manpower, MSMEs can enhance their operational capabilities, innovate more effectively and compete in technology-driven industrial landscape.

### v) Product-specific reheating coils

The electric induction reheater uses heating coils. Since the size and dimension of coils needs to be customized to the dimensions of the feed material, the same coil will not be suitable for feed material of a different dimension. This means that any change in billet size or shape often necessitates the design and manufacture of new coils, adding complexity and cost of operation. For MSMEs, which often produce a diverse range of products in smaller quantities, this requirement can be problematic. The need for multiple, custom-designed coils increases both the initial investment and operational cost, as each coil must be meticulously crafted and calibrated to ensure optimal performance. Furthermore, the downtime associated with changing coils for different products can disrupt production schedules, reducing overall efficiency. The technical expertise required to design, install, and maintain these specialized coils further compounds the challenge, as many of them lack the in-house capabilities to manage such complex processes. To mitigate this, there is a need for advancements in coil design that allow for greater flexibility and adaptability, as well as support mechanisms that help them manage the technical and financial demands of implementing electric heating technology.

## 3.2.6 Socio-economic dimensions

Steel re-rolling is a critical segment of the steel industry, focused on processing raw steel into usable forms, such as bars, strips, angles, rods, etc., for various applications in construction, manufacturing, and other sectors. Typically, a re-rolling unit employs around 80–100 persons depending on their production capacity and operating nature. The workforce in the coal-based re-rolling industry encompasses a range of roles from coal handlers,roughing and finishing mill workers, supervisor, maintenance technician, and material handling persons. Coal pulverizer is used to grind coal into fine particles to ensure efficient combustion in the furnace. Coal is charged manually into the pulverizer (Figure 8). A team of 8–10 workers are engaged in each for manually charging the coal into furnace. These roles are often trained on job to the workers in small units by some senior personnel which does not require specialized skills or training but needs to follow safety due to the hazardous nature of the work involving dust and high temperature. The industry operates continuously, often on a shift basis, to meet production demands. Challenges include skilled manpower shortage due to impact of automation, and economic fluctuations. To address these, efforts in workforce development through training programmes, apprenticeships and partnerships with educational institutions must be undertaken. With the industry's focus shifting towards technological advancements and sustainability, there is a growing need to reskill the workers to adapt in modern processes and technologies.

**Figure 8:** Coal feeding in the pulverizer

# 3.3 Foundry

## 3.3.1 Background

India is the second-largest producer of castings globally and has ambitious plans for growth, with new capacities being rapidly added. The Indian foundry industry is estimated to produce 12 Mt of castings. There are approximately 5,000 foundry units, of which 85% are small-scale, 10% are medium-scale, and 5% are large-scale. Major foundry clusters in India are Howrah in West Bengal; Rajkot and Ahmedabad in Gujarat; Agra in Uttar Pradesh; Belgaum in Karnataka; Kolhapur in Maharashtra; Vijayawada in Andhra Pradesh; and Coimbatore in Tamil Nadu (Figure 9).

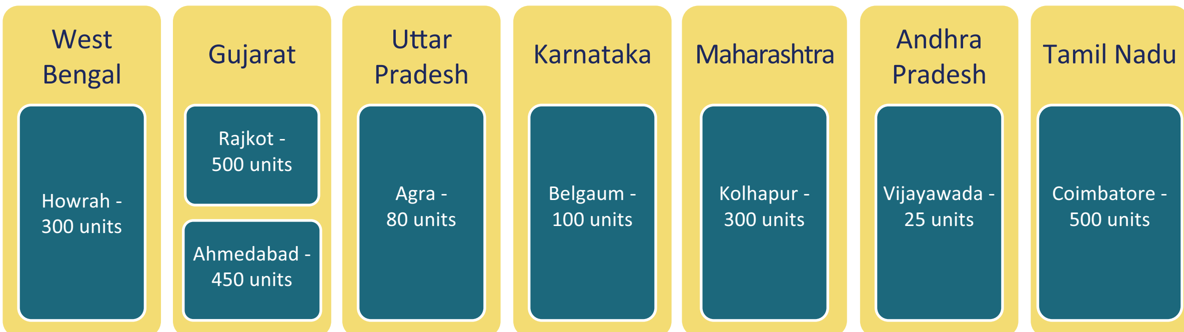



**Figure 9:** Major foundry clusters in India

## 3.3.2 Coal consumption

Melting accounts for a major share of about 70–80% in a foundry unit. There are two primary routes for melting of raw materials in foundry units: electric induction furnace and the cupola furnace. Cupola is the most common type of melting furnace used by small-scale foundries in India. Cupola furnaces use coke (made from coking coal). Most of the cupola route foundries produced castings such as manhole covers, sanitary pipes and castings for motors, pumps, textile, automotive, and other industries.

Coke is used as the fuel for melting cupolas. In India, about 2,000 foundry units use the cupola route. The cupola route foundry units are estimated to produce about half of the total production or around 6 Mt of castings annually. The average cupola furnace consumes 125 kg of coke to melt 1 tonne of iron, resulting in emissions of 405 kg $CO_2$ (Pal, 2021). In addition, there are some process emissions from limestone which is used as a fluxing agent with coal in cupola furnaces. Some small-scale foundries in India use coal-fired core drying chambers.

It is assumed at present that 50% of the total castings produced in India (~ 12 Mt/annum) is through cupola furnace route. The annual consumption of coal by foundry industries in India is estimated to be around 0.75 Mt. With a $CO_2$ emission factor of 3.12 $tCO_2$/t of coke (for coke of Gross Calorific Value of 7,000 kcal/kg), the $CO_2$ emissions from coke combustion in cupola route foundries are estimated to be 2.34 $MtCO_2$.



## 3.3.3 Present coke-based technology

Cupola is the most common type of melting furnace used by small-scale foundries in India. Coke is used as the fuel for melting in cupolas. The metals charged into the cupola are pig iron, cast iron scrap, and foundry returns. The energy performance of a cupola is measured in terms of the quantity of coke consumed per tonne of metal charged. Two types of cupolas are common in iron foundries – conventional cupola and divided blast cupola (DBC). DBC technology, in which air is injected into the furnace through two rows of tuyeres, is more energy efficient compared to conventional cupola. The molten metal from cupola is tapped at temperatures ranging from 1300–1500°C. Figure 10 shows a cupola melting furnace in operation. It is possible to replace cupola with electric induction furnace in the foundry industry.

**Figure 10:** Cupola foundry

A non-mechanized foundry unit in India employs a large number of semi-skilled workers for material handling and pouring operations. Only a handful of the workers involved in trades like cupola operation, electrician, and fitters are in the skilled category.

## 3.3.4 Alternative technologies

### Electric induction furnace

Electric induction furnaces use electricity as their energy source. An electric induction furnace is more energy efficient and has the potential to produce far lower carbon dioxide emissions, depending on the source of the electricity. An electric induction furnace used in foundry is shown in Figure 11.

Induction furnaces offer several advantages over cupola furnaces, including closer control of molten metal temperature, improved product quality, and a better working environment.

**Figure 11:** Induction furnace

## 3.3.5 Barriers and remedial measures

There are several barriers with limitations for the switch-over to electric melting in small-scale foundry units in India, some of which are discussed below.

### (i) High capital investment

In comparison to cupola, an electric induction furnace requires a much higher investment. Further, the unit needs to pay for augmenting the power connection infrastructure. The barrier can be overcome by making soft loans available for adoption of electric induction furnaces and lowering the cost for power delivery to MSMEs.

### (ii) High operating cost

Though switch-over to electric melting will lead to significant reductions in GHG emissions, it is still not viable to produce low-value added castings due to the high price of electricity (~ Rs. 8.75 per kWh) for industrial consumers in many clusters in India such as Howrah. Sensitivity analysis done by TERI shows that the switch-over to electric melting is viable if the electricity price is below Rs. 7 per kWh. Competitively pricing electricity for industrial consumers and developing simplified procedures for MSMEs to sell carbon credits will facilitate the switch-over to electric options.

## 3.3.6 Socio-economic dimensions

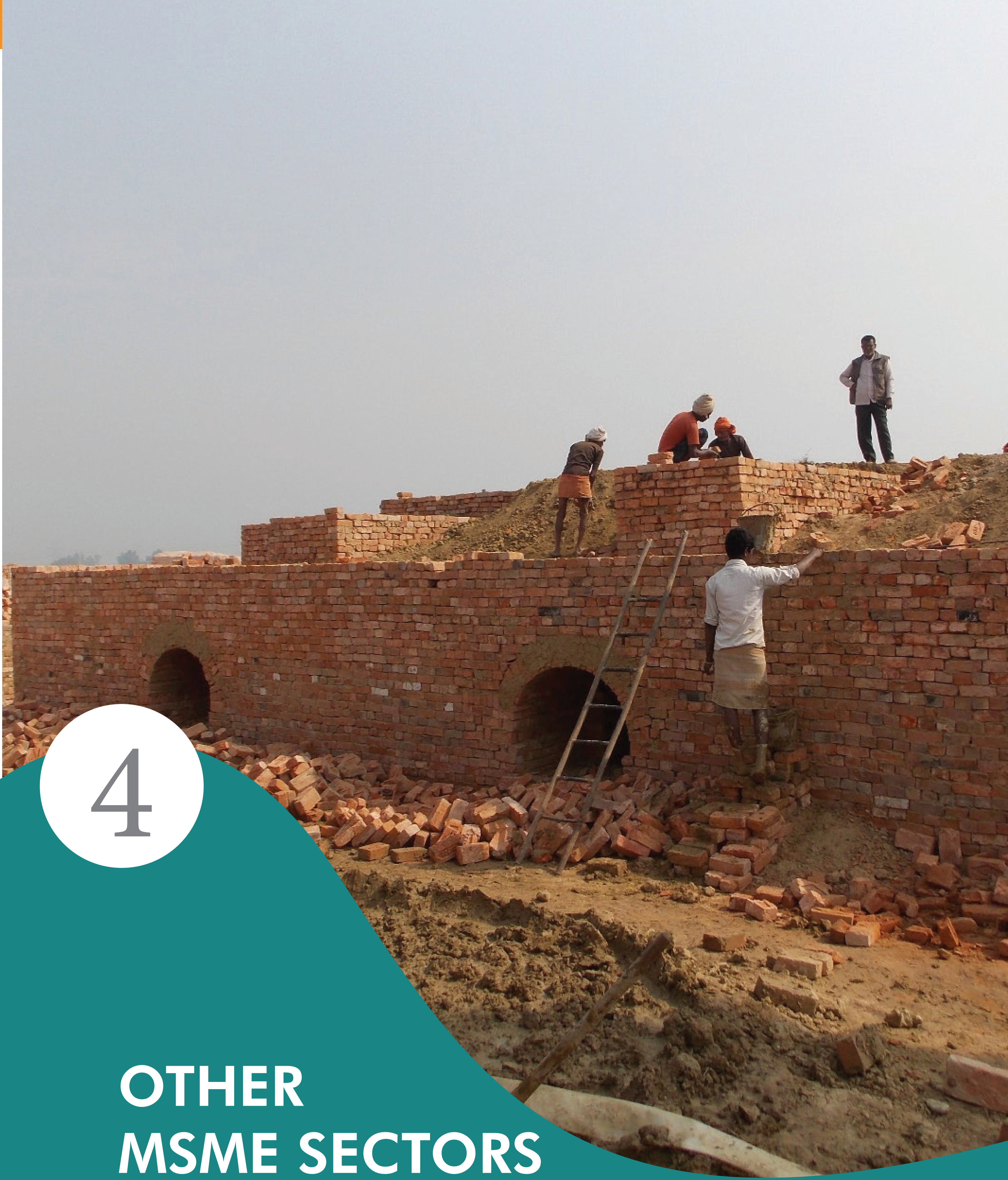
TERI has been working in Howrah foundry cluster for more than two decades. A socio-economic survey of Howrah foundry cluster conducted by TERI, jointly with a local NGO, provided some interesting insights of Howrah foundry clusters. Some of the major findings of the study are summarized below.

- During the 1960s and 1970s, when Howrah cluster was prospering, workers from the neighbouring states, such as Bihar, Odisha and Eastern Uttar Pradesh migrated to Howrah.
- The level of indebtedness is high among the workers. It was found that migrant workers from other states are more savings conscious.
- Lack of new investments, poor infrastructural facilities, shortage of power and worker-centric government policies have led to the industrial stagnation in Howrah.
- The workers suffer from a deep sense of insecurity owing to the decaying state of local foundry units and absence of any social security measures.
- Closure of many foundry units and introduction of contract system have put workers under enormous economic pressures.
- Most of the workers in foundries are employed by contractors and only a small fraction of the total workforce is directly employed by the units.
- Most workers are not availing state healthcare facilities, since it has almost collapsed. Even if the workers are eligible for state medical insurance scheme (ESI), they cannot expect to benefit from it, owing to lack of medicines and treatment facilities in ESI hospitals.
- In general, there is a lack of proper sanitation, drinking water, drainage, ventilation, and lighting in these units.
- Respiratory problems are common among foundry workers. This is probably because of poor indoor air indoor quality (high dust levels) at the workplace.



- Joint pains, especially lower back pain, is a very common symptom among the workers. This is probably caused by high degree of physical labour the workers have to do since most small-scale foundry units have no mechanization in areas like lifting loads and movement of materials within the factory.
- The workers are usually reluctant to use safety equipment such as goggles, boots and gloves even if these are provided by the foundry, since they feel that they affect their productivity and comfort.
- The contract workers are usually paid on piece-meal basis, e.g., number of good castings produced, quantity of raw material charged in cupola, etc.
- The workers usually perceive the relationship with employees as exploitative. The trade unions play a limited role and are involved mainly during wages/bonus negotiations. The unions are usually not concerned about other things such as training, working conditions, medical benefits and so on.
- Most of the workers feel that skill enhancement is useful particularly in areas such as improved moulding practices. They are also interested in skill enhancement in other areas apart from foundry operations.

The situation can be corrected through sustained efforts aimed at providing skill training and creation of alternative employment on a large scale.



# 4

# OTHER MSME SECTORS

# 4.1 Brick industry

## 4.1.1 Background

India is one of the largest producers of red clay bricks in the world. There are an estimated 2,00,000 brick kilns in the country producing about 300 billion bricks (i.e., 530 million $m^3$) per annum. These units are spread across the country. The industry is highly energy-intensive and consumes large amounts of coal. The brick manufacturing process in India is highly labour intensive and an estimated 10 million people are directly employed by the sector (BEE, 2019). The employment provided by the brick industry is seasonal since they operate for about six months (January to June) in a year.

## 4.1.2 Coal consumption

Coal is the main fuel used by the brick industry. Energy consumption accounts for about 40% of a brick's total manufacturing cost. The industry consumes around 50 Mt of coal per annum. Considering $CO_2$ emission factor 1.82 $tCO_2$/t coal (for coal of NCV 4514 kcal/kg), the total emissions in brick production is estimated to be about 91 $MtCO_2$.

## 4.1.3 Present coal-based technology

Bull's Trench Kiln (BTK) and zig-zag fired kiln are the two most commonly used technologies for the manufacture of red clay bricks. A BTK is shown in Figure 12.

**Figure 12:** Bull's Trench Kiln

In the kiln, green bricks are placed along with fuel in a particular pattern and fired. BTKs and zig-zag fired kilns are continuous type of kilns in which the bricks are stacked inside the kiln and the fire is made to move. Coal is fed manually through feed hole covers provided on top of the kiln. The firing temperature is maintained at 1000–1100°C in the firing zone of the kiln. The flue gases are allowed to pass through stacks of green bricks to preheat them before they join the central flue gas duct and exit the chimney. Typically, the temperature of flue gases leaving the chimney is between 80 and 120°C. A picture of worker loading the green cakes is shown in Figure 13.

**Figure 13:** Loading kiln with green cakes

The number of workers involved in different sections in a brick manufacturing unit (using manual moulding) is shown in Table 5.

**Table 5:** Number of workers employed in BTK

| Type of work | Number of workers |
|---|---|
| Green brick moulding | 50–100 |
| Transporting green bricks | 10–15 |
| Loading/setting green bricks in the kiln | 5–10 |
| Ash handling | 2–3 |
| Transporting coal to the kiln top | 2–3 |
| Fuel feeding | 4–6 |
| Unloading | 25–30 |
| Kiln supervision | 3–4 |
| Total | 101–171 |

## 4.1.4 Alternative materials

### (i) Autoclave aerated concrete block

Autoclave aerated concrete (AAC) blocks are eco-friendly and certified green building material. These blocks have lower thermal conductivity, better sound insulation property, high fire and earthquake resistance properties, and three times lighter when compared to red bricks (Figure 14).

AAC blocks are made of a slurry of cement, fly ash, gypsum, sand, water, and aluminium powder. The slurry is aerated with steam in a large mould of about 3 $m^3$ in size. After aeration, the green cakes are cut into desired sizes and cured in autoclaves.

Although coal is used for producing steam, the quantity of coal consumed in manufacture of AAC block is 3–4 times less compared to the manufacture of red bricks. Therefore, significant reduction in coal consumption (and top-soil consumption) can be achieved by adoption of AAC blocks. Subsequently, coal-fired boilers may be replaced with electric or biomass-fired boilers.

**Figure 14:** AAC block

### (ii) Fly ash brick

Manufacturing of these bricks uses fly ash, sand, cement, water and gypsum as raw materials. The raw materials are mixed with water. The mix is then filled into the moulds and bricks are casted by application of controlled vibration and hydraulic pressure. Then the casted bricks are kept in sunlight for 24–48 hrs. After which the sun-dried blocks are kept in shade to air dry for 1–2 days. The bricks are finally left for curing for 14–21 days. Water sprinkling is required during curing to ensure higher strength. The strength of the fly ash bricks depends upon the composition of raw materials.

### (iii) Concrete block

Concrete blocks can be solid or with hollow cavities. The manufacturing of concrete blocks uses cement, sand, water and gravel or aggregate as raw materials. Wet mixture of cement, sand with gravels is casted in wooden or metallic moulds. The concrete is compressed into the mould by application of vibration and hydraulic pressure. After compression, blocks are demoulded and placed in a steel pallet, and loose materials from the blocks are removed by a brush.

## 4.1.5 Barriers and remedial measures

There are several barriers with limitations for the switch-over to alternative materials in India, some of which are discussed below.

## 4.1.6 Lack of awareness

End-users and contractors are unaware of alternative materials like AAC blocks. Raising awareness among stakeholders through social media, radio and television channels, and other mediums can help promote use of AAC blocks.

### (i) Higher cost

The cost of AAC blocks is at least 1.5 times that of red clay bricks (Rs. 5000/$m^3$ for AAC blocks compared Rs. 3000/$m^3$ for red clay bricks). The impact on construction cost by the use of AAC blocks may be a deterrent for builders and end-users.

### (ii) Lack of reliable supply chains

The lack of reliable supply chains at the local level is a hinderance to adoption of AAC blocks. This can lead to delays in procurement and involve additional cost and effort by the construction management team. Development of reliable supply chains and partnerships between manufacturers, distributors, and large construction companies will promote the use of alternative building materials like ACC blocks.

### (iii) Lack of policies and regulations

Apart from The Fly Ash Notification, 1999 by the Ministry of Environment, Forest & Climate Change and subsequent amendments mandating the use of fly ash for manufacturing products like brick, concrete blocks and other construction activities within a 300-km radius of a thermal power stations, there are no policies to restrict the manufacture and use of red clay bricks.  A clear policy to phase-down the manufacturing and use of red clay bricks and regulatory framework for its implementation within a certain time frame should be developed to encourage adoption and eco-friendly building materials.

## 4.1.7 Socio-economic dimensions

Brick making is a traditional but important industry in India. Most of the brickworks are located near urban and densely populated rural areas. The brick workers are mostly migratory and come from the surrounding rural areas and live at the kiln site. Sustainable growth of the brick industry would require adoption of low carbon technologies which meet construction needs, generates employment (opportunities), checks migration (occupational mobility), and uplifts the unorganized rural poor.

TERI has been working in brick sector for several decades. Some insights from socio-economic studies conducted by TERI and other organizations in brick kilns in India are summarized below.

- The work area or the kiln site is highly hazardous. Safety measures are of minimal concern to the employers or kiln owners. Knowing the work site is a fire incident prone area, there is no arrangement of fire extinguisher. Workers move around the kilns with slippers. No safety gears like safety shoes, helmet, or gloves with thermal insulation, are provided to the workers.
- Wages of the brick kiln workers are comparatively less.  The wages are paid on either daily, weekly or monthly basis as decided by the kiln owner. Being seasonal, the workers are laid off and do not have regular jobs during the off-season. In some cases, kiln owners give advance wages to the workers to make them bonded for the next season. Workers do not have the authority to negotiate their wages.
- The brick kiln workers have no awareness on their legal rights and entitlements which is exploited by the kiln owners.
- The workers are often provided lodging facility by the kiln owners. They live in the kiln site in unhygienic conditions. Open defaecation is common and matter of minimum concern.
- Being located in remote areas, brick kiln fails to ensure the safety of the women workers. Harassment or exploitation of women workers is prevalent but such cases are never reported to the local police.
- Being located in remote areas, access to government healthcare facilities is a challenge. Lack of access to medicines and healthcare facilities make the workers vulnerable to health complications.
- The workers have to manually load and unload the bricks in the kiln and transport trucks/tractors. Continuous physical labour without adequate food and nutrition make the workers prone to longterm health issues.



- Brick kiln workers work over extended hours and often do not get paid for overtime. The workers have to work seven days a week without any rest day.
- Chronic exposure to dust and ash in ambient air makes the workers susceptible to lung disease and other issues.

Considering the above, it is imperative to formulate socially and environmentally conducive policies for the sustainable development of the sector.

# 4.2 Pulp & paper

## 4.2.1 Background

India is the 5th largest producer of paper in the world. Paper production has grown brickly in the past decade, from about 13 Mt in 2011 to about 22 Mt in 2022. The break-up of paper production in the country is as follows—writing and printing paper (74%), packaging grade paper (23%), and newsprint paper (3%).

There are about 526 paper plants in India. The sector is quite heterogenous and production capacities range between 5 tpd to 1,650 tpd. Based on the installed capacity, the paper industry can be classified into different categories (Table 6).

**Table 6:** Categorization of paper plants based on the capacity

| Capacity | Number of plants |
|---|---|
| Large (> 300 tpd) | 46 |
| Medium (150–300 tpd) | 96 |
| Small (50–150 tpd) | 233 |
| Micro (<50 tpd) | 151 |
| Total | 526 |

The per capita consumption of paper in the country (15 kg) is much lower compared to the global average (57 kg). The industry provides employment to around 2.5 million people, both directly and indirectly.

## 4.2.2 Coal consumption

The pulp & paper industry is highly dependent on coal for its energy needs. The industry consumes about 15 Mt of coal annually and uses it primarily to generate steam and electricity, which are critical for various production processes. The pulp & paper sector in India emits about 34 Mt of $CO_2$ per annum. The GCV of coal (2775 kCal/kg) is used for estimating the $CO_2$ emissions. The SEC ranges for pulp and paper production through various process routes (Table 7).

**Table 7:** SEC ranges for pulp and paper production

| Process Route | SEC (MkCal/tonne of Paper) |
|---|---|
| Wood Based | 10.77 |
| Agro Based | 9.7 |
| Recycled Based (W/P) | 4.15 |
| Recycled Based (Packing) | 2.26 |

## 4.2.3 Present coal-based technology

The Indian pulp & paper industry, one of the country's oldest and fastest-growing sectors, contributes 5% to global production. In the fiscal year 2022, India's per capita paper consumption was about 15 kg, significantly lower than the global average of 57 kg. This indicates substantial potential for growth in paper demand as the country continues to develop.

The pulp & paper industry plays a crucial role in India's economy, serving various sectors such as education, packaging, publishing, and writing. This industry produces a wide array of products, including paper, paperboard, newsprint, and packaging materials. The rising demand for packaging paper and the rapid growth of online retail are driving the market's expansion.

Coal-based boilers are also used in pulp & paper industry which generate steam and power by burning pulverized coal in a furnace. The heat produced converts water into steam, which is then utilized for pulp cooking, paper drying, and other industrial processes. These boilers typically feature components such as furnaces, burners, super-heaters, economizers, and air preheaters to enhance efficiency and output. The generated steam can also drive turbines for electricity generation, making these boilers a crucial part of the energy and process infrastructure in the pulp & paper sector.

The industry is a notable emitter of greenhouse gases, primarily due to its reliance on fossil fuels for energy and the chemical processes involved in paper production. A brief pulp and paper production process is shown in Figure 15.

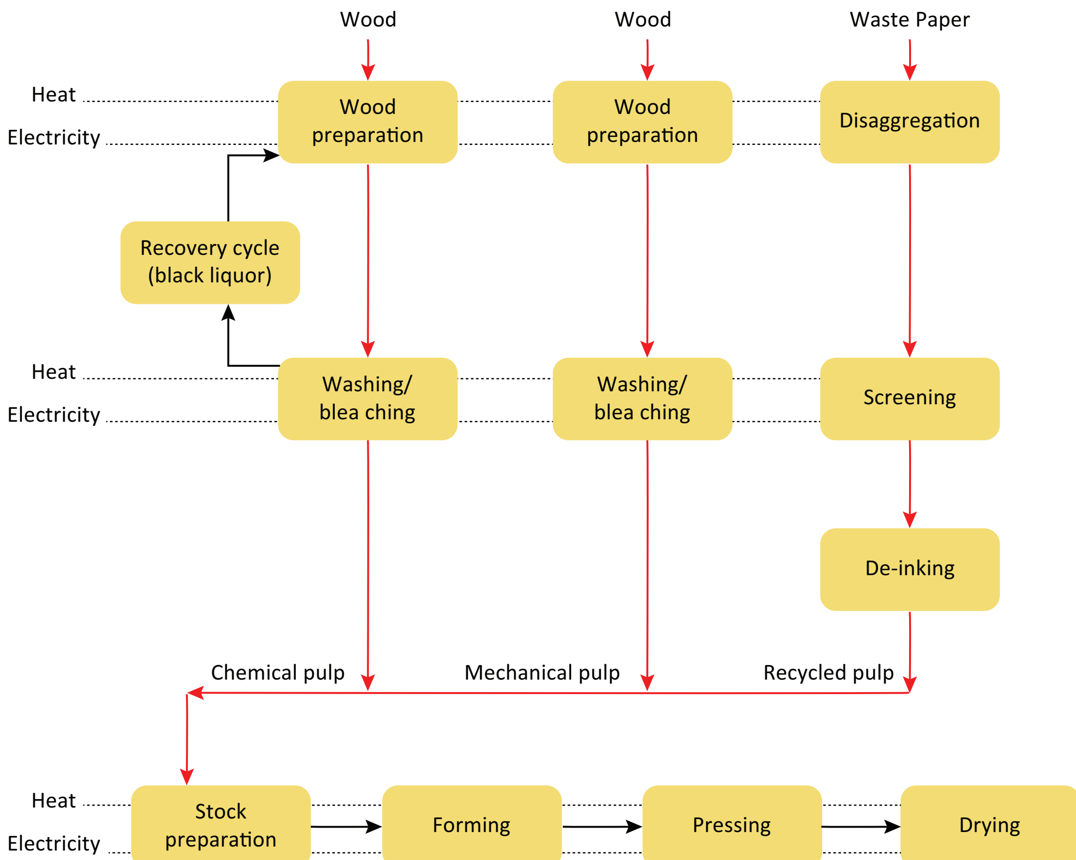



**Figure 15:** Main processes for pulp and paper production

## 4.2.4 Alternate technology

The following sections detail key areas for intervention to reduce carbon dioxide emissions in the pulp & paper industry. These areas are thoroughly explained to offer a clear understanding of the strategies and measures necessary for decarbonizing the sector.

- Improving energy efficiency
- Enhancing circularity and maximizing material efficiency
- Switching to renewable energy (including electrification)
- Fuel switch
- Solar thermal energy system
- Electric hot water boilers
- Biomass fired boilers

### (i) Improving energy efficiency

Improving energy efficiency is the most cost-effective way to reduce energy consumption and related $CO_2$ emissions. The digester, paper machine, and soda recovery are the most energy-intensive sections in paper manufacturing. Between 2003 and 2014, the Indian pulp and paper industry reduced its energy intensity by 42%. However, further efforts are needed to continue reducing energy intensity in these key sections of pulp and paper mills. This can be achieved by adopting best available technologies (BATs), such as upgrading the steam system, using high nip presses, installing turbo blowers for vacuum applications, utilizing white liquor indirect heaters, implementing low-energy drying systems, and improving hood and pocket ventilation systems.

### (ii) Enhancing circularity and maximizing material efficiency

Increasing the proportion of paper produced from recycled materials will help reduce the sector's energy intensity. This approach also offers several co-benefits, such as reducing primary wood consumption, lowering water usage, and generating less waste. However, it may not significantly reduce emissions since primary pulp production mostly relies on bioenergy from wood, while recycled paper production primarily depends on fossil fuels due to the lack of by-product bioenergy. Despite its benefits, using recycled fibre faces challenges such as collection difficulties, potentially higher future import prices, and a limited recycling lifespan of up to seven cycles.

In addition to recycling, improving material efficiency by reducing paper consumption will be crucial. While paper demand might decrease in some areas due to digitalization, e-governance initiatives, online education, alternative packaging, and changing behaviours, certain industries and applications will still require paper. These include packaging made from recycled paper, government and administrative documents, the legal and finance sectors, and marketing and advertising. The rate at which paper demand declines in India will depend on factors such as technological advancements, regulatory changes, and societal attitudes towards paper usage and environmental sustainability.

### (iii) Switching to renewable energy (including electrification)

Utilizing renewable energy sources like solar and wind will significantly reduce carbon dioxide emissions while providing cost savings and enhancing energy security. Paper mills can maximize their use of in-

house solar and wind power generation or procure renewable energy through open access. Installing solar panels on mill premises can help meet electricity needs, especially as processes become more electrified. Additionally, solar thermal systems can be used for low to medium temperature processes, such as pulp drying.

The drying process is one of the most energy-intensive stages in pulp and paper manufacturing. Currently, steam is used for drying, requiring about 947 kWhe of steam per tonne of paper, equivalent to 1263 kWhe of coal (assuming a boiler efficiency of 75%). Adopting electrification processes, such as in cooking machines, liquor evaporators, paper-making machines, electric infrared dryers, and lime kiln electrification, will be key long-term options for decarbonization.

### (iv) Fuel switch

Switching to low-carbon fuel options like biomass and waste for combustion can significantly reduce emission intensity. Currently, about 30–40% of the energy required for steam generation is sourced from biomass, such as rice husk, wheat straw, bagasse, and black liquor, while the remaining 60–70% is met with coal. Paper mills produce substantial organic waste, which can be converted into fuels for use in boilers, reducing reliance on fossil fuels. Anaerobic digestion of organic waste can generate biogas, an eco-friendly process fuel. The industry aims to increase biomass usage in boilers due to stricter pollution regulations and rising fossil fuel costs. Implementing energy efficiency measures will also enable greater biomass generation. These efforts will accelerate the replacement of coal with biomass.

However, the availability of biomass in large quantities and bulk transportation is a concern.

### (v) Solar thermal energy system

For hot water at low temperature (30–150°C) a concentrated solar thermal energy system such as flat plate collector or evacuated tubular collector may be used. Adoption of renewable energy-based solutions will save costs and reduce emissions. When such systems are combined with a heat exchanger, it can provide hot air, hot water or steam as required.

### (vi) Electric hot water boiler

Switching to electric hot water boiler is used for heating and hot water supply is an environmentally friendly option. These boilers can be suitable for dye industries since they only require hot water for the production process and do not need steam. Multi-tubular once-through hot water electric boilers are commercially available globally but are not available in Indian market.

### (vii) Biomass fired boiler

Switch-over from a coal-fired system to a biomass-fired system is considered as a carbon-neutral option, provided the biomass comes from a sustainable source. A high-pressure biomass-fired cogeneration system may be used to generate steam as well as power.



## 4.2.5 Barriers and remedial measures

## Barriers

### (a) High Initial Investment Costs

Transitioning from coal to cleaner energy sources requires significant capital investment. This includes the cost of installing new infrastructure, upgrading technology, and retrofitting existing facilities. The financial burden of these investments can be a major deterrent for many companies. The barrier can be overcome by providing suitable financial incentives to industry to accelerate the adoption of renewable energy.

### (b) Energy Supply Reliability

Coal provides a reliable and continuous energy supply, which is critical for the uninterrupted operation of pulp and paper mills. Renewable energy sources such as solar and wind is intermittent and may not always meet the energy demands without adequate storage solutions or backup systems. There is a need to support RD&D initiatives targeted at development and demonstration of these technologies.

### c) Economic Considerations

The economic feasibility of transitioning to cleaner energy sources is a significant barrier. Even though renewable energy technologies are becoming more cost-competitive, the fluctuating prices of alternative fuels and the economic life cycle of existing coal-based infrastructure can make the transition less appealing financially. Adoption of combined heat and power (CHP) and advanced boilers and furnaces will be required to overcome this barrier.

### d) Regulatory and Policy Constraints

In some regions, regulatory environments and policy frameworks are not conducive to rapid decarbonization. A lack of supportive policies, subsidies, or incentives for adopting cleaner energy technologies can hinder progress. Inconsistent or weak regulations on emissions and environmental standards also contribute to the challenge. This requires the support of Policy and Regulations from the central level.

## 4.2.6 Socio-economic dimensions

TERI has undertaken work in pulp and paper clusters across various locations, including Morbi, Meerut, Vapi, Tamil Nadu, Chennai, Kashipur, and Muzaffarnagar. Some socio-economic insights from micro and small-scale pulp and paper units are summarized below.

- The workers suffer from a deep sense of insecurity owing to the decaying state of local pulp and paper units and absence of any social security measures.
- Workers are frequently exposed to hazardous chemicals such as chlorine, sulphur dioxide, and other bleaching agents, which can lead to respiratory issues, skin irritations, and long-term health problems.
- Most workers are not availing state healthcare facilities, since it has almost collapsed. Even if the workers are eligible for state medical insurance scheme (ESI), they cannot expect to benefit from it, owing to lack of medicines and treatment facilities in ESI hospitals.

- The workers are usually reluctant to use safety equipment such as goggles, boots and gloves even if these are provided by the unit, since they feel that they affect their productivity and comfort.
- The physically demanding nature of many tasks, such as lifting heavy loads and repetitive motions, can lead to musculoskeletal disorders and chronic pain.
- Poor ergonomic practices contribute to back pain, joint problems, and other physical ailments among workers.
- Irregular shift patterns, including night shifts, disrupted sleep cycles can negatively impact overall health and well-being.
- Despite the demanding nature of the work, wages can be low, especially for unskilled or semi-skilled workers, making it difficult to meet living expenses. In certain regions, employment may be seasonal, causing fluctuations in income and job insecurity.
- Workers in certain sections of the mill, such as drying and pressing, are exposed to high temperatures, which can cause heat stress and dehydration. The work environment can be dusty and polluted, contributing to respiratory issues and other health problems.
- The workers usually perceive the relationship with employees as exploitative. The trade unions play a limited role and are involved mainly during wages/bonus negotiations. The unions are usually not concerned about other things such as training, working conditions, medical benefits and so on.
- There is a lack of proper sanitation, drinking water, drainage, ventilation and lighting in these units.

The situation can be corrected through sustained efforts aimed at providing skill training and creation of alternative employment on a large scale.

## 4.3 Textile dyeing

### 4.3.1 Background

The textile industry is a significant contributor to the country's economy, and accounts for 2.3% of GDP, and 12% of the country's total exports (Invest India, 2024). The industry is the second largest employer, next only to agriculture and employs an estimated 45 million people (PIB, 2021). The country is the third largest exporter of textiles & apparel in the world and a has a share of 4.6% of the global trade in textiles and apparel (Ministry of Textiles, 2023).

Dyeing of textiles, one of the most energy intensive processes in textile industry, is concentrated in the MSME sector. The steam for heating the water is mainly produced from coal fired boilers, although biomass is also used in some clusters. Some of the major dyeing clusters in India are Surat and Jetpur in Gujarat, Solapur in Maharashtra, Tirupur in Tamil Nadu, Pali in Rajasthan, and Panipat in Haryana (Figure 16).

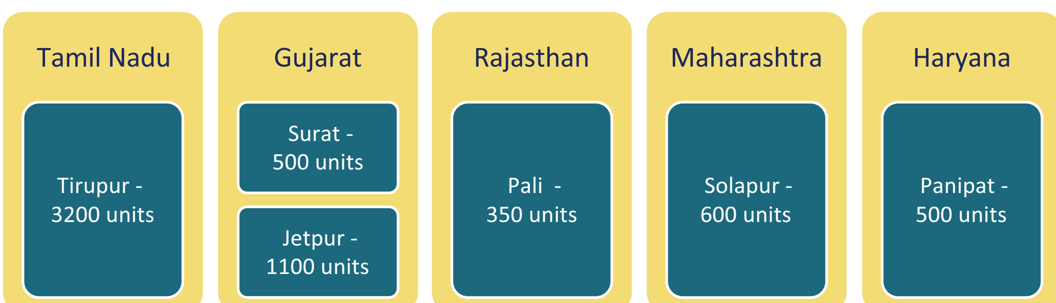



**Figure 16:** Major textile dyeing clusters in India

## 4.3.2 Coal consumption

Thermal energy accounts for 70–80% of the total energy consumption in dyeing units (Bhaskar, 2013). Steam is usually generated by burning of fossil fuels which is largely consumed in heating of water for dyeing and subsequent drying process (P.Aravin, 2008). The dyeing process, starting with water at 50˚C, achieves a maximum temperature of 98˚C and then the water is discharged usually without heat recovery.

Coal is used by textile dyeing units in boilers and thermic fluid heaters. Typical SEC ranges 2,000 to 6,000 kcal/kg (thermal) in dyeing units (Pavan, 2014). This is because of wide variation in the manufacturing process, type of cloth, and water consumption. Assuming an average SEC of 3,500 kcal/kg and 7,800 million kg of cloth (~50% of total production) is dyed per annum using coal-fired boilers, about 6 Mt of coal is consumed per year by the textile dyeing industry. Considering $CO_2$ emission factor of 1.82 $tCO_2$/t coal (for coal of NCV 4514 kcal/kg), $CO_2$ emissions by combustion of coal in textile industry is estimated to be 11 $MtCO_2$.

## 4.3.3 Present coal-based technology

Coal is used as fuel in boilers. The steam generated in boilers is used to meet the heat requirements in dyeing machines (jiggers). Boilers of capacity ranging between 10 and 25 TPH is used in majority of the dyeing units. In general, steam at low pressure (3.5–4.5 $kg/cm^2$) is required for the process heating.

Coal is also used in thermic fluid heaters. Thermic fluid heaters are used to generate hot air for drying machines (stenters). The hot thermic fluid passes through the heating coils of stenter machine and exchange heat to generate hot air. Capacities of thermic fluid heaters used in textile units range between 1.5 and 5 Mkcal/hour.

## 4.3.4 Alternative technologies

### (i) Biomass-fired boiler

Switch-over from a coal-fired system to a biomass-fired system is considered as a carbon-neutral option, provided the biomass comes from a sustainable source. A high-pressure biomass-fired cogeneration system may be used to generate steam as well as power.

### (ii) Solar thermal energy system

For hot water at low temperature (30–150$^{o}$C) a concentrated solar thermal energy system such as flat plate collector or evacuated tubular collector may be used. Adoption of renewable energy-based solutions will save cost and reduce emissions. When such systems are combined with a heat exchanger, it can provide hot air, hot water or steam as required.

### (iii) Electric hot water boiler

Switching to electric hot water boiler for heating and hot water supply is an environmentally friendly option. These boilers can be suitable for dye industries since they only require hot water for the production process and do not need steam. Multi-tubular once-through hot water electric boilers are commercially available globally but are not available in Indian market.

## 4.3.5 Barriers and remedial measures

There are several barriers with limitations for the switch-over to electric/RE hot water boilers in textile units in India, some of which are discussed below.

### (i) Technology development

There are few reliable manufacturers of solar thermal hot water systems in India. Moreover, high efficiency electric hot water boilers, especially of larger capacities, are not commercially available in the country.  There is a need to support RD&D initiatives targeted at development and demonstration of these technologies.

### (ii) High capital investment

In comparison to fossil fuel-based boilers, electric or solar thermal based hot water systems require higher investment. Further, the unit needs to incur additional expenses to augment their power supply. The barrier can be overcome by providing suitable financial incentives to industry to accelerate the adoption of electric or solar thermal systems.

## 4.3.6 Socio-economic dimensions

Employing an estimated 45 million people, the industry is the second largest employer, next only to agriculture. The sector is also in perfect alignment with larger government initiatives like Make in India, Skill India and Women Empowerment and Rural Youth Employment.

A significant barrier to increase in adoption of new efficient technologies like solar thermal water heating system is the lack of availability of skilled operators and technicians to operate and maintain them in textile units. Low skills in maintenance can lead to lower productivity. If electric boilers are imported from industrialized countries, it would be difficult to maintain them locally. Increased availability of trained operators and technicians at clusters will accelerate the adoption of new technologies and lead to their higher productivity.  Training centres could be established in collaboration with leading technology suppliers at the cluster. Financial incentives need to be provided by the government for training of the existing operators and technicians in textile units.

The representation of women is extremely low in textile industry in India when compared to China, Bangladesh and in south-east Asian countries like Vietnam, Cambodia and, Indonesia. Therefore, special schemes could be placed on training women in the training centres at cluster level.



5

# FIELD RESEARCH IN SELECTED IRON & STEEL CLUSTERS

Steel production serves as the backbone of developing economies like India, as it is necessary for industrialization and infrastructure growth. Steel is extensively used in engineering products, automobiles, and infrastructure such as buildings, bridges, ports, and railways. Iron and steel production is heavily dependent on fossil fuels due to the high heat requirements needed in these processes. The sector is the largest source of $CO_2$ emissions, responsible for around 7% of global emissions from the energy system (IEA, 2019).

The MSMEs account for 40% of the total steel production in India (Gulia, 2023). Most of these steel MSMEs are clustered in Odisha, West Bengal, Jharkhand, and Chhattisgarh, called the "steel belt" of India (Alexandra Mallett, 2022). These small producers who often cater to local or regional markets, are highly price-sensitive, and primarily rely on coal-based DRI and BF/BOF technologies. Due to their small size and lack of financial support, the decarbonization of MSMEs is the hardest link in the overall decarbonization transition of the steel sector in India (SAMEEEKSHA, 2022).

Numerous strategies and roadmaps have been proposed for decarbonation of the iron and steel sector including rapid and widespread adoption of carbon capture utilization and storage (CCUS) and green hydrogen DRI production. However, these strategies for large iron and steel producers may not be applicable for MSME steel clusters in India. To reduce carbon emissions among MSMEs, nothing short of socio-economic transformation may be required.

This chapter summarizes the results of field studies conducted by TERI in the three steel clusters. The transition in the steel sector is not limited to shifting of fuel and technology but also involves forming an economy that includes reskilling/upskilling of workers, and institutional strong policy interventions, to facilitate the use of low-carbon technologies (Janardhanan, 2020). Hence, the objective of this study was to investigate the socio-economic impacts stemming from the gradual phasing out of coal in coal-based iron and steel industries in these areas. The research focused on essential socio-economic dimensions of the workforce such as demographics, residential and commuting patterns, education, training and leisure activities, other employment opportunities, facilities and benefits, trade union and grievance redressal, salary/wages and working hours, awareness about government schemes, and future aspirations, which are presented in the chapter.

## 5.1 Study approach and methodology

Thus, transition in the sector will have a direct or indirect impact on people associated with the industry. Studies on Just Transition[1] in India tend to focus on the coal sector (upstream workers involved in mining and transportation of coal). However, the purpose of this study was to investigate the impact on downstream workers like steel MSME workers. The existing literature highlights examples of energy transitions in the past that often trigger job loss, mental and physical stress, migration, and resistance from the public (Saxena, 2023). So, Just Transition supports the most impacted workers and communities by offering them retraining, new job opportunities, and community support. The key principle is proactive thinking that takes into account the implications and plans accordingly to reduce the negative impacts.

To look at Just Transition approaches as concrete ways to make green industrial transformation without exacerbating socio-economic and environmental disparities a reality, information was collected from three

1 The idea around Just Transition is to ensure that the transition to a low carbon economy is equitable and fair, it will take into account the rights and needs of workers, who are most impacted by the transition.

steel clusters – Durgapur (West Bengal), Giridih (Jharkhand), and Raipur (Chhattisgarh). Team members from TERI worked with a local survey agency MART Global Management Solutions, Kolkata, with previous experience in the region. Methods included surveys, focus group discussions (FDGs), and interviews with key informants such as formal/informal industrial workers, supervisors/ technicians, executives/ engineers, industrialist/factory owners, local NGOs/community groups/SHGs, and representatives (DIC, MSME-DFO, etc.).

The research study was carried out with semi-structured questionnaires along with FGDs and in-depth interviews were conducted to capture the insights and information from the target respondents. Primary surveys were conducted among key cluster-level stakeholders in the selected clusters. Secondary information was gathered from the industry bodies and government institutions. Most of the industries visited during the survey are MSMEs. Industries survey includes sponge iron/DRI, steel re-rolling mills (producing TMT bars, MS bar, rod, angles, channels) and wire-drawing units (MS wire, MS nail, M S Nail barbed wire). These industries were concentrated in the clusters Durgapur (and surrounding areas such as Asansol, Raniganj, Jamuria) in West Bengal, Giridih in Jharkhand, and Raipur in Chhattisgarh.

## 5.2 Workers in steel clusters

In these industrial clusters, the majority of workers handling coal are unskilled and work as helpers in different sections such as furnaces, loading and unloading operations. The workers handling coal are employed across different industries like sponge iron/DRI, steel re-rolling mills and foundries. Photographs from a sponge iron industry and steel re-rolling mill are given in Figure 17.

**Figure 17:** Sponge iron unit in Durgapur

The permanent employees in the MSMEs comprise of both skilled and semi-skilled workers. Some of the workers have even undergone training from ITI and other vocational institutions. The permanent workers usually work as rolling mill operators, furnace operators, and other machine (like air compressor) operators.

In the industries in organized sector (mainly larger MSMEs), workers are engaged for longer periods while in smaller MSMEs the engagement of workers depends on the order that company received from the market. For example, the workers employed by smaller MSMEs in Raipur cluster were found to be engaged for a limited period (between 10 and 15 days per month). In Durgapur cluster, the average engagement of a contract worker was between 15 and 20 days/month. Due to market and profit maximization trends, the employment contract has been on the rise in India. According to the Annual Survey of Industries, out of the total 13.6 million workers employed by 249,987 factories in India in FY22, 5.4 million workers (40.2%) were contract workers (Business Standard, 2024).

The workforce in the MSME is engaged directly by the companies or hired through contractors. The survey showed that a significant percentage of the workforce in Giridih and Raipur (80–90%), are employed through contractors (as contract workers) and very few of them (10–20%) are appointed directly by the MSMEs. The workers who are on the payroll of the company are generally in the skilled category and include mechanical fitters, electricians, gas cutters/welders, and steel melting shop operators. The contractors have a significant leverage over individual workers for providing the work. While fulfilling the employment needs of the workers, the contractors dictate the terms of engagement with factory authority like employment duration, remuneration, and other conditions. The contractor also decides where to place the workers and negotiates the terms with the employer. In most of the MSME clusters, majority of the workers are hired through contractors who deal directly with the industry for their remuneration. In Giridih and Raipur, it was found that the contractor retains a portion of the wages as their profit margin. This is also done so that the workers cannot run away from the contractor. In the FGDs, it was revealed that contractors often do not provide the wages in time to the workers and delays of 10–15 days are common.  The asymmetry in bargaining power between contractors and workers helps the contractor to retain a higher commission and earn handsomely at the expense of workers. The duration of engagement is determined solely by the firm's requirements, and contractors have no say in that. All these observations indicate that individual workers are potentially disadvantaged in MSMEs and this needs to be addressed through policy interventions.

## 5.3 Demographics of the workforce

Within these industrial areas, individuals from diverse age groups are represented, with the majority falling between the ages of 30 and 50 years. During the FGDs, some workers shared their experiences (Figure 18). It was revealed that although the workers have not undergone any formal training, they have spent between 5 and 20 years working in metal-based industries and have learnt new skills on-the-job through hard work and commitment.

**Figure 18:** FGD with workers in Giridih

With some exceptions, most of the unskilled workers are from local areas (within the state). Some workers have migrated from other neighbouring states like Odisha and Bihar. A significant portion of skilled workers (including managers, engineers, and diploma holders) in larger MSMEs are from states in southern and western Indian states such as Tamil Nadu, Kerala, Andhra Pradesh, and Maharashtra.

Workers in the MSMEs mostly stay with their families within a radius of 8 km from the workplace in nearby villages. The family structure among the workforce also differs. Most of the workers from neighbouring states have relatively small family sizes and live in rented quarters. On the other hand, people who were originally from the state (son of the soil) live with their extended families.

It was observed that the workforce is overwhelmingly male-dominated and job opportunities for female workers in MSMEs are relatively less. Women workers are employed for jobs like pantry in administrative office and cleaning and metal recovery in the shop-floor. Most of the females are married and have to do household work as well. Some of the women are involved in agriculture, and cultivate crops in small landholdings, mainly for self-consumption. In some clusters like Raipur, it is observed that some women are the members of SHGs and engaged with the local Anganwadi[2] centres. Few females also get work in the industries administrative office for cleaning and pantry service.

## 5.4 Residential and commuting patterns

Workers in these industrial regions exhibit diverse residential and commuting patterns. Some permanent employees, especially from other states, stay within the factory premises in the bachelor's quarters provided by the MSME. Most of the others are staying in nearby places and commute through their own transport. The bicycle is the most common mode of transport for unskilled workers while skilled workers like electricians and fitters use motorbikes.

There is no public transport in the areas where the factories are located. Few contractors are providing transport to bring the workers from nearby villages. The worker who does not live in nearby villages, basically stays in a rented house near the workplace in a radius of 5 km, and commutes by and through public transport.

## 5.5 Education, training, and leisure activities

The workforce in industrial belts of Jharkhand and Chhattisgarh lacks formal education and often rely on thumb impressions for official documentation. Thumb impressions were commonly observed in Giridih and Raipur clusters. The literacy levels in Durgapur are relatively better and most workers can read and write and some of them have studied up to 8th standard. Workers across the clusters have not received any formal training within the companies or from training institutions like ITI and have learnt the skills through hands-on work. There is a notable absence of training opportunities such as ITI or any other private training institution to further enhance their skills at the cluster level. Although some states like West Bengal have a number of ITIs, but the workers in most cases do not have the minimum education like 10th or 12th standard to be eligible for the courses. Poor awareness about the admission process to vocational training institutions and high cost of travel and/or staying near the travel facilities are some of the barriers to access these facilities.

2 Anganwadi is a type of rural childcare centre in India. It was started by the Indian government in 1975 as part of the Integrated Child Development Services programme to combat child hunger and malnutrition.



There is no specific leisure activity pursued by the workers in their free time. The workers who have television spend some of their time watching shows/news while others indulge in gossip. On holidays, most of the workers spend time doing household work, visiting the market, take rest or visit their relatives.

## 5.6 Other employment opportunities

Iron and steel industries based on coal are predominant in the surveyed clusters. There are limited employment opportunities in some of the other industries like plastic factories and rice mills in the industrial belt. Relatively few new companies have come up; rather the existing industries have expanded their existing production capacity or diversified to other trades like flyash brick making, flour mills, and so on. Most MSMEs are looking for some form of financial support (like an increase in quota allocation for raw materials and fuels or financial subsidy in new investments) from the government.

## 5.7 Facilities and benefits

In the sphere of facilities and benefits within the industrial settings, notable differences were observed between contractual and permanent workers. Permanent workers enjoy several benefits such as provident fund (PF), ESI, gratuity, medical reimbursements and leave benefits while contractual workers are often excluded from these facilities. Hence, most of the permanent workers have been working with the company for several years unlike the contractual workers who are engaged in loading and unloading of coal in these plants. In addition, the contractual workers face financial insecurity in case of accidents (within or outside of the company), and only receive basic first aid and referrals to government facilities for further treatment. Such incidences were cited by some of the workers during the FGDs. It was also revealed during the interactions with the workers that there have been several instances of coercion from the plant management forcing the workers to accept the decision of the management. Across all clusters it was observed that firms only provide the basic treatment /first aid to contractual workers in case of accidents and the workers themselves have to bear the medical expenditure on their own for prolonged medical treatment. In addition, contractual workers do not have any medical insurance coverage from their employer and the cost of medical treatment over a prolonged period can be debilitating for the workers and their families.

It was found that workers working in hazardous areas like handling of hot metal, protect themselves by wearing triple layer of clothes, use boots/shoes and spectacles. In most instances these are purchased by the workers on their own. From the FGDs with workers, it was observed that different firms have different policies for providing the safety equipment to their staff. In most cases, the company does not have a well-elucidated safety policy. Even when firms have basic safety equipment like safety gloves, shoes, helmets, heat resistance shield and spectacles, they are provided only to furnace operators.

## 5.8 Trade union and grievance redressal

Workers in Giridih (Jharkhand) and Raipur (Chhattisgarh) reported that they have limited means to voice their concerns or problems to their employers due to lack of any trade union in the region. There is a trade union in Durgapur but they are active only during wage negotiations. Before 2011, the trade unions in West Bengal were strong, due to the communist government in the state. Post 2011, the influence of trade unions has come down even in the state. A picture of interaction with workers in Durgapur is shown in Figure 19.

**Figure 19:** FGD with workers in Durgapur

Lack of prior communication between MSMEs and workers regarding layoffs results in sudden layoffs of the workers and leaves them suddenly unemployed without compensation or alternative opportunities for re-deployment within the same company. There is no practice to issue or serve advance notice lay-off.

In some clusters, it was reported that camps are organized by state government to register workers for availing central/state government schemes.  There are few NGOs focusing on socio-economic development of workers in the targeted clusters.

## 5.9 Salary/wages and working hours

Workers surveyed in the industrial clusters are compensated with different salaries based on their employment status. On average, the salary of workers ranges between Rs. 9,000 and Rs.12,000 per month (for contractual workers) and between Rs. 17,000 and Rs. 20,000 per month (for permanent workers). The contractual workers are paid between Rs. 30 and 40 per hour and they work for 12 hours (Figure 20). Their wages (Rs. 360–480 per day) is paid weekly in cash by their contractors. Although there are very few female workers working in iron and steel related MSMEs, their wages, when employed, are much less (Rs 150– 180 per day) in comparison to male workers.

**Figure 20:** A steel-based MSME unit

As previously mentioned, there are no fixed norms for providing financial assistance or insurance coverage for contractual workers. In case of severe injuries or death within the firm premises, the firm may provide lump-sum financial assistance to the family of the deceased. The quantum of financial assistance provided is usually dependent on the pressure from other workers of the firm and the support from local leaders. Compensation to the families upto Rs. 10 lakh (1 million) has been reported in case of accidental death of a worker. From the discussions with the worker force, there is a need for greater equity and protection for workers in MSME units.



Workers in industries such as sponge iron, rolling mills, casting, and other metal industries have noticed significant changes in their work environment over the past decade (Figure 21). Some of the workers perceive a decrease in job opportunities in their industry due to automation processes. Although the salary of the workers has increased, the working hours are much less flexible now compared to the past. For example, the workers earlier could come to their homes during their one-hour lunch break, but they are not allowed to go out of the company's premises now during lunchtime.

**Figure 21:** A steel re-rolling mill

## 5.10 Awareness about government schemes

There is limited awareness about government schemes, allowances, and insurance options among the workers of MSMEs. No specific government support schemes for contractual workers in MSMEs were reported. Few workers are availing medical insurance under the central government Ayushman Bharat scheme.[3] Some of the workers have opened zero balance bank accounts under the government Jandhan Yojana. In some clusters (like Raipur) workers are not aware of the procedures for withdrawing their PF amounts. In some cases, this lack of knowledge leads to employees paying extra fees to brokers to facilitate the release of the amount. Also, there is a lack of awareness among workers regarding the deduction of ESI since salary slips are not provided in many cases.

## 5.11 Public healthcare facilities

It was found that MSME workers tend to avoid government hospitals due to perceived inadequacies in facilities and medications, preferring private healthcare options even at a higher cost. This highlights the need to provide adequate public healthcare facilities in major MSME clusters (Figure 22). For example, the central government has funded building of AIIMS in Deoghar (about 70 km from Giridih). AIIMS, Deoghar can invest in an integrated care centre in Giridih which could be staffed by local health care professionals trained at AIIMS.


**Figure 22:** A public healthcare centre at cluster level

## 5.12 Future aspirations

Workers in the industrial regions express varied aspirations and desires for self-improvement and betterment. While there is limited awareness of external training opportunities for skill enhancement, there is eagerness to learn about various schemes announced by the state and central governments for the benefit of poor families. Workers in Raipur expressed a strong desire to eliminate contractors

3 Ayushman Bharat Yojana is national public health insurance scheme of the Govt. of India that aims to provide free access to health insurance coverage for low income earners in the country.

to ensure fair and timely compensation for their work. An interaction with workers in Durgapur and Raipur in shown in Figure 23, Figure 24 and Figure 25 respectively.

In general, workers are interested in skill development which they know will increase job opportunities. Their aspirations reflect a strong desire for empowerment and better working conditions within the industrial landscape.

During FGDs, the following aspirations were shared by the MSME workers:

- *Skill development:* Skill development programmes after working hours would be welcome.
- *Safety measures*: MSME must prioritize workers' basic safety, providing necessary equipment, dresses, boot shoes and adequate compensation in case of accidents.
- *Healthcare access:* Improved healthcare facilities at local level which is affordable to workers should be provided.
- *Awareness programs*: There is a need for more awareness programmes for workers on government schemes, minimum wages, insurance and other worker support programmes. Also, the workers need to be made aware of the procedures for release of their PF which will avoid unnecessary expenses to hire brokers.
- *Trade union*: Trade unions were more active in West Bengal during the communist government. Even now, union influence is there but they have limited influence over the industries. Workers in clusters in other states felt that the formation of workers' unions will empower them to voice their concerns collectively.
- *Regulations for contractual workers:* There is a need to implement policies and regulations to govern the salary disbursement of contractual workers. This will help to reduce the harassment of the workers in the hands of contractors and ensure timely and fair payments.

**Figure 23:** Stakeholder consultation workshop in Durgapur

**Figure 24:** FGD with workers in Durgapur

**Figure 25:** FGD with workers in Raipur

Addressing the aspiration of the MSME workers will contribute towards their welfare and facilitate a smooth transition to low carbon pathway.

# 6

# JUST TRANSITION FRAMEWORK FOR MSME SECTORS

The Just Transition framework collects and synthesizes information on a possible framework for equitable energy transition to green technologies of selected coal consuming MSME sectors and elaborates the possible steps and options to implement such a framework. The criteria for equitable and sustainable energy transition like identification of alternative technologies, information on and adaptability to green technology, economic, institutional and social aspects, long-term capacity development and dissemination strategies have been discussed. Other elements of a framework to facilitate energy transition like coordination of donors response, mechanisms to monitor and report transition activities and promotion of exchange of information among stakeholders have also been addressed.

The main issue related to widespread adoption of green technologies by MSMEs is to provide a direction to the technological and energy transition in major coal consuming sectors. In the above context, this chapter discusses a participative approach towards the adoption and diffusion of green technologies among major coal consuming MSMEs. The outcome of various steps defined in the framework is the development of an IPP (Integrated Policy Package) at the national level. The approach towards the formulation of an IPP is based on establishing dialogue on climate change issues and technological needs among the major stakeholders like policymakers, MSMEs, academic and R&D institutions and NGOs. The programmes for the implementation of green technologies and information dissemination will necessarily have to be sector-specific, and a broad-brush approach can only defeat the very purpose for which such framework needs to be devised. However, national/state governments need to play a leading role in institutionalizing the climate change debate into the national/state agenda through necessary changes in the organization structures and policy framework. Thus, the major steps proposed in the framework are as follows:

1. Identification of sector priorities for mitigation that are most appropriate for the developmental objectives.
2. Detailed study/investigation of the present technological status and needs of the identified priority MSME sectors, the available technological options and various barriers to the adoption and diffusion of green technologies.
3. Assessment of different technological options to filter out a few technologies from the list of possible options.
4. Formulation of an IPP for adoption and diffusion of green technologies incorporating technological options and enabling policies to promote the same.

The first three steps can be referred to as 'scoping activities' towards the development of an IPP. Since the role of the private sector in the adoption of green technologies is likely to increase in the future, it is important to ensure participation of the sector and of key stakeholders in the entire planning process.

In order to maintain a focus on the issue of climate change at the state level, it is proposed that the state governments create a 'climate change unit' or any other equivalent body under the concerned Ministry. It is this Unit that will coordinate all the activities leading to the formulation of an IPP. For development and execution of the IPP, a state autonomous body (e.g., Energy Transition Centre for MSME (ETC–MSME)) should be established under the concerned Ministry. This will help in speedy implementation of programmes/projects and result in better coordination with various stakeholders. Besides enabling the transfer of green technologies, the IPP will focus on specific barriers related to cost and availability of cleaner fuels, higher capital investment in green technologies, availability of commercially mature technological alternatives, enabling government schemes/policies, skill gaps and other possible hindrances, leading to long-term development of markets for green technologies in coal consuming MSME sectors.

It is proposed that financial support for the green transition should come from multilateral funds (e.g., the Green Climate Fund), whereas the operation of ETC–MSMEs be funded jointly by central/state government, respectively.

## 6.1 Defining green technologies and energy transition

For the purposes of this project, green technologies are interpreted broadly to include the technologies and measures useful for mitigation of climate change.

“Technologies whose use is intended to mitigate or reverse the effects of human activity on the environment. (Oxford dictionary).”

Mitigation technologies include technologies that help slow down climate change by reducing the emissions of greenhouse gases (GHGs). Although there are six GHGs, the major emissions from fossil fuel consuming MSMEs is carbon dioxide ($CO_2$).

In the context of climate change, energy transition has a special relevance.

“*Energy transition is the pathway toward transformation of the global energy sector from fossil-based to zero-carbon by the second half of this century (IRENA).*”

With the environmental issues reaching the global forum and due to several international agreements, there is an increasing pressure on the countries of the world to reduce the emissions of GHGs. Green technological options offer a potential for the mitigation of GHGs through adoption of such technologies in existing facilities and their use in the upcoming projects.

With regard to green technologies, the policies of the central and state governments can create an enabling environment for successful transition. The multilateral organizations (e.g., under the charter of UN, World Bank, etc.) can play a crucial role in funding various projects through multilateral funds.

In the context of MSMEs, it is worthwhile pointing out that they are almost exclusively held privately. Hence, the role of private sector is crucial for the adoption of green technologies and that both the central and state governments need to play a supportive role to overcome barriers to attracting investment in these areas.

Some states argue that the technology rests with the private sector, so it is difficult for governments to do anything. However, the role for governments in encouraging energy transition cannot be denied. At the state level, several governments are framing policies for energy efficiency and climate action. However, there is a significant potential to scale-up implementation through enabling policies and financial support.

## 6.2 Current issues and experiences of Just Transition

### 1.1.1 Overview

The recent IPCC Synthesis Report underlines that the catastrophic impacts of climate change is already here and the world is well past the point where limiting global temperature rise to 1.5 $^{\circ}$C is virtually impossible. With growing calls for taking action to curb effects of climate change, countries across the world are shown to be standing at the same starting line, to decarbonize their economies, with the same goal. These ambitious, and necessary targets, however, need to reflect how every country at the starting line now, has a history of its own, and the progress to phase-out coal cannot be measured in a linear



sense. As countries in the North started off their industrialization process decades before the countries in the South, the one-size-fits all will not work.

## 1.1.2 Barriers

The barriers to JT are very sector specific. Major barriers can be categorized under the following groups:

### (i) Information gap

India has done quite well compared to other developing countries in proactive domestic actions such as commitment to renewables, a cess on coal, a national policy for electric vehicles and increase in forest cover. However, in each area of domestic action there is a need to study and evaluate the diversity of the available technological options that might suit domestic needs. There is an urgent need to develop an effective information support system and institutional infrastructure to facilitate selection of appropriate technologies for different sectors. There is also a need for better coordination of information on available and appropriate technologies that could benefit developing nations. Further, there is need to give a fillip to North-South cooperation in the development and diffusion of green technologies so that they are affordable. In parallel, the issues related to the lack of awareness/information and lack of skilled manpower needs to be address on war-footing.

### (ii) Financial barriers

Switchover to green technologies often entail high upfront investment costs. Several studies have shown that non-availability of financial means is a main barrier to adoption of green technologies by end-user industry. MSMEs, in general, do not have either the inherent financial capacities to undertake major technological upgradation within their process to bring about energy and environmental improvements. Financial support is especially needed when the initial investment requirements are high and payback period is unattractive. Governments, both at the central/state levels can play a proactive role by identifying target MSMEs (preferably a cluster/region), and then developing tailor-made programmes for them. Innovative business models could be developed to make access to finance easier for the switch-over to cleaner technologies.

### (iii) Lack of in-house capacity

Energy transition is a complex phenomenon. It is necessary for MSMEs to be equipped with the capacity to select and absorb the new technology. Lack of in-house capacity also results in the new technology seldom reaching the designed operational efficiency and often deteriorating significantly over the life of the equipment. This brings to focus the *need for local capacity building* to effectively manage the technological changes. This could be facilitated by programmes that facilitate training of present as well as future staff on operation and maintenance of the new technology.

For example, the operation of gas-based DRI plant or induction billet heater requires new skills. Skilled operators for the new technologies are not readily available to MSMEs nor is such training imparted in existing Industrial Training Institutes (ITIs) in the country.

### iv) Policy inadequacies

Government policies play a significant role in determining where investment is to be made. Some countries like Germany have made extraordinary progress in recent time to formulate the right policy instruments (tax

incentives, etc.) to ensure development and promotion of cleaner technology. Formulation of policies on cleaner technologies have remained limited to declaration of intent, due to lack of institutional arrangements for their implementation in several developing countries. An example of policy inadequacies is in the case of high electricity prices in some states of India. The promotion of cleaner electric technologies is very much dependent upon the tariff structure of state electricity distribution companies (DISCOMs). For example, the electricity charges in West Bengal are much higher, compared to Gujarat. Within West Bengal there is substantial variation in electricity tariffs between the major DISCOMs.

In the absence of a comprehensive net-metering policy for solar power in states like West Bengal, it becomes difficult for MSMEs to invest in captive solar power plants. Another important issue regarding policy measures is to put in place measures (e.g., tax incentives, special technology missions, etc.) for encouraging the adoption of cleaner technologies for MSMEs.

An elaborate discussion about addressing these barriers is given in the framework.

## 6.3 Key elements of a framework

The proposed framework takes into consideration the key issues in development, adoption and diffusion of cleaner technologies for coal-based MSME processes in India. Various issues discussed in the framework relate to the identification of sector needs, present technological status and technology needs, assessment of various technological options, and development of an integrated technology programme. The framework discusses various key elements pertaining to industry participation, issues of technology adoption, information dissemination and role of the government and donor organizations in diffusion of cleaner technologies.

## 6.4 Proposed framework

### 6.4.1 Overview

The potential of clean technology transfer to combine economic growth with the protection of the environment in developing countries was recognized in Agenda 21, arising out of the Rio Summit in 1992.

Any framework for the adoption and dissemination of cleaner technologies in MSMEs must address issues of sustainability. For the new technology to be sustainable, the technologies should preferably complement the developmental needs of the region. Hence, identification of the sector priorities for the development and adoption of cleaner technologies is essential for developing an integrated technology programme. Once the priority sector (s) are decided, an understanding of the present technological status and technology needs of these sectors is required to ensure the right match between available technologies and sector-specific situations. A holistic assessment of various technological options in the sector along with identification of market potential would ensure selection of appropriate technologies in line with the existing capabilities.

Development of sector-specific integrated technology programmes is required for promotion and diffusion of cleaner technologies. The integrated programme should address major elements that will facilitate the adoption of technology like policy initiatives, capacity building, information dissemination, reskilling, etc. A system to assess the effectiveness of the above programmes on an ongoing basis and to provide feedback needs to be developed so that the necessary modifications could be made to improve the adoption of cleaner technologies.



Central to the whole approach is the promotion of national and regional cooperation among the sector and emphasizing the role of multilateral/bilateral donor agencies to promote the adoption of cleaner technologies, including upskilling of the workforce.

### 6.4.2 Identification of sector priorities for mitigation

As per initial assessment, six MSME sectors are crucial for mitigation of emissions of greenhouse from coal, viz., direct reduction of iron (DRI) /sponge iron, brick, pulp and paper, textile dyeing, steel re-rolling mills (SRRM), and foundry. The comparative importance of these sectors regarding mitigation of emissions of greenhouse gases depends on a number of factors, such as coal consumption, availability and viability of alternative green technologies, existing power infrastructure and cost of power as well as socio-economic factors, which have been elaborated in the previous chapters.

Green technologies can be a dominant force in combating the detrimental effects of GHG emissions. However, it is worth mentioning here that technology is always woven in the social and economic fabric of a country. Therefore, any technological innovation should take into account socio-economic parameters for widespread adoption. For example, in many sectors such as bricks and textile dyeing traditional sources (biomass based) play a very important role in the energy systems. Thus, it is imperative that each sector must define its own priorities for GHG mitigation. The priority list must strive to strike a balance between the international concerns regarding climate change and socio-economic development agenda of the country.

The prioritization exercise must distinctly highlight the important issues in different sectors (Table 8).

**Table 8:** Identified sector priorities in the context of energy transition

| Sectors | Priority areas |
|---|---|
| Sponge iron/DRI | • Hydrogen-based technologies |
| Brick | • Autoclaved aerated concrete block<br>• Flyash brick<br>• Concrete block |
| Textile dyeing | • Electric boilers<br>• Solar thermal energy systems |
| SRMM | • Electric heaters |
| Foundry | • Electric melting furnaces |

Having identified the priorities, all the sectors must report their priorities to the state/central governments. Identification of sector priorities and its availability with a nodal government agency (like the Ministry of Power/Ministry of MSMEs) would help in better response to future energy demand. Once the sector priorities are already set and agreed upon by various stakeholders, additional resources required for energy transition can be planned in a proactive manner.

## 6.5 Assessment of various technological options

After the initial identification of technological needs in different priority sectors, an assessment of all the technological options for their technical and economic feasibility must be carried out. The objective is to filter out a few technologies from a long list of priorities identified in the previous step. The technology assessment should be carried out taking into consideration various factors like present

level of technological capacity in the sector, skill requirements for the new technology, initial cost of the technology, etc.

A socio-economic analysis will help in identifying potential benefits of technology to the society and the economy. It is possible that some of the technologies might be economically unattractive but might have attractive social benefits. For example, the social benefits of a solar thermal energy system for textile dyeing sector, through improvement of the local environment and energy security may overshadow the economic benefits given to the sector. In such cases, a careful examination must be carried out to determine the economic sustainability of the technology in the longer term. For example, the adoption of a new technology might be uneconomical in the short-term but it might be economically viable in the long run when the volumes increase and the markets evolve. The technologies identified for their socio-economic relevance must be tested for their market potential to determine their sustainability over a period of time.

The technologies must be segregated as per their anticipated market potential into the categories of high market potential, moderate market potential, and low market potential. In order to enable decision making at this stage, it might be required to carry out a preliminary market survey or sector studies for the shortlisted technology options. Technological options having high market potential are most promising for adoption and diffusion. Such options are economically viable as it is and can be adopted in different prioritized sectors for widespread adoption. The green technologies having moderate market potential are those needing some external reinforcement (may be financial or institutional support) for enabling adoption and diffusion. With respect to the green technologies having high and moderate market potential it is important to identify the barriers to technology transfer and adoption. The above market surveys and sector studies can be used to identify and collect information about the barriers (financial, training, information, lack of skills, etc.) and views of the user groups. For example, the main barriers for the adoption of electric heating technology can be the unavailability of technology from local sources and requirement of substantial changes in plant layout. The improved efficiency of the new technology may make it a financially viable project but still it cannot be adopted in the sector(s) due to the above barriers. At this stage, the sectors should give adequate focus on the options with high and moderate market potential.

## 6.6 Development of an integrated policy package (IPP) for adoption and diffusion

Without deliberate and appropriate planning, the gradual phase-out of coal is expected to lead to substantial economic and socio-economic losses. Hence, JT requires careful planning and implementation. To enable the speedy implementation of IPP and better coordination with various stakeholders, a nodal Ministry at the central and state level should be made responsible. The responsibilities of the nodal Ministry should include:

- Identifying various sources of green technologies,
- Recommending policy framework to the government to create an enabling environment for adoption and diffusion of the green technologies,
- Formulating a blueprint for capacity building in different sectors,
- Creating an information dissemination framework,
- Developing projects for funding and coordinating with other ministries/donor organizations, and

- Assessing various programmes/projects and financial arrangements.

One of the main outcomes of the IPP, besides facilitating technology adoption, would be long-term market development for green technology. In addition, the IPP should meet the principles of a JT, which include social inclusion, decent work for all, and poverty reduction.

The policy package for JT integrated the three mechanisms:

- Information: promotes capacity building and information sharing
- Regulation: creates a strong push for green technologies
- Financial incentives: creates a market for green technologies

The proposed policy package consists of a group of policies as shown in Figure 26:

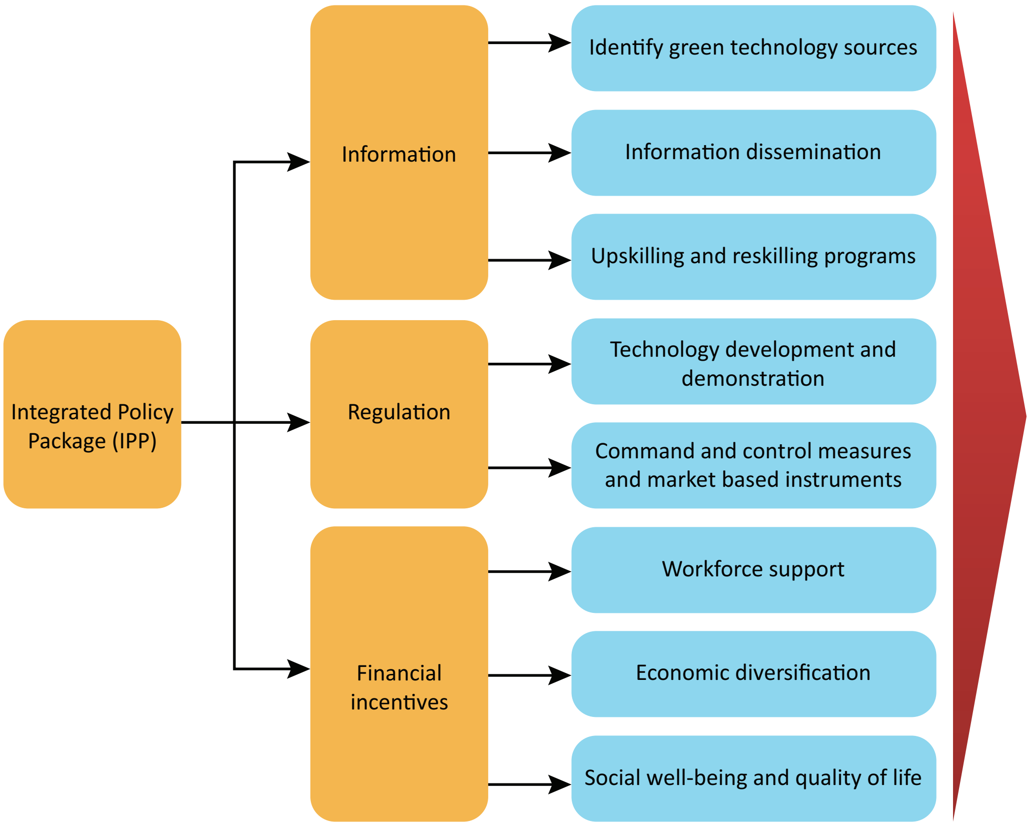



**Figure 26:** Various elements of the IPP

## 6.6.1 Information

### (i) Identify green technology sources

As a first step to effectuate adoption and diffusion of green technologies, it is imperative to identify various sources/vendors of the technology. An informative technology compendium for each technology (e.g., electric arc furnace, electric induction furnace) will be a guidance to the buyer and avoid chances of technology dumping. The compendium should include a comprehensive list of technology suppliers and some equipment specifications for improved energy efficiency.

The information database should be made available to the users through industry association networks. This is discussed in more detail in the next section.

### (ii) Information dissemination

One of the essential elements of successful technology adoption is the provision of support services to MSMEs to facilitate evaluation of technological options in the context of their own requirements (TERI, 1997). One of the major objectives of nodal Ministry is to prepare innovative projects for disseminating information about green technologies to various national stakeholders and user groups.

The nodal Ministry should be responsible for dissemination of information. It can provide centralized information regarding the government policies in the context of green technologies, information about various technological options, and possible financing options. The major objective of the Ministry will be to prioritize the dissemination of information to those sectors of the economy which do not have access to such information.

For disseminating information about green technologies in the unorganized sectors, various innovative tools can be used. In MSMEs, the information dissemination strategy can be to contact the producers through industry associations, sector specific exhibitions, etc. Extensive use of media (television, radio, newspapers, etc.) can be used to disseminate information in these unorganized sectors. Social media could also be a vehicle to reach out to industry networks to raise their level of awareness about environmental concerns and adoption of green technologies. The Ministry could even host its own web page, where information about the technology, their supplier, etc., is available.

### (iii) Upskilling and reskilling programmes

A significant number of direct and indirect workers related to the coal consuming MSMEs are likely to be affected by the transition. In addition, a large number of induced jobs that arise from economic activity in the area, but which are not directly related to the MSMEs will also be affected. A package to protect the direct and indirect workers affected by the decline in coal consuming industry needs to be put in place. The package could include services and assistance for the affected workers consisting of help to the workers to relocate to different industries and regions, training and retraining programmes in clean energy jobs in the solar PV industry and general career services. Since it is unlikely that all job losses in the coal sector will be compensated by jobs created in the clean energy sector; a wider strategy for creation of new economic activities is needed, including other sectors such as services (trade, hotels, travel) and infrastructure projects. Women workforce could be educated and empowered by establishing dedicated technical and vocational education and training colleges and by providing childcare facilities close to training centres. An initiative to mentor and coach young women for jobs in the renewable sector should be started.

Building local human capacity is essential to developing successful technological capacity in the country and is essential at every stage of the technology transfer process. It is only through investment in human capacity that the tacit knowledge associated with the technologies and innovations can be transferred to the host firms/institutions in these countries. National universities, technical institutes, industrial training institutes, etc., can play a vital role in training the workforce for new green technologies. The capabilities of these institutions must be upgraded. The universities can introduce new curriculum to impart the required skills to students and researchers. Similarly, upgrading training institutes will help in providing trained and skilled manpower for the implementation, and operation and maintenance of green technologies both in the formal and informal sectors. Governments and multilateral and bilateral agencies should ensure that training and capacity building programmes sponsored by them take into consideration the local needs and conditions of region.

For example, skilling and reskilling of the steel sector will see significant growth in new roles which include- specialized DRI kiln operators trained in using hydrogen or natural gas, non-coal-based fuel injectors in blast furnaces, operators of synthetic gas producer, robotics operators, etc. (Law, 2023). There is a good possibility that these workers can be reabsorbed within the sector after reskilling/upskilling. However, the potential challenges involved with reskilling of workers is their behaviour as most of the workers are middle-aged, they might be less adaptive to learning new skills and financial costs associated with reskilling and upskilling. Another significant challenge in reskilling is preexisting vulnerabilities in these low-income, coal dependent districts. There is a significant disparity in the quality of education in India. Rural areas in India, often lack adequate education infrastructure and resources. Additionally, focusing on theoretical knowledge in the country, often overlooks the importance of vocational training. Therefore, to address these challenges strong national and subnational policy interventions will be needed that promote skill development and foster industry-academia collaborations (Education-for-All-in-India, 2023).

## 6.6.2 Regulation

Government policies on investment, taxation and environment play a significant role in determining the areas/sectors where new investment is made. Some countries such as Germany have implemented successful public policies to assist rehabilitation of workers and communities affected by closure of coal mines. The objective of the policy initiatives should be to create an enabling environment for adoption and dissemination of green technologies, while simultaneously promoting economic activity through public interventions. Both the issues must be addressed simultaneously in the policy making process to effect in a coherent outcome. For example, it will be pointless to promote solar thermal energy systems through macro policy measures (relaxation of import duties, encouraging adaptive R&D, etc.) when the market barriers (high first initial costs, O&M are big barriers) prohibit their wide dissemination.

Transition measures should be based on an in-depth assessment of current policies and their extension to the MSME sector. With regard to implementation strategies, there are no universal norms, instead, an integrated policy considering the characteristics of technologies and target groups addressed is needed. Though policymaking is the job of several ministries, the nodal Ministry can assume the role of an advisor to other ministries.

### (i) Technology development and demonstration

Initiation of sector-specific technology development and demonstration programmes for sectors where there is no appropriate green technology are needed. Once the new technology is successfully developed and demonstrated in a MSME within the cluster they can be replicated in the other units. The centre/ state governments could invite international donor organizations to support these programmes and help in facilitating partnerships with international technical experts. This approach is more appropriate for MSMEs that have been producing products using conventional technologies. For example, in the DRI sector we can switch from using coal to hydrogen. The development of such technology with international assistance must take into consideration the twin objectives of reducing greenhouse gas emissions and keeping the cost of technology economically attractive for widespread adoption. Role

of local consultants (NGOs, R&D institutes, etc.) and engineering contractors is of prime importance here, since the development of technological capacity takes place in a network of users, technology consultants, and engineering firms.

### (ii) Command and control measures and market-based instruments

The central/state governments can use several command-and-control measures to promote the use of commercially available green technologies in different sectors of the economy. However, the use of command-and-control measures, if implemented without proper planning and support measures, is not advisable as it might lead to widespread public backlash and unprecedented economic disruptions.

Over the years increasing emphasis is being given to market-based instruments, mainly carbon taxes, carbon certificates, etc., either to supplement or a substitute for conventional command and control instruments. Market-based mechanisms can be cost effective, minimizing the aggregate cost of achieving an environmental target, and can provide dynamic incentives for the adoption and diffusion of better technologies.

### (iii) Other policy measures

Ease of bureaucratic approval procedures for environmental clearance and ease of availability of land for firms investing in green technologies will certainly encourage investments in this area. Another way of encouraging private sector investments in green technologies is by providing support to banks and other financial institutions to advice firms on technology choices and to design innovative credit instruments for economically feasible green technologies that often need high capital investments.

*Public procurement policy:* Another area where the policy initiatives can aid the diffusion and implementation of the green technologies is through public procurement. Policy initiatives that encourage the procurement of green products by the public sector and other government owned organizations (municipal corporations) will lead to development of the domestic market (demand) for the product.

## 6.6.3 Financing incentives

The role of financing incentives is crucial for addressing the issues of technology adoption and capacity building in the context of JT. The MSME sector will need large amounts of financial support for not only the technology needs of the energy transition but also to address the socio-economic implications of the jobs lost to realize JT. This is important to ensure fairness for workers and communities subject to negative impacts of the transition away from fossil fuels.

There are many existing mechanisms to address climate change (GEF, GCF, emissions trading, developmental assistances, multilateral/bilateral grants, etc.). There is a need to fine-tune the existing mechanisms to address JT issues. This is even more as jobs related to MSME sector are severely hampered by local factors like low per-capita incomes, low literacy rates, persistent poverty, sluggish economic growth, and concerns over job security.

The financing plan can be categorized into the following heads:

### (i) Workforce support

There is need to support training and reemployment of existing workers affected by the decline in coal consumption, including indirect employment in related industries.



### (ii) Economic diversification and livelihood generation

To promote economic diversification and reorientation away from coal, there is a need to support local infrastructure like creation of training institutions, industrial parks to attract new businesses, and the promotion of local tourism. Workers can potentially explore employment opportunities in other sectors including renewable energy, other manufacturing/agro-based/rural industries, animal husbandry, fisheries, agriculture, tourism and sustainable forestry, and so on. Both central and state governments should support the diversification of the regional economy by investing in renewable energy, tourism, agriculture, animal husbandry, and other products from forests. A diverse economy can help to provide alternative livelihoods to vulnerable workers. The government should quantify the investments needed for alternate livelihoods and just transition. This estimation will act as an important narrative for financing just transitions as these numbers can provide a sense of the budget required for assisting alternate economies.

### (iii) Social well-being and quality of life

Financing needs to support quality of life—like roads, housing and electricity and water supply needs to be addressed for the workers affected by the transition. For an equitable and just transition, it is necessary that all three levels of the government—the central, state, and municipal have similar policies and programmes. Additionally, for effective implementation of the existing policies, coordination between all three levels of the government is crucial. In addition, support from other stakeholders like leading MSME units, industry associations, and district-level government officials is required for an equitable transition at the cluster level.

## 6.7 Assessing the effectiveness of the programmes/projects on an ongoing basis and providing feedback for modifications

To measure the effectiveness of various programmes/projects on an ongoing basis there is a need for periodic assessment. This would help to identify the most effective options and policies in different situations so that modifications could be made in the proposed IPP. Assessment of the programmes can be done through cluster/sector-level surveys and studies. The surveys will also help in a better understanding of the ongoing programmes and to make course corrections, if needed.

## 6.8 Conclusions

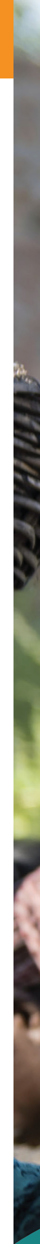
Effective diffusion and implementation of green technologies is essential for stabilization of global climate change. The key challenge for JT is to reduce the risk of economic problems for MSMEs as well as mitigate the impacts on workers and local governments. Active participation of local stakeholders in the design and implementation of the JT policies is important to develop effective interventions.

Since transition from coal is not a priority for developing countries at present, it is important that strategies for implementation and diffusion of green technologies reinforce their developmental priorities.

This project has attempted to provide a framework for JT for major coal consuming MSME sectors, keeping in view the sector-specific barriers. This framework will necessarily have to be very sector-specific, as a broad-brush approach can only defeat the very purpose for which such programmes need to be devised. The central/state governments need to play a leading role in institutionalizing the JT debate into the national/state agenda through necessary changes in the organization structures and policy framework.

Since most of the MSME sectors have limited experience in JT, there is a greater need for more consultation with all the stakeholders (governments, industry, education & training institutes, NGOs) to enhance the understanding of the barriers and possible remedial measures. Strengthening social dialogue is necessary to achieve a fairer and better-informed transition. A consultative committee for MSMEs could be an important step in that direction.





# ANNEXURE

# Annexure 1: Policy brief - Just Energy Transition in Steel Manufacturing: Insights from Three Secondary Steel Clusters in India

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Coal feeding operation (Source: TERI)

## Abstract

India is currently the second-largest producer of crude steel. The iron and steel sector significantly contributes to GDP and generates substantial employment. The sector is highly heterogeneous: apart from few large-scale primary steel plants, there are a large number of secondary steel producers who fall under the small and medium-scale industries. Coal has been playing an important role in the overall growth of steel industry in India and has brought all-around development in steel producing regions/ clusters, particularly in the states of West Bengal, Odisha, Jharkhand, and Chhattisgarh in eastern India. Any transition from coal to alternative cleaner options would destabilize the existing ecosystem and have

huge socio-economic implications for these regions. Millions of workers who are employed not just in coal mining and distribution sector, but also in industries that use large quantities of coal such as steel will lose their livelihood during the transition.

To explore how coal-dependent industrial clusters can embark on a sustainable and equitable energy transition pathway, TERI examined the social implications of the transition in three secondary steel clusters in India's steel belt (Durgapur, Giridih, Raipur). This paper draws on the empirical insights from the cluster studies and deliberates on the following points. To begin with, energy transition must consider industry-specific context. Secondly, policies and regulations to achieve green energy transition must leave none behind. Thirdly, investments in green energy infrastructure must be concurrently complemented by social support. Finally, a robust policy framework is needed to assist rehabilitation of workers and communities.

## Introduction

The iron and steel sector plays an important role in the Indian economy and has been a core pillar of its economic and industrial development. India accounts for about 6% of the global installed capacity and is the world's second largest producer of crude steel, after China. The sector has been vibrant and growing rapidly. Contributing around 2% to the nation's gross domestic product (GDP), it is also a major contributor towards employment generation with about 2.5 million people employed directly and indirectly (MoS, 2017).

The Indian steel industry exhibits diversity with wide variety of technologies employed and the range of firm sizes. Majority of secondary steel producers use coal to manufacture sponge iron/direct reduced iron (DRI), which is further processed to make steel. Crude steel products like billets and ingots are subsequently processed into finished steel products by re-rolling them into angles, strips, and bars. Small and medium scale re-rolling mills use coal in their reheating furnaces for this process. These plants are geographically clustered around coal mining belts in Eastern and Central India around Durgapur, Giridih, Raipur, Jharsuguda, and so on.

This paper draws on the empirical insights from recent studies conducted by TERI among three steel clusters—Durgapur (West Bengal), Giridih (Jharkhand), and Raipur (Chhattisgarh). The narrative includes the perspective of workers as well as people indirectly affected, such as their families. The following section highlights some of the major coal-based micro, small and medium enterprises (MSMEs) in India and discuss the context for an equitable energy transition for them. Insights from field surveys/interviews conducted in the three steel clusters and policy recommendations are presented in subsequent sections.

Workers in coal yard (Source: TERI)

### Industrial clusters

The industry sector is the largest consumer of commercial energy. The sector accounts for nearly half of the total primary commercial energy consumption in the country (MoSPI, 2024). The small-scale industry sector is the backbone of

industrial activity, accounting for over 90% of industrial enterprises, 45% of the industrial output, 40% of total exports and employing the largest number of people after agriculture (MoMSME, 2017-18). Many energy-intensive industries in the MSME sector like sponge iron, red clay bricks, steel re-rolling mills, foundry, textile dyeing, food processing, pulp and paper and so on use coal in their manufacturing processes and emit high volume of greenhouse gases (GHGs). Incidentally, some of these sectors are also large employment providers in India. This necessitates adopting a Just Transition approach to coal phase-out that addresses mitigating climate change while ensuring workers, communities and businesses are protected, and economic gains are made.

In India, to decarbonize the industry sector, numerous strategies and roadmaps are being proposed to promote the rapid and widespread adoption of green hydrogen, renewable energy power sources, and carbon capture technologies. However, these strategies being proposed for large-scale plants may not be techno-economically viable for small-scale industries. Amid these developments, there are growing calls for 'Just Transitions', arguing that typical ways of responding to change (e.g., closing a factory), will exacerbate the socio-economic inequities in the society. In the Indian context, significant research emphasizes the need for a structural transformation of the coal sector to achieve a just transition. This transformation includes governance reforms to develop a comprehensive framework at national, state, and local levels, focusing on consensus-building, socio-economic transformation, and green development (TERI, 2023) and highlight the social effects of moving away from coal (Pai, 2021). Furthermore, research has focused on potential implications of these changes on certain sub-populations such as women (Singh, 2023).

## Insights from three steel clusters

The area surrounding the Chota Nagpur Plateau, located in eastern part of India, covering the states of Jharkhand, West Bengal and Chhattisgarh has a dense concentration of steel clusters. These clusters heavily rely on coal as a primary energy source for steel manufacturing. To curb carbon emissions from production processes effectively, nothing short of industrial transformation is required (Nilsson, 2021).

The shift from coal to low carbon fuels like green hydrogen will lead to closure of a large number of small and medium steel industries resulting in job losses and overall economic downturns in the region. Local communities built around coal-based industries will face the risk of displacement, while workers may struggle with skills mismatches as they transition to new sectors. The disproportionate burden of energy transition on marginalized sections of the population would need addressing. Preserving job losses by re-skilling affected workers and communities amid this transition will be crucial.

A primary survey was conducted to examine the socio-economic impacts of coal phase-out on coal-dependent steel industries in three clusters in the Chota Nagpur region. Durgapur emerged as a major steel hub after the establishment of Durgapur Steel Plant, a large integrated steel plant, in 1960 while the industry grew in Giridih and Raipur in the 1990s due to easy availability of coal, power, and land. The study focused on various dimensions such as employment, workforce socio-economic demographics and alternative employment opportunities. The findings revealed distinct differences between the steel industries across the clusters. Among these clusters, Durgapur exhibited relatively better conditions for the workers in terms of job security, employment opportunities, awareness levels, literacy rates, daily wage rates, working hours, and social benefits. In contrast, Raipur and Giridih presented slightly less favourable conditions for workers, although specific nuances varied within each region. All the clusters have a prevalence of local workers, complemented by migrants from neighbouring districts or states.

The study revealed that the workers in all three clusters receive poor wages and face a high degree of socio-economic stress in their daily life. It identified several challenges faced by steel workers such as the absence of worker unions, long working hours, irregular salary disbursement, lack of safety measures, inadequate financial compensation for workplace accidents and non-existence of training/skilling opportunities. Basic safety equipment like helmets, goggles, gloves and protective clothing are often not provided or utilized, even in hazardous conditions, leading to frequent serious injuries. Most of the workers are hired through labour contractors, resulting in temporary employment, particularly in small and medium-sized plants. Temporary workers in these steel plants are most vulnerable to exploitation by their contractors. Except for Durgapur, the temporary workers in other clusters do not have social benefits like provident fund (PF), employees' state insurance (ESI). The situation is different in West Bengal since labour unions are active in the state due to its history of left front government for 34 years (1977 to 2011). The absence of labour unions has led to exploitation of workers by the contractors, which is more prevalent in Giridih and Raipur clusters. Often, wages are not paid on time, and a portion is retained by the contractor, making it difficult for workers to leave their employment.

The study underscored the need for formulating and implementing comprehensive interventions and policies to maintain overall well-being and livelihoods of workers across industrial clusters and to ensure equitable and sustainable energy transition.

# 1. Policy Recommendations

Without appropriate policies and regulations, the phase-out of coal risks significant economic and job losses in MSME clusters dependent on coal. Hence, Just Transition demands meticulous planning and execution. The following recommendations, which are by no means exhaustive, can be considered.

## 1. Energy transition must consider industry-specific context

The steel industry is a key employer in the industrial clusters of the Chota Nagpur Plateau region. It is crucial to design transition strategies and actions that are appropriate for the steel industries in the region. Policy objectives should aim to foster an enabling environment for adoption and dissemination of green technologies, while stimulating economic activity through public interventions. Both the issues must be addressed simultaneously in the policy making process to achieve coherent outcomes. For instance, promoting green hydrogen among small and medium sponge iron industries through macro policy measures like production-linked incentives and tax incentives would be ineffective when other significant barriers—such as technological limitations in steel making, high capital cost and operating cost prohibit their wide adoption in such clusters. Therefore, the government must devise a green transition strategy that balances overarching policy measures with the needs of the specific industry clusters.

Coal unloading in progress (Source: TERI)

## 2. Policies and regulations to achieve green energy transition must leave none behind

The steel industries employ a large number of workers—many of them are temporary or contractual in nature and have no social security or legal protection. A just and equitable transition demands a people-centric approach, prioritizing vulnerable groups like these workers and their families. Since there are less economic alternatives available in the region, sustainable transition necessitates robust support for alternative livelihoods, skill development, and adequate public financing. Currently, urban-centric training facilities pose accessibility challenges for rural workers. A significant percentage of temporary workers working in the steel plants are involved with coal handling. The shift to new technologies threatens the livelihoods of these temporary workers. In addition, a large number of indirect jobs, especially of people involved in transportation of coal by rail/road and those employed by commercial establishments in surrounding areas are likely to be impacted. There is a need to create alternative economic opportunities for these sections of the population. These could involve skilling them in other trades such as welding, fitting, electrical work, masonry, and similar fields, or providing training for alternative employment opportunities in sectors like agriculture or rural-based industries such as agro-processing and brick manufacturing. Development of skill training infrastructure at the cluster-level will play a crucial role. The training infrastructure should be set up in partnership with local industry and business associations to align with both immediate and future workforce needs.

## 3. Investments in green energy infrastructure must be concurrently complemented by social supports

A large number of indirect as well as induced jobs are created from economic activity in the area but are not directly related to the steel industries. A package to protect the indirect and induced jobs affected by the decline in industries that consume coal needs to be implemented. The package could include services and assistance for the affected people consisting of helping them to adopt different trades and general career services. Since it is unlikely that all the indirect job losses cannot be compensated by jobs created in the clean energy sector; a wider strategy for creation of new economic activities is needed, including incentives for development of other industries or service-oriented business in the affected areas.

## 4. A robust policy framework to assist rehabilitation of workers and communities

Government policies on investment, taxation, and the environment play a significant role in determining the sectors where new investments are made. Some countries, such as Germany, have successfully implemented public policies to aid in the rehabilitation of workers and communities affected by the closure of coal mines. There is a need to refine existing rehabilitation policies to address Just Transition issues. This is crucial as the potential clusters facing impact already experience low per-capita incomes, low literacy rates, persistent poverty, sluggish economic growth, and concerns about job security.

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# Annexure 2: Summary of the Thematic Session on 'Balancing Economic Competitiveness and Environmental Sustainability: Green Transition for Coal-Dependent MSMEs'


January 31, 2024 Kolkata

Thematic session Speakers (L-R): Mr Joy Chakraborty, Consultant, WBREDA; Mr Indranil Das, Senior Consultant, MART Global Management Solutions; Mr S Mukhopadhyay, Assistant Director (IEDS), MSME DFO, Kolkata; Mr Vijay Beriwal, Chairman, FCDA; Mr Vikas Varshney, Director, Megatherm

Moderator: Mr Prosanto Pal, Senior Fellow, TERI

The thematic session focused on the critical journey of Micro, Small, and Medium Enterprises(MSMEs) towards a sustainable future, emphasizing the importance of a fair transition away from coal power.

The moderator, Mr Prosanto Pal, Senior Fellow, TERI kicked off the discussion by highlighting the potential negative effects of a coal transition on coal consuming MSMEs, emphasizing the critical need for policies and incentives to help these businesses. He discussed India's commitment to a sustainable future, as evidenced by the ambitious targets set at COP26, such as achieving a net-zero carbon footprint by 2070 and using 50% renewable electricity by 2030. Mr Pal emphasized that this transition presents an important opportunity for collaboration, knowledge sharing, and job creation in new sustainable sectors, as well.

Building on this foundation, Mr Vikas Varshney, Director, Megatherm looked into modernizing Indian foundries with next-generation green furnaces and Industry 4.0 automation. He emphasized the benefits of solid-state technology and induction heating over traditional, polluting methods. Varshney highlighted the financial and technological challenges that MSMEs face during this transition, emphasizing the critical role of government support in facilitating the adoption of these new technologies.

Mr Vikas Varshney addressing audience during the seminar

Mr Vijay Beriwal, Chairman, FCDA subsequently addressed the real-world challenges of transitioning away from coal, emphasizing the financial and technological barriers that MSMEs face. He discussed foundries' economic viability, emphasizing the significant implications of switching to induction furnaces, as well as the critical roles that lower electricity costs and government subsidies play in facilitating this transition.




Mr S Mukhopadhyay speaking at the event

Mr S Mukhopadhyay, Assistant Director (IEDS), MSME DFO, Kolkata shifted the conversation to government initiatives to help MSMEs during this transitional period. He emphasized the importance of striking a balance between economic competitiveness and environmental sustainability, arguing for a sector-specific approach to policymaking and encouraging MSMEs to collaborate to advocate for favourable policies.

Mr Indranil Das, Consultant, Mart shared his preliminary findings from surveys conducted in coal-dependent regions, revealing that the workforce is willing to adapt to the changing context if adequate retraining and alternative employment opportunities are provided. He also mentioned a general lack of awareness among workers about government programmes, emphasizing the need for improved communication and support mechanisms.

Mr Joy Chakraborty, Consultant, WBREDA subsequently explained the complexities of West Bengal's net metering policies, as well as the implications for MSMEs looking to implement solar energy solutions. He advocated for a comprehensive approach to sustainability that includes energy efficiency, water management, and waste management to help MSMEs make a fair and efficient transition.

These discussions painted a picture of the complex landscape that MSMEs must navigate as India transitions away from coal. The session's collective insights emphasized the importance of a balanced approach that takes into account economic viability, environmental sustainability, and social equity in order to ensure a fair and inclusive transition for MSMEs.

## Key Questions Asked

- How can the transition impact coal consuming MSMEs, and what are the strategies for mitigating adverse effects?
- What are the opportunities for MSMEs in adopting cleaner technologies and renewable energy sources?
- How can skill development and reskilling of the workforce facilitate a smooth transition
- for MSMEs?
- What role do government policies and incentives play in supporting MSMEs through this transition?
- How can technological innovations contribute to reducing the carbon footprint of MSMEs?

> MSME plays a very important role in Just Transition, particularly the coal consuming MSMEs... Any transition in coal will have a very adverse effect in many of the coal consuming MSMEs.
>
> **Mr Prosanto Pal**
> Associate Director, Industrial Energy Efficiency

> Technology development and cooperation are required to make alternative technology affordable, alongside enabling policies and capex support for a just transition.
>
> **Mr Prosanto Pal**
> Associate Director, Industrial Energy Efficiency

> We have come out with a new model that is green furnaces with Industry 4.0 automation, focusing on modernization and energy efficiency.
>
> **Mr Vikas Varshney**
> Director, Megatherm

> The major root of steel making is still the blast furnaces... but green furnace is the most efficient and productive induction melting furnace, incorporating the best aspects for parallel and series circuits.
>
> **Mr Vikas Varshney**
> Director, Megatherm

> The transition is really possible by addressing challenges for the MSME industries such as reduction in the electricity cost, KPEX subsidy, net metering in solar power.
>
> **Mr Vijay Beriwal**
> Chairman, FCDA

"The skill development part is very vital for this labour force... they view skill development as an opportunity for alternate income or to sustain their current jobs during the transition."

**Mr Indranil Das**
Consultant, Mart

"We should not have a single use of water; days are coming when single use of water will also be banned... A holistic circle including energy efficiency, renewable energy, resource optimization, water, and waste management is required for a Just Transition."

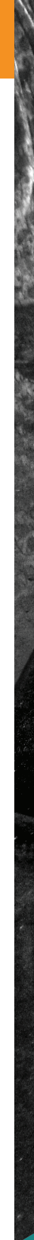
**Mr Joy Chakraborty**
Consultant, WBREDA

"The government has launched schemes like Zero Defect Zero Effect (ZED), Lean Manufacturing Scheme, and Digital MSME to encourage energy efficiency in MSMEs."

**Mr Sitanath Mukhopadhyay**
Assistant Director, Min. of Micro Small & Medium Enterprises, Govt of India

"Foundries are 90% MSME in the country, and an industry wants survival, viability. When we talk about this transition... there is also a concern about the cost implication."

**Mr Vijay Beriwal**
Chairman, FCDA



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