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OCT'2023

PEOPLE-CENTRIC APPROACH
KEY TO RAPID AND EFFECTIVE CLEAN ENERGY TRANSITION

Volume 9 explores the nuances behind key transitions happening in the climate and energy space from a people-centric lens. This edition covers three broad economic sectors undergoing a transition - the coal & power generation sector, the automotive sector and the transition in the battery sector. The people-centric lens offers a wide perspective to look at sustainability, inclusivity and equity aspects of transition from a sectoral, institutional and socio-economic lens, as is highlighted in this volume. The themes of the last eight volumes are captured alongside.

……

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PREVIOUS VOLUMES

Volume 1: Current State of Play – February 2020
Provides a brief narrative of the Indian power sector and its policy implications across the power sector value chain.

Volume 2: The Road to Clean Electricity - July 2020
Provides an overview of renewable energy in India and assesses its progress across the value chain.

Volume 3: Unpacking the impact of electricity demand – February 2021
Deep dives into assessing the impacts of electricity demand.

Volume 4: Decarbonizing the Power Sector: October 2021
Discusses the role of states and end-users in its race to decarbonize the power sector.

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Captures the high-level insights of the COP 26 and a sentiment analysis

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Conducts a thorough assessment of the rise in extreme weather events and its possible impacts on the power sector value chain

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INTRODUCTION

01

INTRODUCTION

Climate change is the biggest existential threat to humanity. As per a recent analysis, over the last 30 years, for every USD 3 spent on development, around USD 1 is lost to extreme weather events caused by climate change①, resulting in a global loss of USD 3.8 trillion. This has far-reaching implications for the environment, economic opportunities, social construct, and more. To address this global crisis, there is an urgent need for transitioning to clean technologies and practices. It is true that these changes will cause upheaval in the lives of people and communities, particularly for those engaged in erstwhile emission-intensive activities, even though the benefits of a low-carbon system are multifold. Some of these challenges are captured in Figure 1.

Several studies have validated that the prospect of job creation outweighs the risks and uncertainties associated with the clean energy transition②. However, to ensure minimal impact on the communities, the discourse on people focused transition is of paramount importance.

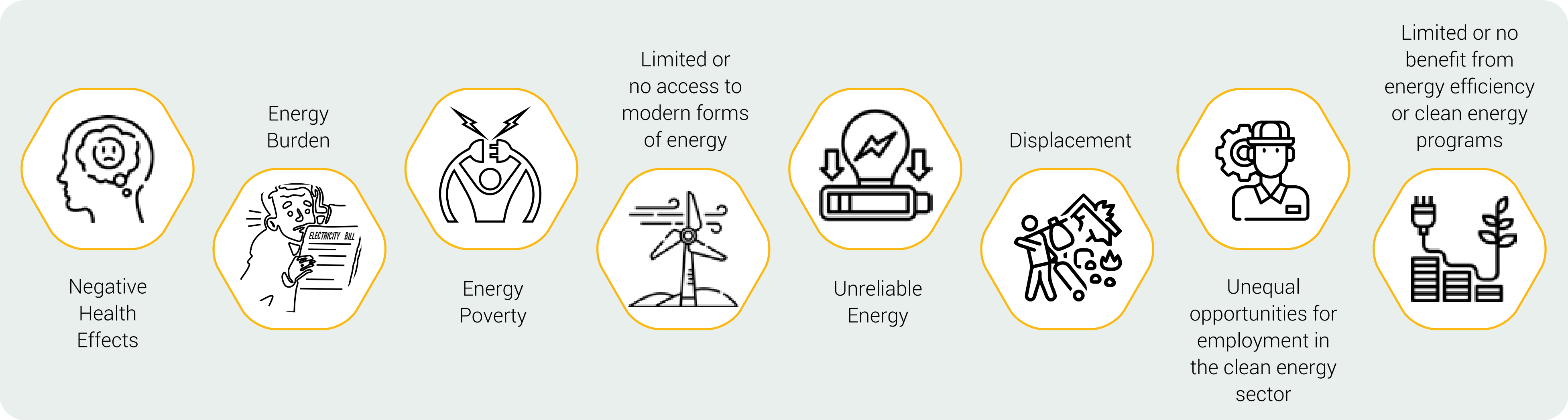
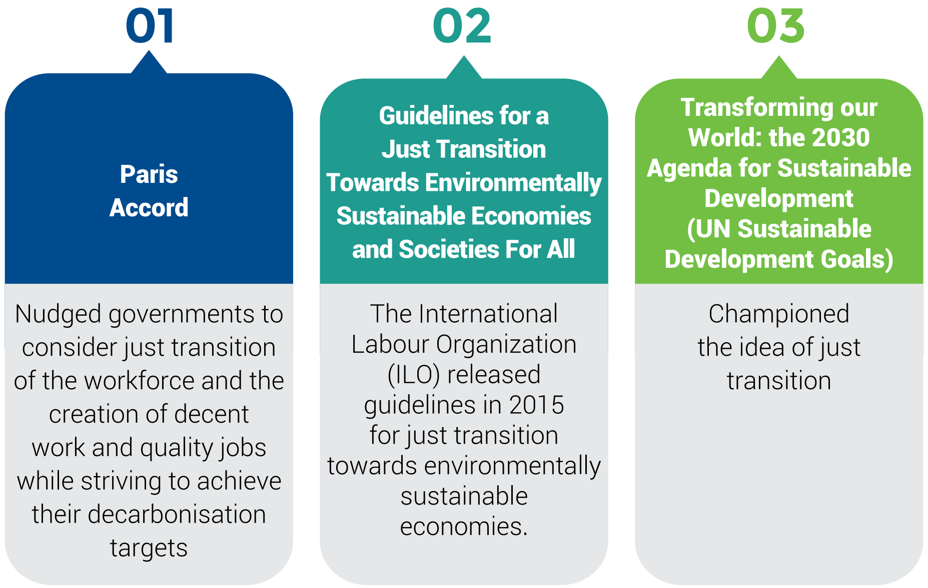


Figure 1: Various forms of energy injustices③,④,⑤,⑥,⑦,⑧,⑨

The shift towards clean energy technologies is no longer a question of if, but rather when and how. It is important to ensure that this transition isn't solely about abating emissions, but also focuses on creating a resilient and just society for all. To achieve this, it is necessary to put the people at the center of this transition.

Figure 2 highlights the three major vectors that have mainstreamed just transition at the global forum. First, the Paris Accord, nudged governments to consider just transition of the workforce and the creation of decent work and quality jobs while striving to achieve their decarbonisation targets. Second, the International Labour Organization (ILO) released guidelines in 2015 for just transition towards environmentally sustainable economies. Finally, the United Nations Sustainable Development Goals also championed the idea of just transition.



01

Paris Accord

Nudged governments to consider just transition of the workforce and the creation of decent work and quality jobs while striving to achieve their decarbonisation targets

02

Guidelines for a Just Transition Towards Environmentally Sustainable Economies and Societies For All

The International Labour Organization (ILO) released guidelines in 2015 for just transition towards environmentally sustainable economies.

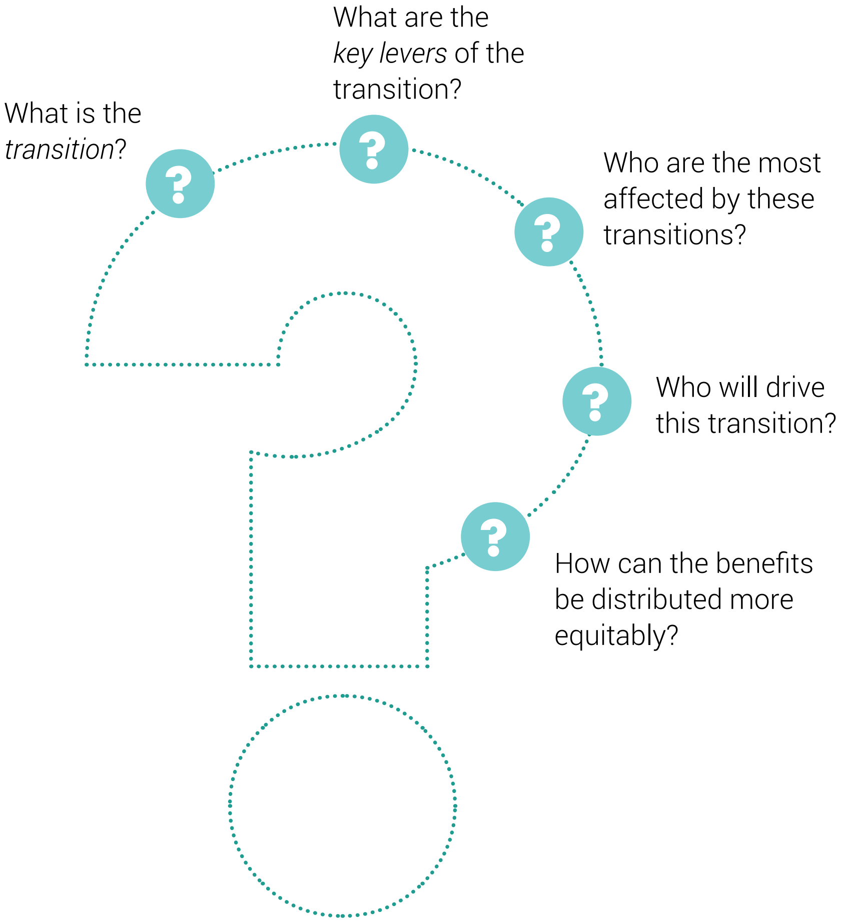
03

Transforming our World: the 2030 Agenda for Sustainable Development (UN Sustainable Development Goals)

Championed the idea of just transition

Figure 2: Main vectors of 2015 that mainstreamed Just Transition Discourse ⑩, ⑪, ⑫

This Volume is specifically designed to give us all a new pair of glasses to view our energy systems differently and recognise the inequities within them. As we explore the sectoral transitions in coal, automobile, and battery sectors, we intend to unfurl the following critical questions:



What is the *transition*?

What are the *key levers* of the transition?

Who are the most affected by these transitions?

Who will drive this transition?

How can the benefits be distributed more equitably?

02

DEFINING THE TRANSITION

02

DEFINING THE TRANSITION

Transition Sectors

This series attempts to examine sectors that are undergoing an energy transition. In order to provide a comprehensive analysis of various aspects of the transition, the selection criteria involved a detailed examination of these sectors encompassing two broad types of transitions: those driven by climate action and those influenced by market forces. In the case of the former, the transitions are those from coal to renewable energy and internal combustion engines (ICEs) to electric vehicles (EVs) as both of these transitions are directly related to India's Nationally Determined Contributions (NDCs). However, as for the latter, the transition from lead-acid batteries to lithium-ion is indirectly related with India's NDCs and therefore, more market driven. Table 1 summarises these transitions.

Table 1: A summary of sector-wise transitions

Transition	**Thermal Power to Renewable Energy**	**Internal Combustion Engine to Electric-powered**	**Lead-acid Batteries to Lithium-ion Batteries**
Contribution to the Economy	• Revenue from Coal Mining contributes ~ 0.7 percent to India's GDP⑬; Mining and Quarrying Sector accounts for almost 2.5 percent of India's GDP. • In 2021-22, coal contributed to more than 34 percent of Indian Railways' total revenue and 46 percent to Freight Revenue.⑭	Automobile sector accounts for 7 percent of India's GDP.⑮	Lead-acid battery sector contributes 0.3 percent to India's GDP.⑯
Baseline Situation	• Share of RE-based power generation in India's installed capacity: ~41 percent • Share of RE in primary energy supply: 3.8 percent • Share of RE in electricity generation: 22 percent⑰	• For FY 22-23, EV penetration in India was around 5.59 percent.⑱ • In FY 2023, EV registrations reached over 1.2 million, an increase of over 154 percent from the previous year.	• In 2021, market size of lead-acid batteries in India was around USD 10 billion.⑲ • Lead acid cost per usable kWh per cycle in 2022 was USD 0.275.

Transition	Thermal Power to Renewable Energy	Internal Combustion Engine to Electric-powered	Lead-acid Batteries to Lithium-ion Batteries
	• In FY 2023, Coal and Lignite production reached a record 937.9 MT, an increase of 14% from the previous year.⑳ • As of Q1 of FY 2023-24, CIL produced 223.36 MT of coal, the highest ever.㉑	• Of the registered EVs, 62.6 percent are 2-Wheelers, 32.7 percent 3-Wheelers and the rest are others.	• Li-ion cost per usable kWh per cycle in 2013 was USD 0.22 while it dropped to USD 0.045 in 2023.㉒
2030 Endline/ Targets	Achieve 50 percent of total capacity from non-fossil fuels.	A 30 percent increase in e-mobility by 2030 resulting in ~8 crore EVs on road.㉓	For achieving the target of 30 percent e-mobility by 2030㉔, the capacity target of 49,377 MW/246,885 MWh of battery energy storage in High Demand Scenario has been set.㉕
Workers/ Comm-unities Affected	13.1 million out of which ~ 1.1 million are involved in coal power generation.㉖	~ 13 million㉗	• Around 71,636 workers were employed in the manufacturing of batteries and accumulators in 2020.㉘ • However, this number does not consider employment in the informal battery sector.
Investment size or opportunity	Annual Investment of USD 20-26 billion required to achieve RE targets by 2030.㉙	• Foreign Direct Investment of around USD 8-10 billion expected in the year 2023. • By 2030, the market of EV power packs is anticipated to witness a growth of USD 300 billion.	The market of EV power packs is set to grow to USD 300 billion by 2030.
Key Impacted States	Jharkhand, Orissa, Chhattisgarh, West Bengal, Madhya Pradesh and Tamil Nadu	Andhra Pradesh, Maharashtra, Tamil Nadu, Haryana and Karnataka	Andhra Pradesh, Tamil Nadu, Telangana, West Bengal, Himachal Pradesh and Maharashtra㉚

03

TRANSITION LEVERS

03

TRANSITION LEVERS

This section is a deep-dive on the various levers that are facilitating the three key energy transitions being experienced in India. It emerges that the shift toward either solar or wind-based energy, electric vehicle or lithium-ion batteries is a steady response to the fall in technology prices, enhancing energy security with a focus on Make In India and provision of consistent incentives for the promotion of clean energy in the country.

Table 2: In-depth look at the levers that enable key energy transitions in India

Limiting Global Temperature Rise : Updated INDCs to UNFCCC			Market-induced Transition
Parameter	**Power Sector**	**Automobile**	**Battery**
Favourable Cost-Economics	The tariffs for RE-based power hover around INR 2-3/kWh while for coal-based power, it is around INR 4/kWh.㉛	Total Cost of Ownership (TCO) for majority of electric vehicles in India has reached cost parity.㉜ • TCO for electric 2-wheelers is 70 percent lower than that of their petrol-powered counterparts, surpassing TCO parity. • In the private car segment, TCO for EVs is currently higher, but subsidies help achieve TCO parity in both low and medium-cost segments. • Four-wheeler taxis have lower operating costs and a lower TCO of about 31 percent than their CNG counterparts. • E-buses outperform their ICE counterparts in all sub-categories (AC/Non-AC, 9m and 12m).	Lithium-ion battery pack prices have reduced substantially from USD 732/kWh in 2013 to USD 151/kWh in 2022, representing a declining annual growth rate (CAGR) of approximately 98 percent.㉝

Parameter	Power Sector	Automobile	Battery
Enhancing Energy Security	Although India is the world's fifth largest coal producer, it is one of the major importers of coal, with an import dependency of over 20 percent in FY 2021.㉞	- India is the third largest consumer of oil and gas in the world and had a high overall net import dependency of around 41 percent in 2021-22.㉟ - Interestingly, the road transport sector itself accounts for 85 percent of India's oil and gas needs.㊱	The transition to lithium-ion batteries is gaining more acceptance due to their high energy density, longer life cycle, and lower self-discharge rate. Further, this acceptance is fuelled by the discovery of lithium-ion reserves in Jammu & Kashmir, providing a significant domestic source of lithium for battery production.
Conducive Policy Environment for Alternate Technologies	- At the national level, continued upstream and downstream incentive schemes are being developed and implemented to promote RE such as the Production Linked Incentive (PLI) Scheme for Solar Modules, Renewable Purchase Obligation (growing from 24.6 percent for FY 22 to 43.33 percent for FY 30), Energy Storage Obligations (up from 1 percent in FY 24 to 4 percent in FY 30), Renewable Generation Obligation, Green Open Access Rules, etc. - At the state level, policies on renewable energy including solar and wind, are being developed and implemented to promote clean energy.	- At the national level, the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME)– a subsidy scheme came into force for the promotion of EVs and will remain in effect until March 31st 2024.㊲ - At the state level, more than 25 states have notified or drafted their EV policies.㊳	- With an outlay of INR 18,100 crores, the Production Linked Incentive (PLI) scheme has been introduced, which specifically targets Advanced Chemistry Cell (ACC) manufacturing.㊴ - Saubhagya Scheme: Achieved the bare minimum by connecting households to the electricity grid. - Smart Meter National Program (SMNP): Aims to replace 250 million conventional meters with smart meters.㊵

04

TRANSITIONING FROM COAL TO RENEWABLE ENERGY

04

TRANSITIONING FROM COAL TO RENEWABLE ENERGY

Being a major contributor to meeting India's energy needs, accelerating economic growth and providing employment. It is, however, facing the winds of transition due to its large emission footprint and a growing challenge against the declining cost of renewable energy. There is a wide spectrum of coal-based economy encompassing mining, transportation and finally the end-use sectors. The aim of this section is to explore the sub-segment of coal-based power generation for its transition-related nuances.

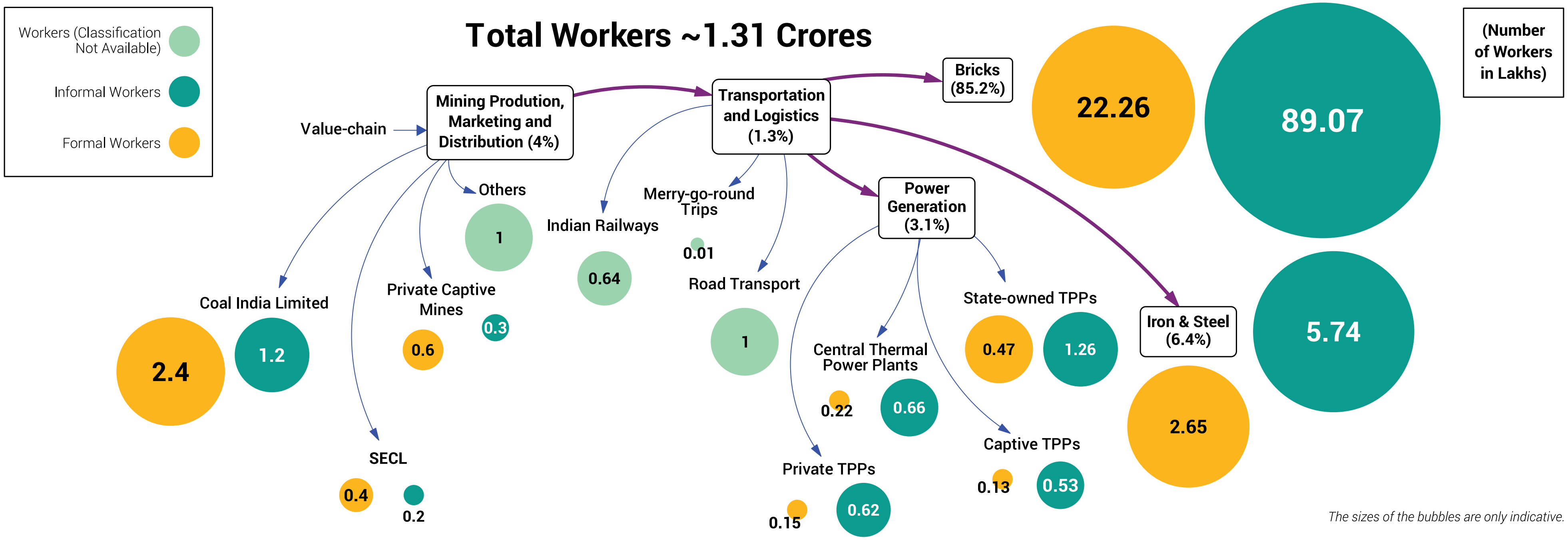


Figure 3: Coal-based Livelihood Ecosystem [41] *Representation by Authors*

The Coal-based Livelihoods Ecosystem

According to the estimates, over 1.31 crores (13 million) people are employed in the entire ecosystem of a coal-based economy, which includes mining operations, coal transportation and end-use in major economic sectors.

The majority of the workforce is employed in the bricks industry; however, this series does not include this industry due to the lack of credible and authentic data on this highly segregated and informal industry.

The next largest employer in the sector is the Iron & Steel industry. This is also not covered in this series owing to the largely technological nature of transition for the industry and lack of data on its manpower.

This series focuses on the coal-powered generation industry, which includes mining, coal transport and power generation, employing close to 11 lakhs (1.1 million) people.

Coal-based Power Generation Sector (Mining, Transport & Power Generation)

- The coal mining ecosystem employs the maximum number of workers, approximately 5.6 lakh, if coal mining for power generation is taken into account.
- It includes job roles that are specific to the type of mines. As on 31st March 2021, there were a total of 442 mines reported in India, with 190 underground mines and the remainder open cast mines.㊷ Despite contributing only around 5 percent of the total coal production by Coal India Limited (CIL), the underground mines employ nearly 44 percent of the total workforce.㊸
- As most of the underground mines are reported to be unprofitable, they are more susceptible to closure in the near future. Since 2008, India has closed down 123 underground coal mines. ㊹

Figure 4: Type of Workers in Mining Operations [45]
Representation by Authors

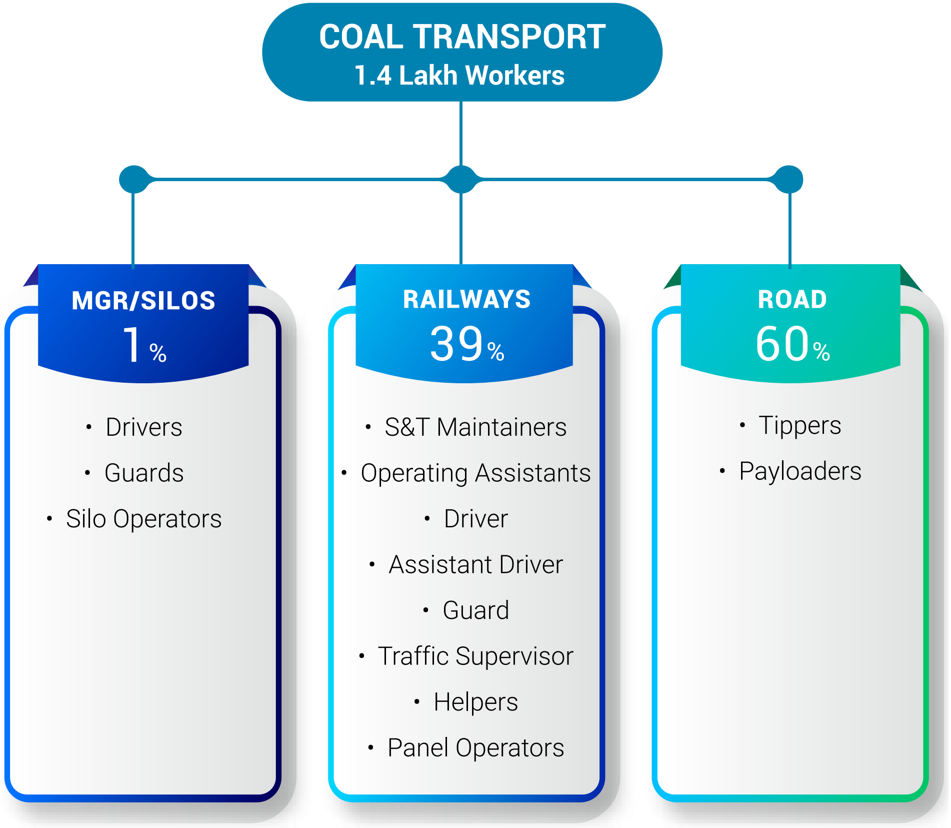
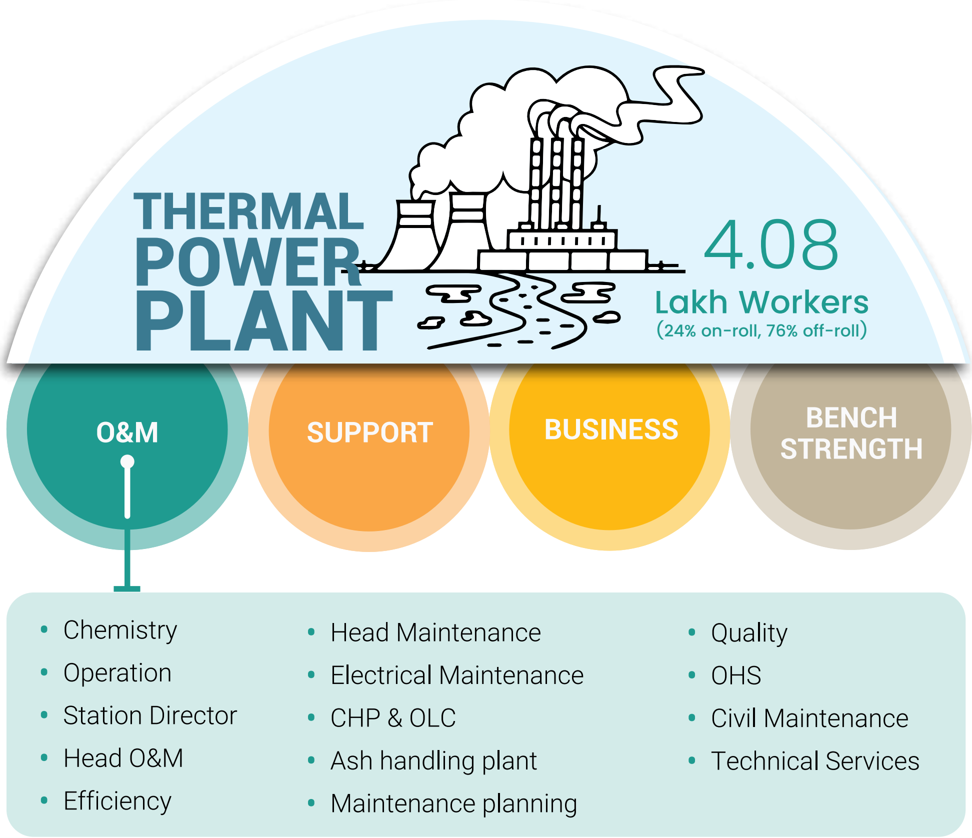


Figure 5: Type of Workers in Coal Transportation [46]
Representation by Authors

- An estimated 1.4 lakh workers are employed in the transportation of coal for power generation.
- The main modes of transport include road, railways and merry-go-round trips. The key job roles associated with each of these modes are illustrated in Figure 5.



- Chemistry
- Operation
- Station Director
- Head O&M
- Efficiency
- Head Maintenance
- Electrical Maintenance
- CHP & OLC
- Ash handling plant
- Maintenance planning
- Quality
- OHS
- Civil Maintenance
- Technical Services

Figure 6: Type of Workers in Thermal Power Plant [47]
Representation by Authors

- Considering the coal-based power generation industry, Thermal Power Plants across the country employ close to 4 lakh workers.
- Out of this, almost 24 percent of the workers are formally on-roll, while the rest are involved informally.

Renewable Energy Job Roles

Table 3: Full-time Employment Coefficients (FTE) for RE projects [48]

FTE Coefficients	Ground Mounted	Rooftop Solar	Wind
Business Development	0.05	1.53	0.06
Design	0.2	8.85	0.1
Construction and Commissioning	2.7	13.84	0.6
O&M	0.5	0.5	0.5
Total	3.45	24.72	1.26

- In 2017, the country had an estimated 4.86 lakh solar jobs. In order to achieve the target of 450 GW of solar-based installations by 2030, the number of solar jobs is expected to increase significantly to over 9 million. There is, however, the possibility of multiple counting in the employment estimates based on per MW job ratios, in case the same worker is working on different projects and a new worker is not necessarily employed for every new capacity.
- In contrast to coal-based thermal power plants, solar plants have a significantly lower employment intensity, especially for utility-scale projects. The majority of the jobs are in the pre-operations stage including business development; design and pre-construction; and construction and installation. These jobs are for a short duration of time and the number of long-term jobs during operation and maintenance are relatively low.
- Table 3 highlights the per MW employment figures for various capacities of solar plants, which are compared with the man-to-MW ratio of thermal power plants, which varies from 1 to 3 in certain cases. If induced employment in the local economy is also taken into account, the number is estimated to be twice or thrice this value.
- Besides this, grid integration requires new skill sets which are currently lacking.

Facets of Transition

1. Coal Production and Employment

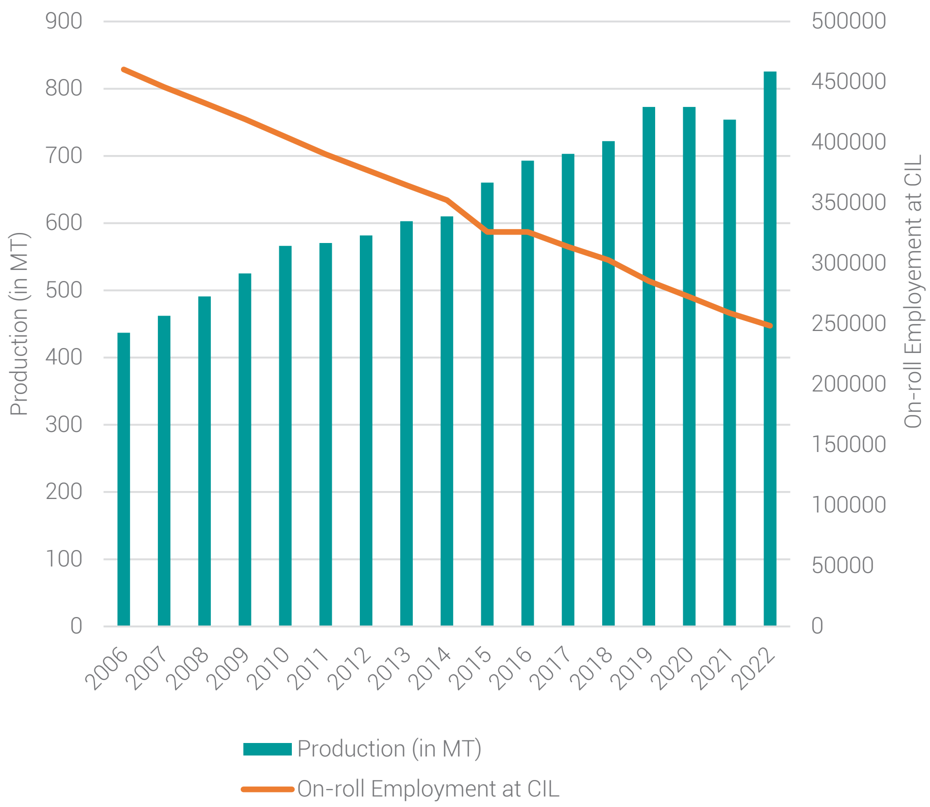


Figure 7: Coal Production vs On-roll Employment[49]

- Despite the fact that coal production has increased by 91 percent since 2006, formal employment at Coal India Limited has actually dropped by -46 percent in the same period.
- This could be attributed to growing mechanisation and a preference for outsourcing work to contractors.

2. Coal Capacity Addition (Target vs Achievement)

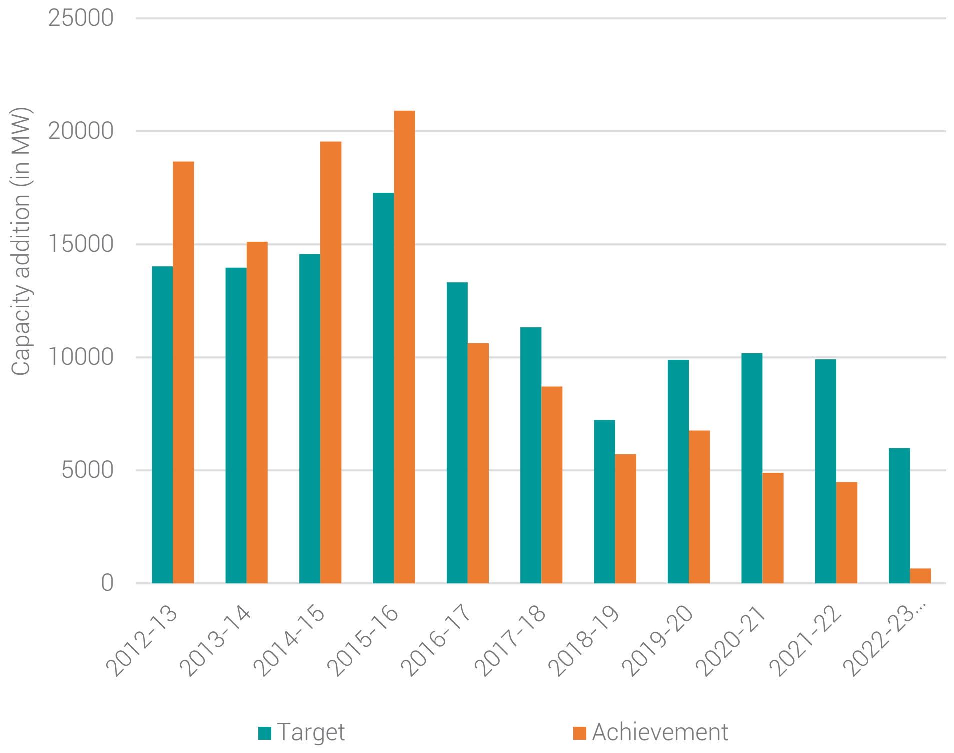


Figure 8: Coal Production vs On-roll Employment

As per the Central Electricity Authority's Optimal Generation Mix Report, the additional coal capacity estimated for the year 2029-2030 ranges from 12.7GW to 19.1 GW, this is in addition to the under-construction capacity of 26.9GW.[50]

However, as past evidence indicates that over the 10 years period, between FY 13 to FY 23, a total of 116.1 GW of capacity was achieved as against 127.7

GW of planned capacity. Further, the coal installed capacity exceeded planned capacity until FY 16; however, since 2015, the advent of mass capacity enhancements in solar and wind energy has led to a decline in coal installed capacity as compared to the planned capacity.

3. Dependency of States on Coal Revenues (51)

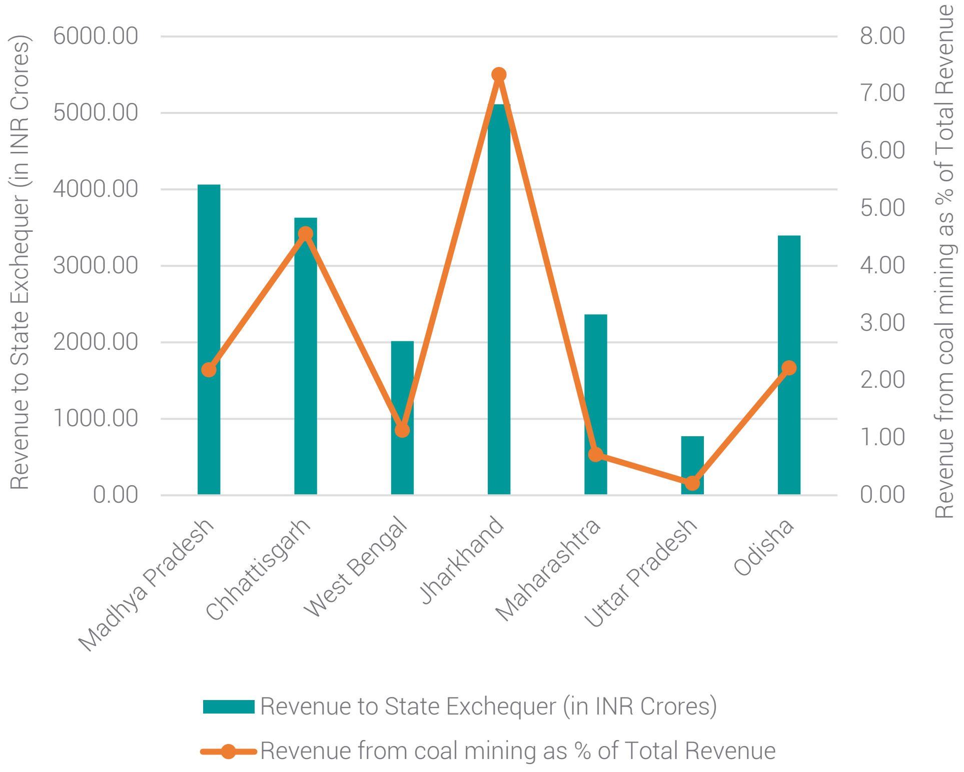


Figure 9: Coal-dependency of States

As part of its mining operations, Coal India Limited makes payments to the Union Government and State Governments of the respective states where the mining operations take place. Odisha, Jharkhand, Chhattisgarh and Madhya Pradesh are the top four states in which CIL pays the largest levies.

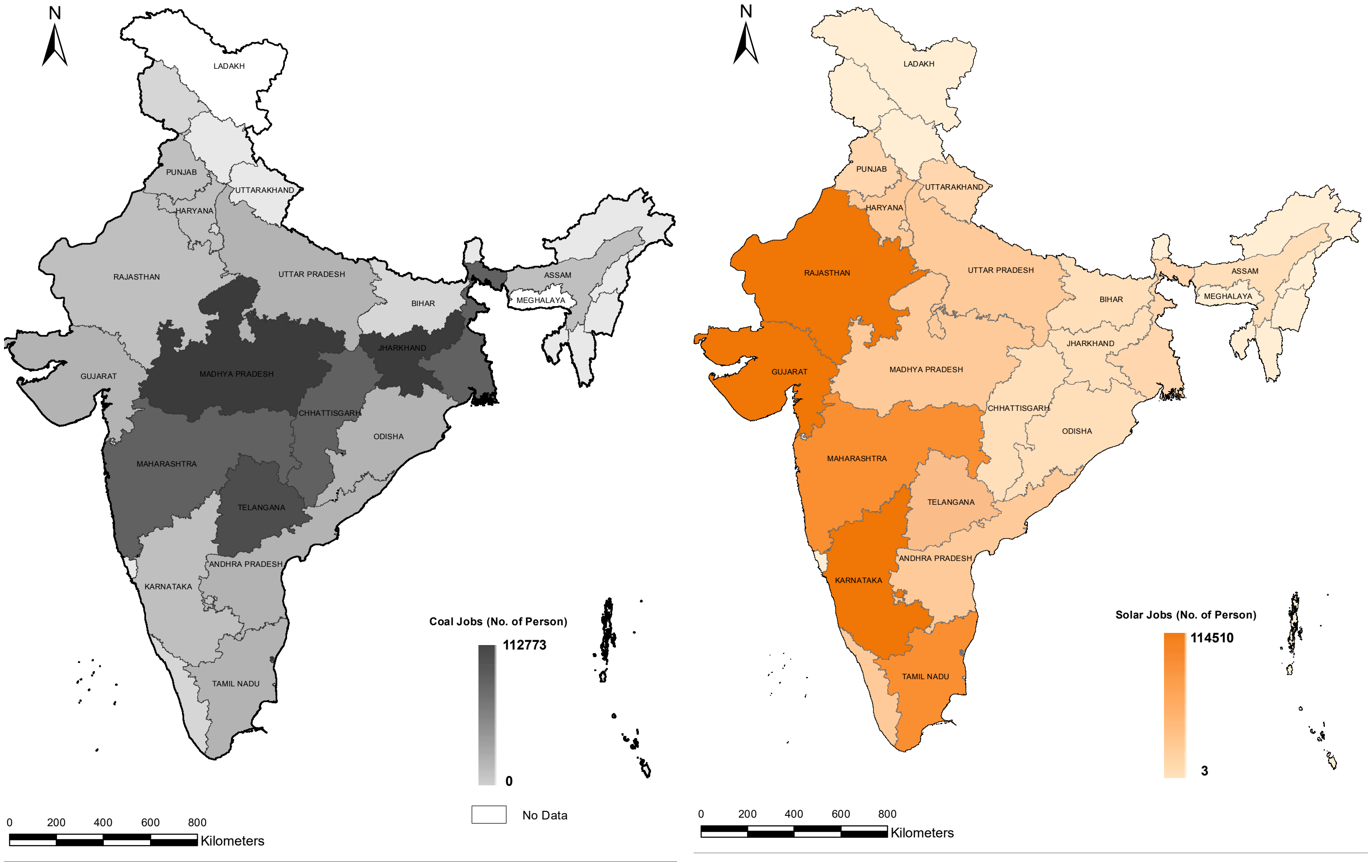
The dependence of a state's economy on coal can be assessed by comparing its revenue share received from CIL to the total amount of revenue received. According to this comparison, the economies of Jharkhand, Chhattisgarh, Odisha and Madhya Pradesh are considerably more dependent upon coal mining than those of West Bengal, Maharashtra and Uttar Pradesh.

Moreover, Jharkhand has the highest revenue share from coal mining among all the states, contributing almost 7.5 percent to the total revenue. Extent of coal dependence of a state like Jharkhand can be understood from the fact that the state exchequer received a higher revenue in FY 22 than the actual budgetary expenditures of key sectors such as energy, transport and agriculture.

A significant portion of the state's revenue from coal mining is derived from the District Mineral Foundation (DMF) funds, which is contributed by the mining companies. For instance, in FY 22, almost 18 percent of Jharkhand's total revenue from mining was contributed by DMF, which amounts to over INR 900 crores.

Furthermore, as per the mandate, DMF utilisation is intended for a variety of environmental and community-based interventions. However, a snapshot of DMF fund's utilisation across major mining states showcases substantial underutilisation of the fund. Also, it is important to note that the DMF receives revenue from the mining of other minerals as well and operates as a trust.(52)

4. The Employment Paradox: Coal Vs Solar Jobs



Distribution of Coal Jobs in India (53)

Distribution of Solar Jobs in India (54)

Figure 10: Geographical Distribution of Coal and Solar Jobs in India

It is apparent from Figure 10, that there exists a geographical divide between areas with high coal dependence and areas with high renewable energy potential and installed capacity.

Coal is mostly found in the eastern and central parts of the country while the up-and-coming renewable energy capacities are located in the western and southern parts of the country.

Since the coal-based economy is quite old and established, a lot of RE-based capacity remains to be added, implying that a significant number of RE-related jobs are likely to be created in the near future.

This further translates to the location of jobs for these sectors in different parts of the country, which consequently will necessitate migration of the existing workforce from coal-dominant areas to potential RE locations for employment.

Impact of Transition on Livelihoods

In the context of transition impact, different types of workers are likely to encounter a host of uncertainties and challenges. Several factors including socio-economic profile of workers, job roles and skills and political-economic settings, result in a skewed degree of vulnerability among different types of workers. In order to maintain the principles of an equitable transition, it is imperative to address these vulnerabilities as part of planning and implementation of transitioning away from fossil-fuels. From a secondary research-based assessment of vulnerability of various types of workers in the coal-based ecosystem, the following matrix can be used to assess their vulnerability.

Table 4: Vulnerability Matrix for Workers in Coal Ecosystem

	Least Vulnerable				**Most Vulnerable**
	🟩	🟩	🟩	🟧	🟥
Broad Category of Worker	Managerial	Officers	Technical Workmen – On-roll, formal employees of the company.	Informal Workers (through contractors)	Informal Workers (without contract) in Mine Operations, Power Plants, Bricks, Iron & Steel and Other Industries
Job Roles	Managers and above	Engineers, Administrative Officers, Human Resources, Departmental Officials	Shift in-charge, plant supervisors, Technicians, Maintenance Workers, Contractors (Civil works, Maintenance, Labour Contracts)	Technical Workmen and Support Staff	Helpers, Cleaning Staff, Loaders-Unloaders, Overburden Removers, Miners, Transportation Workers
Rationale for Vulnerability	Highly paid, job security, highly skilled	Higher salaries, social security cover, better economic assets, highly skilled, job security, pension benefits	Covered by employee benefits of the company, regulated salaries, social security benefits, better economic assets	Minimum Wages, Lack of employee benefits, task specific skill sets	Low Wages, Poor Social Security Cover, Low Job Security, Redundant/Replaceable Skillsets, Not part of registered worker unions, Mostly Migrant Workers, Seasonal Jobs
Skill Sets	Indian Engineering Services State Engineering Services Grade-A Officers	Executive Engineers Superintendent Engineers Junior Engineers Other officers	Skilled workforce ITI (Industrial Training Institute) Trained professionals	Semi-skilled and Unskilled ITI (Industrial Training Institute) Trained Professionals Apprentices	Unskilled Workers

Job Roles and Skills in Renewable Energy Sector

Skilled Workers

Engineers, O&M Professionals, Business Development, Regulatory Compliance

Construction Workers

Electrician, Mason, Plumber, Welder, Glazier, Plasterer, Carpenter, Helper

Unskilled Support Staff

Cleaning of Panels, Security Guards

Other Skills

Quantitative Modelling (e.g., Spreadsheet, optimisation, financial, engineering, etc.), Technology R&D, Qualitative Analysis, RE Integration and Grid Related)

Key Takeaways

Data Research & Analysis	• Develop a database and inventory of the coal sector for livelihood, community dependence, vulnerability of workforce • Social, Economic and Environmental Impact Assessments for coal-based economy should be conducted
Skill Development	• Conduct decentralised, regional and factory/mine-level skill development and training workshops • Reskilling for energy efficiency related technologies, renewable energy jobs, other industrial jobs in coal-rich regions
Social Welfare	• For the workers which are largely informal and not covered under any social protection scheme, strategies to bring them under the ambit of social security cover needs to be designed and implemented • Inclusion of pension, insurance, health cover, education, and other social security instruments
Institutional Set-ups	• Setting up of the Just Transition Taskforces or Commissions, such as the one recently formed in Jharkhand, for inter-departmental and federal cooperation and collaboration, at the national and state level
Financing	• For certain elements having higher returns in the immediate future, equity-based instruments needs to be explored. • For elements such as severance packages and skill development that have a comparatively longer return cycle, blended financing, concessional financing and debt-based instruments may be considered • Several skill development and capacity building initiatives can be funded with DMF funds which are largely underutilised in most of the mining-intensive states

05

TRANSITIONING FROM INTERNAL COMBUSTION ENGINE (ICE) VEHICLES TO ELECTRIC VEHICLES (EV)

05

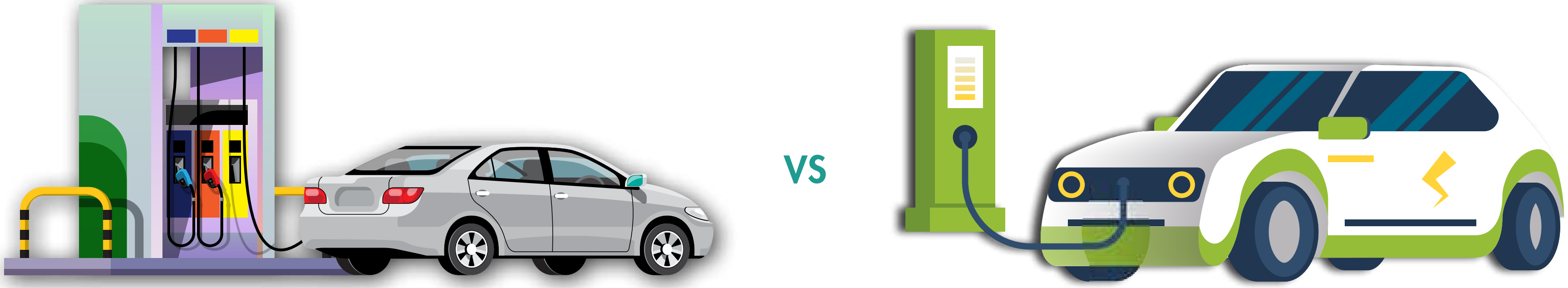
TRANSITIONING FROM ICE TO EVs

The automotive sector is rightly referred to as the mother of the manufacturing sector in the Indian economy since it directly impacts the fortune of several other manufacturing industries in the sector including rubber, lead, plastics, iron and steel, aluminium, chemicals and more. Concurrently, it has a huge impact on the services sector as well which includes banking, logistics, insurance, service, repair, etc. As the automotive sector undergoes a transition, it will have a significant impact across the ecosystem. Therefore, a curated approach is necessary to reduce the impact of this transition, especially for sectors and industries that lack the resources to forge a path forward.

In order to examine the transition vectors in detail, let us deep dive into the existing automotive value chain as captured in Figure 11. The ICE vehicle value chain is a complex system involving multiple players and processes, all working together to produce and maintain vehicles that are relied upon by millions of people globally.

The automotive industry is a significant contributor to employment, generating one of the largest numbers of jobs among non-agricultural sectors.

- The Automotive Mission Plan (AMP) 2026 forecasts the creation of 65 million direct and indirect jobs within the automotive sector over the next decade.
- This is in addition to the 25 million jobs created in the previous decade.
- As of 2020, the automotive sector employed 12.72 million people directly and indirectly, which includes aspects such as auto component manufacturing, service and maintenance.
- Figure 11 illustrates the breakdown of jobs in the automotive sector capturing various sub-sectors including auto-component manufacturing, Auto-Original Equipment Manufacturers (OEMs), and Research & Development, and others.
- Approximately 44 percent of the workforce in the automotive sector is employed in the service industry(55).



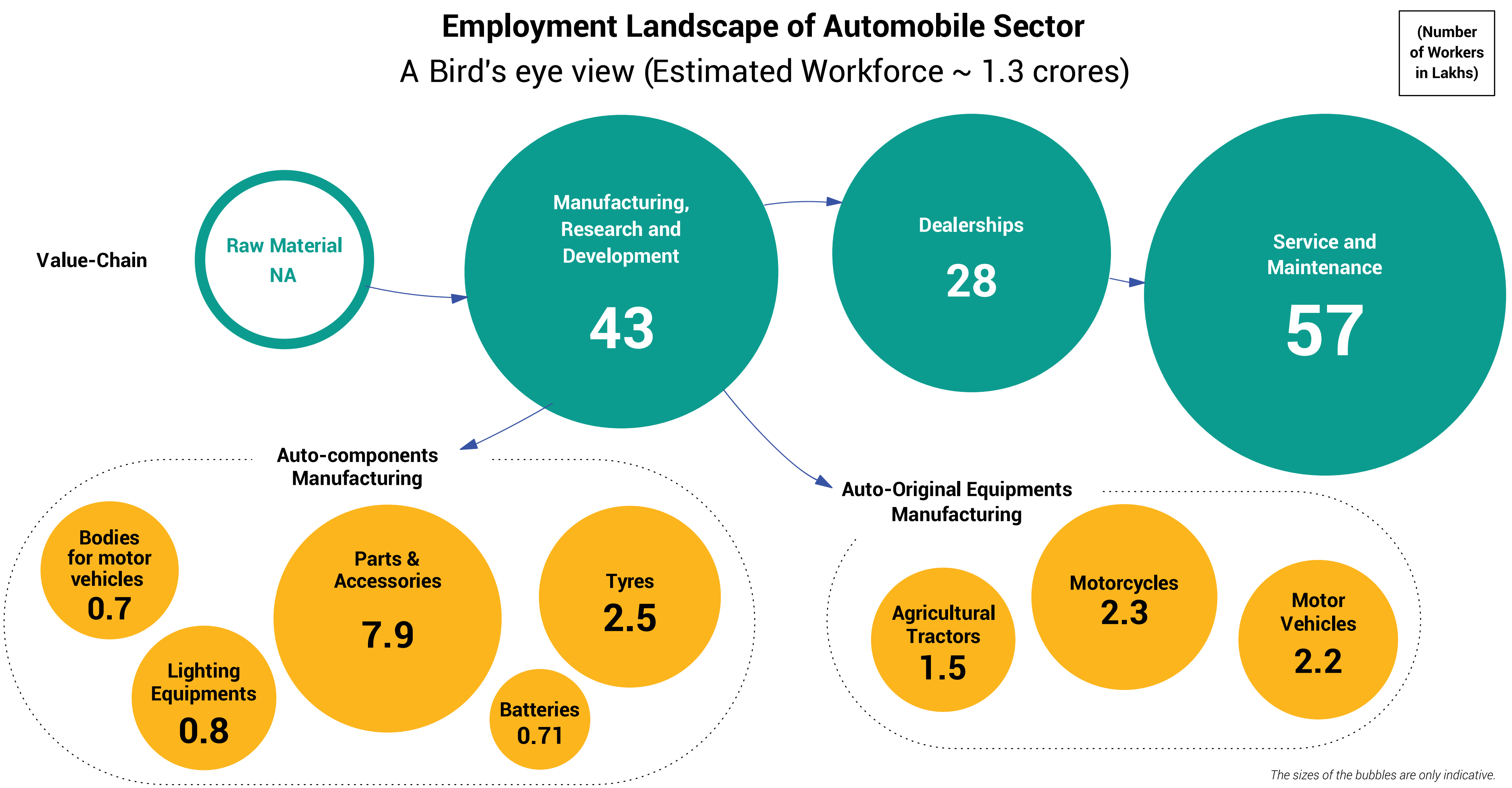


Figure 11: Employment Landscape of Automobile Sector - A Bird's Eye View (Estimated Workforce ~ 1.3 crores)[56]

From the above analysis, it can be concluded that a significant portion of the workforce employed in the automotive sector is about to undergo one of the major sectoral transitions.

Impact of Transition Across the Ecosystem

The automotive sector is witnessing the biggest market disruption as it transitions towards EVs and other allied technologies. This transition is likely to impact the nature of jobs across the value chain, with each aspect of the value chain experiencing varying levels of disruption. Interestingly, the jobs and associated skills in the sector are evolving rapidly, which will result in the creation of multiple new jobs in the next 3-5 years. At the same time, there will be some jobs that will be lost during the transition as the manufacturing of ICE vehicles is significantly different from EVs. Figure 12 captures the indicative list of existing and future jobs post-transition.

	Auto-Components Manufacturing | **Auto-Original Equipment Manufactures**	**Dealerships**	**Service and Maintenance**
Existing Jobs	• Body shop manager & technician • Refinisher • Paint manager & technician • Auto electrical manager & technician • Tool room operator • Manual spot welder & assistant • Assembler and filter • Routine machine loading/unloading • Logistics-internal material transfer and storage • Quality control manager • Packing executive	• Lot Manager • New Vehicle Prep Manager • Accessories Manager • Sales Executive • Washing and Maintenance Staff	• Engine Repair Technician • Service Technician • Standing and primming jobs • Body Paint Technician
Future Jobs	🔵 Electromechanical Technician 🔵 Electronics Technician 🟢 Networks and Computer system applications 🟢 Data Analysis 🔴 Operators to manage and maintain robots 🔴 Programmers for Sensor interaction 🔴 Motor control Engineer	🟢 Digital Marketing Professional • Home sales consultant • Digital content writer • E-Outlet sales consultant	🔵 EV Technician 🔵 Battery Technician 🟢 Predictive Analysis • Advance Paint Technician

🔵 Mechatronics
🟢 Data Analytics & AI
🔴 Robotics

Figure 12: Summary of Jobs in Various Sub-sectors [57],[58]

In terms of manufacturing, the transition to EVs has prompted discussion on performance, safety features and driving experience at the forefront. As a consequence, traditional manufacturing is deemed outdated, while the infrastructure developed during the previous industrial revolution does not suffice. Even the skills acquired to operate that infrastructure are obsolete and the innovation cycle has been shortened as well. The growing demand for new features will nudge manufacturers to roll out new models and variants in a lesser timeframe. It is therefore expected that a high emphasis will be placed on digitalisation, automation and changes to processes and facilities. Figure 13 captures the list of skills that will be considered by the manufacturers.

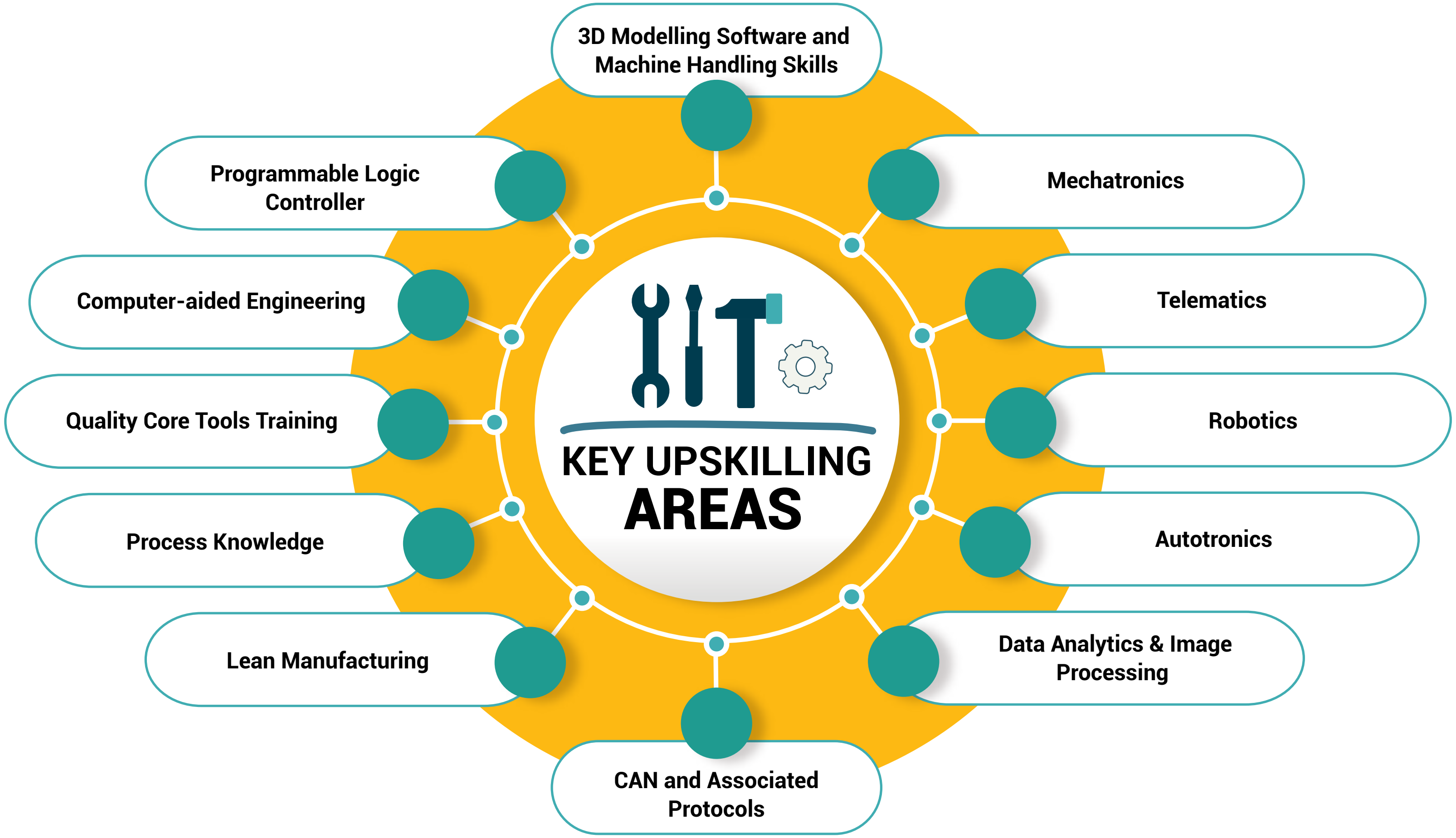
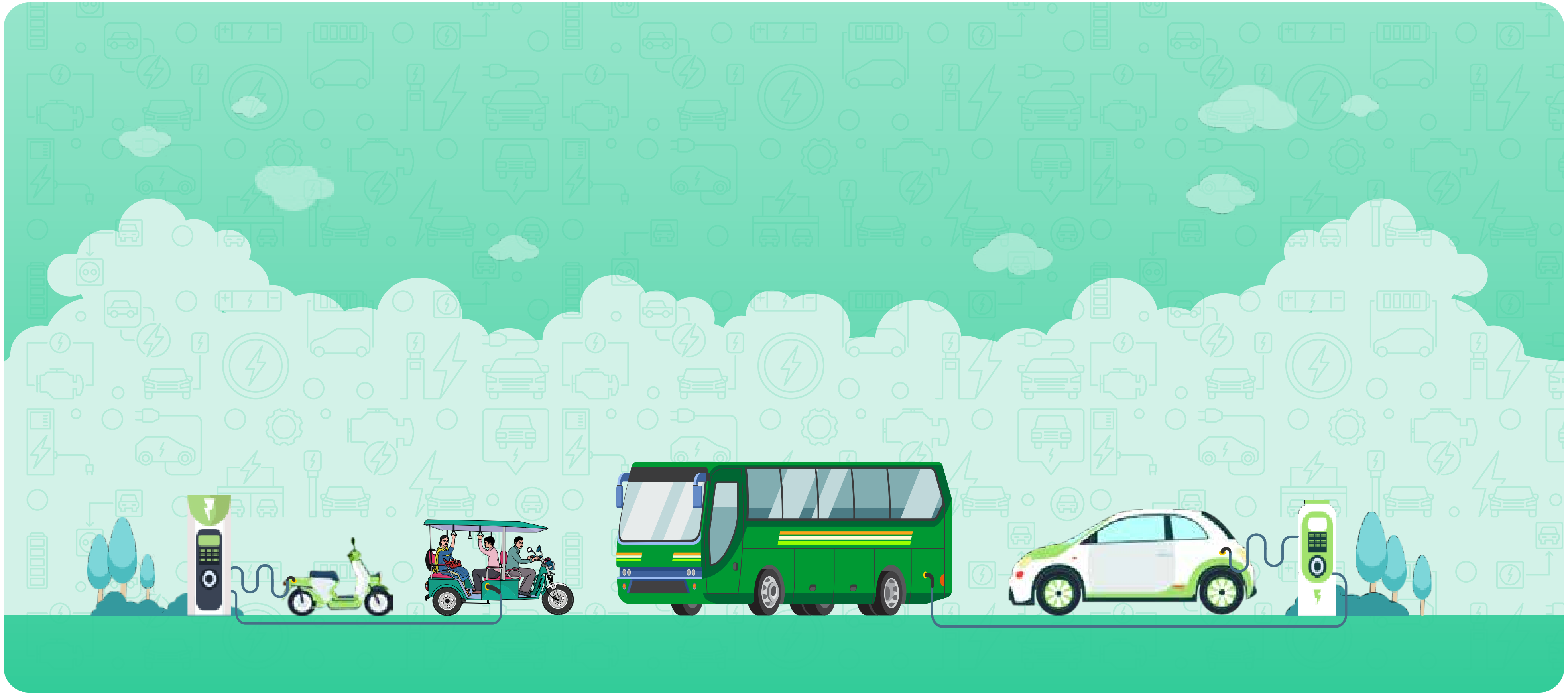


Figure 13: Key Upskilling Areas ⁵⁹



As for dealerships, the transition is unavoidable since the new generation of customers demand personalised purchasing journeys tailored to their needs, desires and character. As a result, the workforce must be equipped with digital marketing skills and approaches while simultaneously be capable to gauge the changing customer needs and provide insights to OEMs.

For the service and support ecosystem, it is anticipated that the transition to EVs will alter the entire dynamics. With substantially fewer moving parts, the vehicles will experience significantly reduced downtime. Moreover, there will be an increased focus on predictive and preventive maintenance which will necessitate building capabilities in the field of mechatronics and data analysis.

Furthermore, a spate of jobs will crop up in the charging infrastructure space including but not limited to field failure analysis engineer, customer support engineer, and charging station manager/ supervisor. This transition can contribute significantly to India's growth provided the sector is successfully able to address the skill gap to meet the requirements of future jobs.

Key Takeaways

Data Research & Analysis	• Establish a detailed registry of ICE component providers intending to transition to EVs and by what means • Develop a dedicated portal to share information and enhance transparency • Commission research to identify skills required across the value chain. Involve universities and other academic institutions to develop dedicated training programs to meet those requirements
Skill Development	• The Auto Sector Skill Development Council (ASDC), the apex industry body for skill development in the automotive sector needs to be capacitated. The council could design and release courses on EVs to skill new workforce as well as reskill and upskill the existing workforce. • Provide a specific focus on servicing professionals and tier-3 & 4 auto-component manufacturers that lack the resources necessary for a smooth transition • Build strategies to attract workforce from other related industries like IT, telecom, etc.
Social Welfare	• For the workers who are largely informal and not covered by any social protection scheme, strategies should be designed and implemented to bring them under the ambit of social security cover such as pension, insurance, health cover, education and any other social security instruments
Institutional Set-ups	• Ensure increased coordination among all tiers of government to expedite the development of an acceptable just transition plan • Strengthen industry-academia collaboration to ensure optimal demand-supply ratio
Financing	• Create a dedicated funding pool » To provide training to retrain and reskill existing workforce » To assist existing ICE component manufacturers in initiating the transition

06

TRANSITIONING AWAY FROM LEAD-ACID BATTERIES

06

TRANSITIONING AWAY FROM LEAD-ACID BATTERIES

Over the past century, lead-acid batteries have been used in a wide variety of applications and are still being used today. About 85 percent of the world's lead is used to manufacture lead-acid batteries(60), which include stationary storage applications, Starting, Light, and, Ignition (SLI) batteries in ICE vehicles, etc. Although they are low cost, durable, and a reliable option, but they are relatively heavy and have a limited lifespan. Additionally, they require regular maintenance, such as topping up the electrolyte and inspecting the terminals for corrosion.

Lithium-ion batteries, on the other hand, are lighter, more efficient, and have a longer lifespan than lead-acid batteries. They require little to no maintenance, and they can hold their charge for longer periods, making them ideal for portable electronic devices like smartphones and laptops. They also have a higher energy density, meaning they can store more energy per unit of weight or volume. Table 5 showcases a comparison between the two battery chemistries.

With advances in technology and the increasing demand for portable electronics and electric vehicles, the transition from lead-acid to lithium-ion batteries has been inevitable.

- While lithium-ion batteries growing twice as fast as lead-acid batteries, the latter is experiencing a noticeable downward trend in the country when compared to previous years(62).
- According to the Annual Survey of Industries 2019, approximately 71,636 people were employed in the manufacturing of batteries and accumulators.
- It is noteworthy that more than half of these workers are concentrated in four states: Tamil Nadu (20 percent), Andhra Pradesh (14 percent), Telangana (10 percent) and West Bengal (10 percent).

Figure 14 provides a comprehensive breakdown of employment within the battery and accumulator manufacturing industries for the country. Please note that this data pertains only to the manufacturing sector, and the information regarding employment in other areas of the value chain is limited, as discussed in the subsequent section.

Table 5: Comparison between Lead-Acid and Lithium-ion Batteries(61)

Characteristics	Lead-Acid Battery	Lithium-ion		
		Cobalt	Manganese	Phosphate
Specific Energy (Wh/kg)	30-50	150-250	100-150	90-120
Cycle Life (80%DoD)	200-300	500-1000	500-1000	1000-2000

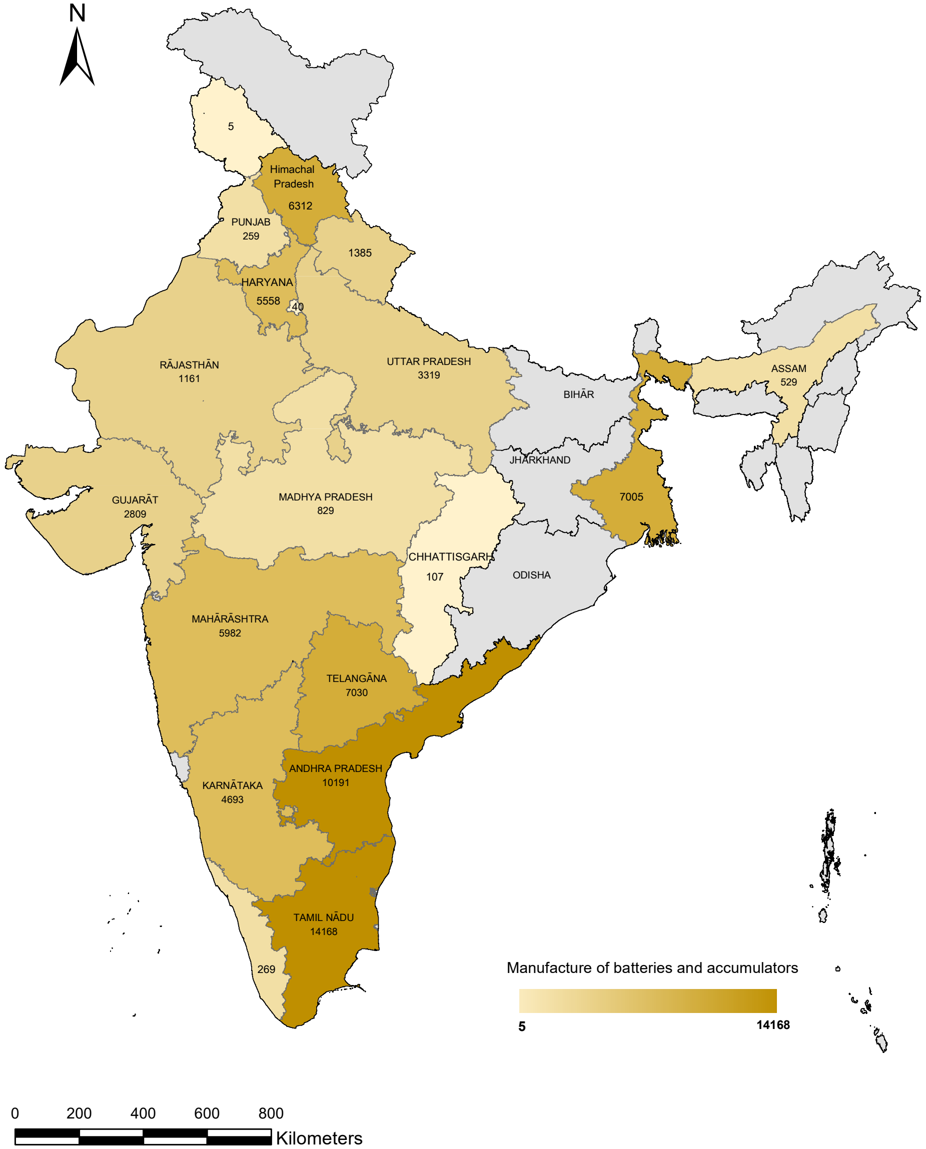
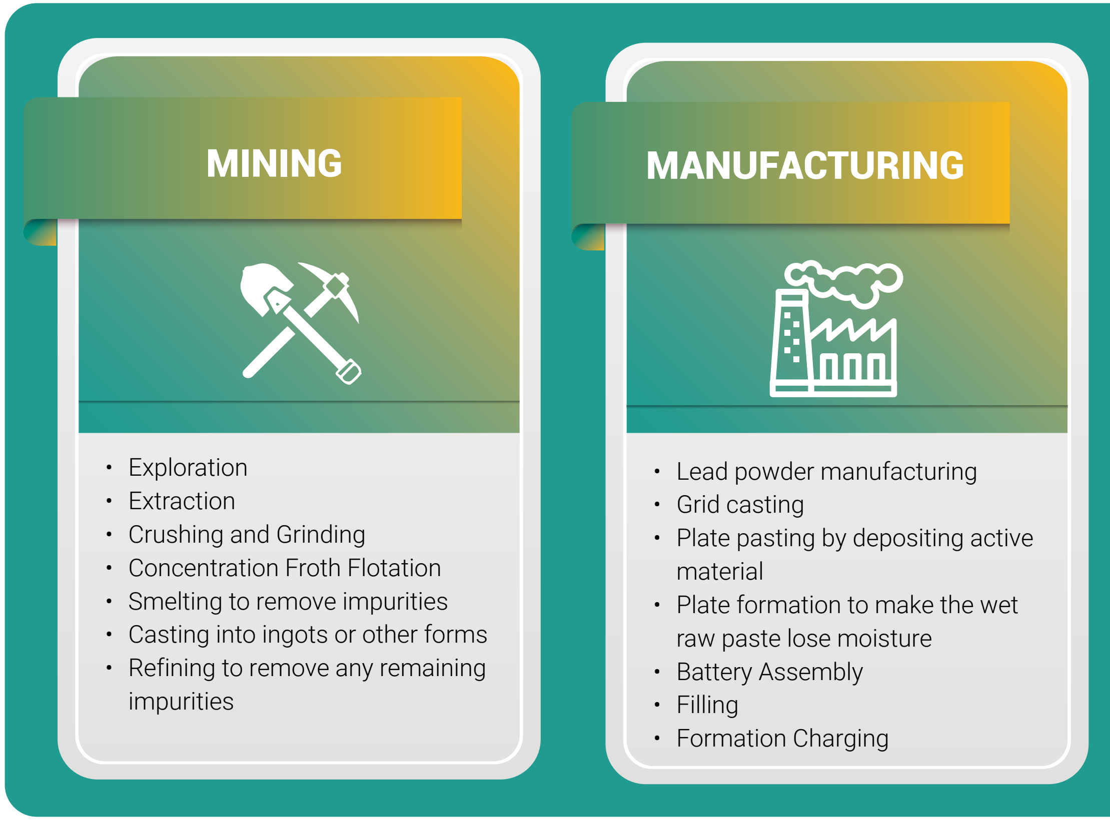


Figure 14: State-wise Estimate of Employment in Battery Sector ⁶³

Lead-Acid Battery Ecosystem

In 2021, the overall market size of lead-acid batteries in India was nearly USD 10 billion[64], with their applications primarily in transportation, industrial storage, as well as commercial and residential storage. The transportation segment, however, accounted for around 50 percent of the total market revenues in 2020[65].

In Figure 15, we have examined the interconnected elements of the lead-acid battery ecosystem in India and the impact of its transition to Li-ion batteries for each of the aspect in detail.



MINING

- Exploration
- Extraction
- Crushing and Grinding
- Concentration Froth Flotation
- Smelting to remove impurities
- Casting into ingots or other forms
- Refining to remove any remaining impurities

MANUFACTURING

- Lead powder manufacturing
- Grid casting
- Plate pasting by depositing active material
- Plate formation to make the wet raw paste lose moisture
- Battery Assembly
- Filling
- Formation Charging

Figure 15: Lead-Acid Battery Value-Chain[66], [67]

1. Mining

In 2021-22, 16.34 million tonnes of lead & zinc ores were produced, an increase of 6 percent over the previous year. Around nine private sector mines were responsible for the production of lead and zinc ore in the country with Hindustan Zinc Limited (HZL) being the leading mining entity. As shown in Table 6, interestingly, the production of lead concentrate decreased by 2 percent whereas the production of zinc concentrate increased by 5 percent during the year. Rajasthan was the only state producing lead and zinc ores and their concentrates.

Table 6: Lead-Zinc Ore Mining Capacity in India[68]

Mineral/Sector	2021-22		2020-21	
	No. of Mines	Qty. (Million Tonnes)	No. of Mines	Qty (Million Tonnes)
Lead & Zinc Ore	9	16.34	10	15.46
Public	1	-	2	-
Private	8	16.34	8	15.46

RETAILING

- Distribution
- Display
- Sales

COLLECTION

- Prescribed Collection Agents
  - Retailers under the Deposit Refund Scheme (DRS)
- Scrap Dealers
- Itinerant Collectors

RECYCLING

Formal Recycling Processes

- Pyrometallurgy
- Hydrometallurgy
- Aqua-desulphurization
- Lono-metallurgical process
- Electro-winning

Informal Recycling Processes

- Informal smelting

2. Manufacturing

The top six lead-acid battery manufacturing states in India are Maharashtra, Tamil Nadu, Telangana, West Bengal, Andhra Pradesh, and Himachal Pradesh.[69] This is based on our analysis showcasing that these states house many major battery manufacturers like Exide Industries Ltd., Amara Raja Batteries Ltd., and more and have well-developed manufacturing infrastructure in place. It is, however, difficult to determine the exact contribution of these states to the total lead-acid battery production of the country due to a lack of data.

3. Retailing

Once the batteries are manufactured, they are distributed to various customers and end-users, such as automotive manufacturers, telecom companies, and households. There is a well-developed network of distributors and dealers in India who help to market and sell the batteries. The distribution network typically includes several layers of intermediaries such as regional distributors, stockists, and retailers, that connect battery manufacturers with end-users. Multiple players participate in the market, ranging from large multinational companies to small local distributors. However, the data regarding these players is not readily available in the public domain.

4. Collection

Collection of the lead-acid batteries is a critical component of efficient battery recycling. A number of collection routes exist in India such as authorised battery dealers, scrap dealers (*Kabadiwalas*) and designated recycling facilities. The authorised battery dealers are responsible for collecting used and discarded batteries from their customers and returning them to the manufacturer or to a designated recycling facilities. These dealers are required to comply with government regulations and guidelines as well as maintain records of the batteries that are collected and disposed of.

Kabadiwalas also play an important role in the collection of lead-acid batteries. They collect used and discarded batteries from various sources, including individual households, commercial establishments, and other industries and then sell them to the recycling facilities (both formal or informal) or battery manufacturers who use them to recover valuable materials such as lead and acid.

Around 197 million Kg of battery waste is produced annually in India.[70] However, there is no information available regarding the distribution of battery waste based on their collection routes.

5. Recycling

The hazardous nature of lead-acid batteries necessitates proper recycling and disposal in order to prevent contamination of the environment. In India, there are 33 authorised lead-acid battery recyclers, such as Gravita India Ltd and Eco-Bat Technologies Ltd, that specialise in safe and sustainable recycling of lead-acid batteries[71],[72]. Despite this, there are instances of illegal and informal battery recycling occurring in several geographical areas. According to the estimates, over 90 percent of lead-acid batteries are recycled in India through the informal sector.[73]

To address the issue of informal recycling, the Government of India has implemented various policies and regulations aimed at promoting sustainable and formal recycling practices. These include the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016, which regulate the import, export, and management of hazardous waste, and the Battery Waste Management Rules, 2020, which provide guidelines for the environmentally sound management of used lead-acid batteries.

Impact of Transition Across the Battery Ecosystem

In the energy storage sector, the transition from lead-acid batteries to lithium-ion batteries is causing significant disruption, impacting both technology as well as the employment landscape across the value chain. These disruptive forces will have an impact on different segments of the value chain in different ways. In an interesting development, the sector is experiencing a rapid transformation in job roles and the associated skills required, attributed to the emergence of various employment opportunities for optimising battery manufacturing processes, enhancing efficiency, and exploring new battery chemistry. It is, however, important to acknowledge that this transition will result in some job losses, particularly in the manufacturing and recycling phases. The shift in job requirements is due to the increasing automation in newly established manufacturing units and the setting up of streamlined channels for collection, reuse, and recycling of lithium-ion batteries. Further, the ability of lithium-ion batteries to be repurposed for stationary applications during the reuse phase and the automation of the recycling process contribute to this shift. A detailed analysis of the impact is presented below:

Lead mining is expected to experience a minimal impact on the people and communities since lead is mined along with zinc and the demand for zinc will grow exponentially.

Around 4 lakh people are estimated to be employed in the manufacturing and sales of lead-acid batteries(74). The transition to Li-ion battery manufacturing will have a significant impact on these workers. Although, India's top five lead-acid battery manufacturers in India already have strategies to enter into the Li-ion domain(75), it is important to ensure that there are reskilling programs in place to enable a smooth transition for the existing workforce.

The impact on retail, distribution and collection will be minuscule, similar to that of mining. The dealers and distributors have already diversified or plan to diversify into other products like solar panels, Maximum Power Point Trackers (MPPTs), etc. While the collection agents are considering various other materials.

Another area where the impact will be significant is the recycling of batteries. Even though Lead, the main component of lead-acid batteries is toxic to human health(76), the informal sector recycles a significant share of used lead-acid batteries, thus providing major economic opportunities to them(77). As part of the transition, it is imperative to assist these workers in alternative economic activities by reskilling. This exercise, nevertheless, will be demanding since there exists heterogeneity across geographies with regard to the extent of informal recycling and the associated financial benefits that drive it.

Key Takeaways

Data Research & Analysis	• Conduct research on emerging technologies and innovations in lithium-ion batteries domain
Skill Development	• Provision of apprenticeships to transfer knowledge from the elderly to the younger workforce will go a long way. • Firm commitment to retain, retrain, and redeploy existing workforce in lithium-ion battery manufacturing or any other industry that aligns with their skill or interest will foster a sense of confidence in them.
Social Welfare	• Explore the provision of early pensions for the older workforce for a smooth transition. • Support communities heavily reliant on the lead-acid battery industry in order to help them diversify their local economies and find alternative sources of income and employment.
Institutional Set-ups	• Establish a task force or committee comprising of experts, industry representatives, and government officials to oversee the transition from lead acid to lithium-ion batteries • Foster collaboration between institutions that have successfully transitioned to lithium-ion batteries and those that are currently undergoing the transition
Financing	• Utilise District Mineral Foundation Funds to provide manufacturers with low-interest loans or grants to assist them with their transition efforts as well as support workers in their reskilling endeavors. • Explore public-private partnerships to attract private investments in the transition

07

INSTITUTIONAL TRANSFORMATION- A KEY ENABLER OF CLEAN ENERGY TRANSITION

07

INSTITUTIONAL TRANSFORMATION- A KEY ENABLER OF CLEAN ENERGY TRANSITION

Institutions and communities are the linchpins of a successful energy transition. The institutions must enable innovation and efficient allocation of resources, while maintaining flexiblility and agilility to ensure a smooth transition. Further, the decision makers within these institutions must also be open to new ideas and processes and business practices.(78)

Table 7: NTPC and Energy Transition: Key Statistics

NTPC Installed Capacity Share (as on March 2023)	NTPC RE Share (in MW)	NTPC planned capacity in 2032	NTPC planned RE share in 2032
71.95 GW	6.93 GW	130 GW	60 GW (45% share in the total capacity)

In recent years, behemoths like NTPC, CIL and IOCL have increasingly diversified their portfolios beyond conventional energy sources to include renewable energy and other greener alternatives such as green hydrogen and energy storage. This is significant for India as it sets the tone for a cleaner energy sector in the future. For instance, NTPC, the single largest thermal power company in India, through its wholly owned subsidiary, NTPC Limited, has set an ambitious target of installing 60 GW of renewable energy by 2032, which accounts for almost 45 percent of its overall power generation capacity.(79) The above table indicates that NTPC intends to develop renewable energy-based capacity only and not any new coal-based power plants. According to NTPC's Brighter Plan 2032, with 30 GW, solar energy will account for 23.2 percent share of its total capacity mix, a second highest share after coal at 85 GW. Taking a positive step towards a greener future, India's largest thermal power producer is establishing country's largest solar park in Gujarat, with a massive capacity of 4,750 MW. Further, the largest state-owned coal producer in India and globally, CIL, is foraying into green energy, cleaner transport and improving efficiency of its internal processes to achieve net zero by 2025 at its system operations level(80). It has already carried out pilot projects for battery electric trucks (BETs)(81) and further plans to implement a 3 GW solar power programme by 2023-24.

Leading oil and gas companies likes GAIL and IOCL have announced their commitment to net zero emissions and are moving ahead with the establishment of a green hydrogen economy in India. Moreover, under the FAME-II scheme, INR 800 crores have been allocated to the Oil Marketing Companies (OMCs) to set up 7,432 public EV charging stations in India by March 2024.(82) In a nut shell, all these transitions are critical for India's decarbonisation journey and therefore it is imperative to ensure that any such transition is fair, just and transparent.

Today, most of our central and state level institutions are designed to support a fossil-fuel based, more centralised and unidirectional system. However, the status quo is changing and as a result, there is an inherent need for institutional transformation, driven by climate consciousness, consumer centricity and technology that is rapidly evolving, changing functions/roles/ expectations from institutions, etc. Below is a broad assessment of the central, state and local institutions as well as the implementing agencies that will play a critical role in achieving the net zero target by 2070.

Incorporating various essential elements, the framework begins by establishing the baseline to serve as a vital starting point and reference for evaluating progress, measuring outcomes, and making well-informed decisions. It then identifies key enablers that facilitate or support the transition from the current state to a desired one. In addition, it examines the key disruptors that inhibit the business-as-usual functioning of these institutions and necessitate their involvement in the transition process. Finally, the framework emphasises the Vision 2030 that provides direction and purpose, while acting as a guiding post for achieving the desired state.

Role of Key Energy Institutions- A framework

Type of Institutions	Examples	Baseline Assessment	Enablers	Disruptors	2030 Targets
Central-level Institutions	• Power Companies -CPSEs • Oil & Gas Marketing Companies	• Traditionally fossil fuel heavy • Prioritising RE in their investment plans • Diversifying into sunrise sectors such as EVs, charging infrastructure, etc. • Characterised by intense competition among various public and private entitites	• Favourable RE policy framework & costs. • India's NDC commitment • Government incentives like Viability Gap Funding	• Plethora of health challenges from fossil fuels • Global pressure to decrease carbon emissions	• Increased share of public sector investments in renewable energy • Achieving the diversification agenda of CPSU's • Remodel/transform existing set-ups from coal/oil/gas dominated companies to energy companies.
State-level Institutions	• Discoms • State Nodal Agencies	• Riddled with operational and financial underperformance • Emerging champions promoting clean alternatives such as decentralised RE systems, charging infrastructure, rooftop solar etc	• Increased competition amongst states • Advancing market-based reforms in electricity procurement	• Bidirectional flow of power and consumer taking the centre stage.	• State of the art utilities working towards efficient service delivery • Availability and access to granular data on end use demand patterns (disaggregated by sector, type of activity, appliance)

Type of Institutions	Examples	Baseline Assessment	Enablers	Disruptors	2030 Targets
State-level Institutions	• Energy/ transport departments	• Aging, inadequate and traditional workforce • Consistently encounter low levels of custmoer satisfaction	• Renewable Purchase Obligations for Discoms • Targets set under various state policies like EV policy, solar policy, and more.	• Rapid advancement of technology such as blockchain, digitisation, artificial intelligence, internet of things for smoother operation of business processes could lead to reduced dependence on manual labour.	• Fully electrified vehicle fleet of government departments • All government department buidlings have solar rooftop systems
Urban Local Governments	• Municipal Corporation • Municipality • Town	• Heavily dependent on financial devolutions from State Governments • Inadequate fiscal and financial management systems • Currently focussed on basic amenties of heath, education,water and other public services • Conventionally focussed on socio-economic development as defined by 73rd and 74th constitutional amendments done in 1992 • Lack of autonomy to focus on city level administration	• Leveraging exisiting government financial allocations • Municipal bonds to finance new development projects. • Public private partnerships to deploy key infrastructure projects	• Changing demographic and social dynamics • Increasing urbanisation and population growth • The urgent need of meeting the twin goals of climate and sustainble development such as NDC, SDG targets by 2030	• Availability and access of data (disaggregated by gender, age, ethnicity etc) • Achieving financial and operational autonomy • Increased citizen engagement in aiding service delivery and decision making

INSTITUTIONAL TRANSFORMATION

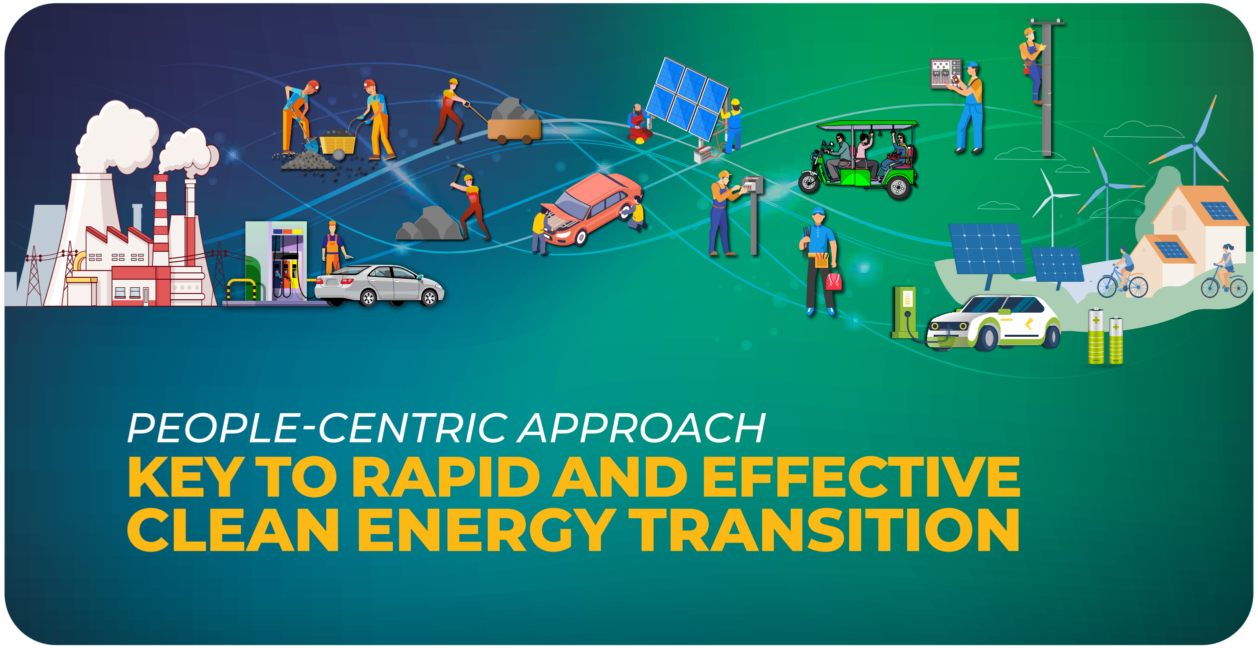
08

CONCLUSION

08

CONCLUSION

India is a large, diverse, and complex country – topographically, climatically, demographically and culturally.[83] This, when coupled with transitions, technologies and policies, creates a myriad of challenges and opportunities. As we embrace a sweeping clean energy transition journey, we are shifting away from fossil fuel-based activities to cleaner energy pathways in all key sectors – industry, buildings, power and transport. Among the many examples of clean energy transitions include the increasing penetration of renewable energy, the shift to electric vehicles, the use of green hydrogen in hard-to-abate sectors, the promotion of battery technologies, etc. These transitions are characterised by a central theme and that is the role of people, which is closely associated with both the former and the latter parts of the current and changing system.



New opportunities lead to employment generation, which results in improved economic opportunities and socio-economic status. Transition, however, causes dislocation[84] and obsolete occupations that result in increased vulnerability for marginalised communities, jeopardise traditional practices and further impact the socio-economic equilibrium. The energy transition will alter most incumbent occupations with respect to task compositions, structural changes and lead to alternative jobs that will require new skills and capacities. There is also a need to foster collaboration, policy coordination and capacity building and upskilling – reskilling efforts at all levels and for the entire stakeholder value chain. Though, any energy transition is driven by technological solutions, it is the social acceptance, community cooperation/participation and institutional strengthening that will ensure its ultimate success.[85]

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Vasudha Foundation is a non-profit organisation set up in 2010. We believe in the conservation of 'Vasudha', which in Sanskrit means the Earth, the giver of wealth, with the objective of promoting sustainable consumption of its bounties.

Our mission is to promote environment-friendly, socially just and sustainable models of energy by focusing on renewable energy and energy-efficient technologies as well as sustainable lifestyle solutions. Through an innovative approach and data-driven analysis, creation of data repositories with cross-sectoral analysis, along with outreach to ensure resource conservation, we aim to help create a sustainable and inclusive future for India and Mother Earth.

VASUDHA
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Green ways for a good earth!

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