ROUTLEDGE

THE ROLE OF COAL IN A SUSTAINABLE ENERGY MIX FOR INDIA

A WIDE-ANGLE VIEW

EDITED BY
Mritiunjoy Mohanty and Runa Sarkar

The Role of Coal in a Sustainable Energy Mix for India

As India switches away from a coal-based to a more sustainable energy use pattern, which pathway will it adopt? What is the nature of challenges that it will face, and who will be affected? Who will gain? This volume offers insights into the steps and challenges involved in this transition and addresses some urgent questions about the possible pathways for India's renewable energy generation.

Including contributions from researchers, policymakers, and practitioners, it draws on different disciplines, ranging from science and technology to economics and sociology, and situates the issue of low carbon transition within an interdisciplinary framework. India has committed to gradual decarbonisation of its economy. This book takes this as its starting point and uses a wide-angle lens, incorporating macro as well as micro views, to understand the possible next steps as well as trade-offs that will inevitably be posed. It incorporates the perspectives of all stakeholders ranging from central and state governments, public and private sector firms, on the one hand, to individuals and local communities, on the other, to explore their role in the transition, their interests, and how these will change and evolve.

This timely volume will be of interest to students and researchers of environmental studies, development studies, environmental economics, political studies, and Asian studies. It will also be useful to academics, practitioners, and policymakers working on issues related to climate change, sustainable development, energy policy and economics, and public policy.

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Preface and Acknowledgements

Established in 1998 as an interdisciplinary platform, the Centre for Development and Environment Policy (CDEP) at IIM Calcutta has a mandate of addressing, through research, teaching as well as training, the complex relationship between economic activities and the natural environment. When a new committee took over the activities of the Centre in July 2021, it decided to choose energy transition as a focus area of its activities. Coincidentally, around the same time, Mr Sumant Sinha, Chairman and CEO of Renew Power, and then, a board member of IIM Calcutta, introduced CDEP to Mr Kartikeya Singh of the Stichting SED Fund (now with Global Energy Futures Initiative), with the idea of connecting academia to civil society organisations working in this area. Soon, CDEP was talking to organisations such as International Institute for Sustainable Development (IISD), Institute for Energy Economics and Financial Analysis (IEEFA), and Climate Policy Initiative (CPI), and the Building Roadmaps for Industrial Decarbonisation and Green Economy (BRIDGE) initiative took shape.

The BRIDGE initiative aims to create knowledge and knowledge bases on how to accomplish an effective and just carbon transition through developing a network of professionals working in the area of low carbon transition financing and strategy and disseminate the new knowledge on how public and private energy firms can adapt to energy transition through open-source networks. Further, it intends to develop policy advisories to focus attention towards just carbon transition for business using non-partisan analysis and research for discussion on this broad econo-socio-technical issue. In addition, it endeavours to build awareness, and train executives of public and private energy firms in evolving best practices on transition in India and other developing nations as well as postgraduate and doctoral students on low carbon transition finance and strategy.

This volume titled *The Role of Coal in a Sustainable Energy Mix for India: A Wide-angle View* is one of the many outcomes of the BRIDGE initiative. While its findings have a clear policy orientation and will, hopefully, inform policymakers in the government and decision makers in the corporate work world, the primary objective of this edited book is to formulate a research agenda for developing pathways towards transition to low carbon economy and creating knowledge support systems to enable a Just Transition. We hope, therefore, that this volume will be a one-stop shop for anyone looking for extant and evolving knowledge, both in terms of theory and its applications, related to transition to low carbon for the coal-fired power industry in India.

The journey towards bringing together this manuscript began around the end of 2021 over several online meetings with researchers and practitioners from CPI,

IEEFA, and IISD along with members of the CDEP committee. After several deliberations, we zeroed in on coal, the power sector, and India as the themes for the first volume. Over numerous meetings, online and, in person, an editorial committee comprising Christopher Beaton, Dhruba Purkayastha, Mritiunjoy Mohanty, and Runa Sarkar worked together to identify potential contributors. This was followed by a two-day workshop in May 2022 at the IIM Calcutta campus, attended by more than 30 researchers and policy practitioners from varied disciplines like Economics, Finance, Political Science, Environment Studies, and Climate Change for brainstorming and formulating ideas. The importance of a dialogue between research and policy through implementable solutions, taking into account not just the techno-economic interests but also the socio-economic considerations, given the existence of a large informal economy and labour market in India was the key takeaway from the deliberations.

The editorial committee then worked together in finalising the title for the volume and selecting and categorising the contributions and arriving at the preliminary structure. The contributions went through a first round of peer review, followed by a write/workshop at IIM Calcutta in December 2022 to enable conversations across contributions while weaving them together. Forty delegates from 24 institutes attended the writeshop. Mritiunjoy Mohanty and Runa Sarkar then took over the more hands-on editorial tasks, including connecting with Routledge for the publication of the volume.

Now that we are at the last milestone of this journey that commenced over a year and a half ago, we look back and realise that none of this would have been possible if the then Director-in-charge Prof. Subir Bhattacharya, had not connected CDEP with Mr Sumant Sinha and Mr Kartikeya Singh. This volume is the outcome of their vision and support. The guiding role played by Mr Christopher Beaton, Dr Dhruba Purkayastha, Ms Vibhuti Garg, and Mr Balasubramanian Viswanathan has been exemplary. Support from the Stichting SED Fund, specifically from Mr Vikas Mehta, Ms Milagros Falus, Ms Shaily Jha, and Mr Sai Siddharth is deeply acknowledged. We are grateful to our doctoral students, Arunika Mishra, Shreyasee Das, Samhita Kasibhatta, Himadri Shekhar Chakrabarty, Ravi Satpute, Manhar Manchanda, and Aiman Nida, who rapporteured for the two brainstorming workshops held at IIM Calcutta.

The unstinted support of IIM Calcutta's Director, Prof. Uttam Kumar Sarkar, faculty, and staff has ensured that this volume has seen the light of day. We wish to place on record our gratitude to Prof. Krishanu Rakshit, and members of the CDEP committee, namely, Prof. Bhaskar Chakrabarti and Prof. Manish Thakur, Prof Sumanta Basu, Prof Kaushik Roy, Prof. Randhir Kumar, and Prof. Arnab Bhattacharya, who working as a team, contributed to different aspects of BRIDGE and bottom lined both the workshops. Prathamesh Mokal and Swathy Swaminathan have spent enormous time and effort behind the scenes, putting together this volume with 21 chapters, 5 boxes, 11 appendices and 57 contributors, including putting up with two cantankerous editors. A big thank you to them!

The team at Routledge has had to be very patient and put up with innumerable changes and postponements. Ms Shoma Choudhury was an enthusiastic supporter of our project from the very first time we mentioned it to her. The painstaking and careful copyediting work of Mr Sanjeevi Nagarajan and his team was invaluable and has added to the volume's readability and clarity. We remain indebted to them.

Finally, we cannot thank enough, every workshop and writeshop attendee and contributors to this volume. Interactions with each one of you have enriched us in myriad ways and we have been humbled by the support received from all of you to ensure that this volume actually sees the light of day. That today there is a network of academics and policy practitioners working together and sharing ideas at the frontiers of climate change is perhaps the biggest gift of this volume.

Mritiunjoy Mohanty and Runa Sarkar

Abbreviations

ACC	Advanced Cell Chemistry
AD	Aggressive Decarbonisation
AEM	Anion Exchange Membrane
AF	Adaptation Fund
AIF	Alternate Investment Fund
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
APS	Announced Pledges Scenario
APTEL	Appellate Tribunal for Electricity
ASI	Annual Survey of Industry
AT&C	Aggregate Technical and Commercial
AUM	Assets under Management
BAT	Best Available Techniques
BAU	Business as Usual
BCC	Banker Charnes and Cooper
BCCL	Bharat Coking Coal Limited
BCD	Basic Custom Duty
BESS	Battery and Energy Storage Systems
BEVs	Battery Electric Vehicles
BHEL	Bharat Heavy Electricals Limited
BMCs	Biodiversity Management Committees
BPS	Battery Procurement Standards
BRSR	Business Responsibility and Sustainability Report
BTPS	Badarpur Thermal Power Station
BTU	British Thermal Unit
BU	Billion Units
C&I	Commercial and Industrial
CAES	Compressed Air Energy Storage
CAFÉ	Corporate Average Fuel Economy
CAGR	Compounded Annual Growth Rate
CAPEX	Capital Expenditure
CBDR	Common but Differentiated Responsibilities
CBI	Climate Bond Initiative
CCL	Central Coalfield Limited
CCS	Carbon capture and storage
CCT	Clean Coal Technology
CCUS	Carbon Capture, Utilisation, and Storage

CDS	Credit Default Swaps
CEA	Central Electricity Authority
CEEP	Centre for Energy, Environment and People
CERC	Central Electricity Regulatory Commission
CESC	Calcutta Electric Supply Corporation Limited
CFA	Central Financial Assistance
CFaR	Cash Flow at Risk
CGTMSE	Credit Guarantee Fund Trust for Micro and Small Enterprise
CIF	Climate Investment Fund
CIL	Coal India Limited
COE-H	Centre of Excellence on Hydrogen
COP	Conference of Parties
COPa	Conference of Panchayats
COPD	Chronic Obstructive Pulmonary Disease
COSATU	Congress of South African Trade Union
CPI	Climate Policy Initiative
CPPAs	Corporate Power Purchase Agreements
CREA	Centre for Research on Energy and Clean Air
CREDA	Chhattisgarh State Renewable Energy Development Agency
CSO	Civil Society Organization
CSR	Corporate Social Responsibility
CSV	Creating Shared Value
CTF	Clean Technology Fund
CWIP	Capital Work-in-Progress
DDUGJY	Deen Dayal Upadhyaya Gram Jyoti Yojana
DEA	Data Envelopment Analysis
DII	domestic institutional investors
DISCOM	Distribution Company
DMF	District Mineral Foundation
DMinF	District Mineral Fund
DMRE	Department of Mineral Resources and Energy
DMU	Decision-Making Unit
DRE	Distributed Renewable Energy
DST	Department of Science and Technology
DVC	Damodar Valley Corporation
EA	Electricity Act
EaaS	Energy-as-a-Service
ECB	External Commercial Borrowing
ECBC	Electricity Conservation Building Code
EcES	Electrochemical Energy Storage System
ECL	Eastern Coalfield Limited
EDLI	Employees Deposit Linked Insurance Scheme
EES	Electrical Energy Storage
EESL	Energy Efficiency Services Limited
EGP	Enel Green Power
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EPF	Employees' Provident Funds

EPFO	Employee Provident Fund Organisation
EPS	Electric Power Survey
ESG	Environmental Social and Governance
ESS	Energy Storage System
ET	Economic Times
ETFs	Exchange Traded Funds
EU	European Union
EV	Electric Vehicle
FAME	Faster Adoption and Manufacturing of Electric Vehicles
FES	Flywheel Energy Storage
FI	Financial Institution
FID	Final Investment Decision
FLDG	First Loss Default Guarantee
FPL	Florida Power and Light
FPO	Farmer Producer Organisations
FRA	Forest Rights Act
FY	Fiscal Year
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEM	Global Energy Monitor
GEMo	Green Economy Model
GHG	Greenhouse Gas
GIB	Great Indian Bustard
GIS	Geographic Information System
GNDTP	Guru Nanak Dev Thermal Power Plant
GoI	Government of India
GSDP	Gross State Domestic Product
GSS	Green, Social, Sustainability
GVA	Gross Value Added
GW	Giga Watts
GWh	Gigawatt-Hour
HCI	Heavy and Chemical Industry
HDI	Human Development Index
HPO	Hydro Purchase Obligation
HTES	High-Temperature Energy Storage
ICE	Internal Combustion Engine
ICMA	International Capital Market Association
IDDI	Industrial Deep Decarbonisation Initiative
IDF	Infrastructure Debt Fund
IEA	International Energy Agency
IEEFA	Institute for Energy Economics and Financial Analysis
IGCC	Integrated Gasification Combined Cycle
IH2A	India Hydrogen Alliance
IIP	Index Of Industrial Production
IISc	Indian Institute of Science
IISCO	Indian Iron and Steel Company
IISD	International Institute for Sustainable Development

ILO	International Labour Organization
InvIT	Investment Trust
InvITs	Infrastructure Investment Trusts
IOC	Indian Oil Corporation
IoT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
IPG	International Policy Group
IPPs	Independent Power Producers
IPSF	International Platform for Sustainable Finance
IR	Indian Railway
IRA	Inflation Reduction Act
IRDAI	Insurance Regulatory and Development Authority of India
IREDA	Indian Renewable Energy Development Agency
IRENA	International Renewable Energy Agency
IRP	Integrated Resource Plan
ISRO	Indian Space Research Organization
JETP	Just Energy Transition Partnership
JREDA	Jharkhand Renewable Energy Development Agency
JSLPS	Jharkhand State Livelihood Promotion Society
JT	Just Transition
JTAC	Just Transition Advisory Committee
JV	Joint Venture
KILA	Kerala Institute of Local Administration
KPI	Key Performance Indicator
KSTPS	Kota Super Thermal Power Station
KTPS	Khaperkheda Thermal Power Station
L&T	Larsen and Toubro
LCOE	Levelized Cost of Electricity
LDES	Long Duration Energy Storage
LE	Life Extension
LIC	Life Insurance Corporation of India
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LSG	Local Self-governance
LTES	Low-Temperature Energy Storage
LTO	Lithium Titanate
MAHAGENCO	Maharashtra State Power Generation Company
MBD	Multilateral Development Banks
MBED	Market-Based Economic Despatch
MCDA	Multi-Criteria Decision Analysis
MCL	Mahanadi Coalfield Limited
MDO	Mine-Developer-Cum-Operator
MEA	Ministry of External Affairs
MES	Mechanical Energy Storage System
METI	Ministry of Economy, Trade and Industry
MIDH	Mission for Integrated Development of Horticulture
MMDR	Mines and Minerals (Development and Regulation)
MNRE	Ministry of New and Renewable Energy

MOC	Ministry of Coal
MoEFCC	Ministry of Environment, Forest, and Climate Change
MoF	Ministry of Finance
MoP	Ministry of Power
MoPNG	Ministry of Petroleum and Natural Gas
MoSPI	Ministry of Statistics and Programme Implementation
MOU	Memorandum of Understanding
MPCB	Maharashtra Pollution Control Board
MSME	Micro, Small, Medium Enterprise
MT	Million Tonnes
MtCO2e	Metric Tonnes of Carbon Dioxide Equivalent
MTEE	Market Transformation for Energy Efficiency
MTOE	Million Tonnes of Oil Equivalent
MTPA	Million Tonnes per Annum
MUDRA	Micro Units Development and Refinance Agency
MW	Mega Watts
NABARD	National Bank for Agriculture and Rural Development
NAPCC	National Action Plan on Climate Change
NBA	National Biodiversity Authority
NBFC	Non-Bank Finance Company
NBFI	Non-Banking Financial Institution
NCL	Northern Coalfield Limited
NCLT	National Company Law Tribunal
NDA	National Designated Authority
NDA	National Democratic Alliance
NDC	Nationally Determined Contribution
NEC	North Eastern Coalfields
NEDLAC	National Economic Development and Labour Council
NEMMP	National Electric Mobility Mission Plan
NEP	National Electricity Plan
NETRA	NTPC Energy Technology Research Alliance
NGO	Non-Governmental Organization
NGT	National Green Tribunal
NHM	National Hydrogen Energy Mission
NHPC	National Hydroelectric Power Corporation
NLC	Neyveli Lignite Corporation
NLDC	National Load Despatch Centre
NMEEE	National Mission on Enhanced Energy Efficiency
NMET	National Mining Exploration Tax
NNBOMP	New National Biogas And Organic Manure Programme
NOC	No-Objection Certificate
NPAs	Non-Performing Assets
NPC	National Planning Commission
NPS	National Pension Scheme
NPV	Net Present Value
NREL	National Renewable Energy Laboratory
NTPC	National Thermal Power Corporation
O&M	Operations and Maintenance

OB	Over Burden
OECD	Organization for Economic Cooperation and Development
OEM	Original Equipment Manufacturer
OJT	Office of Just Transition
ONGC	Oil and Natural Gas Corporation
OPG	Ontario Power Generation
PAT	Perform-Achieve-Trade
PCC	Presidential Climate Change Commission
PDAG	Policy and Development Advisory Group
PESA	Panchayat Extension to Scheduled Areas
PFC	Power Finance Corporation
PFRDA	Pension Fund Regulatory and Development Authority
PHS	Pumped Hydro Storage Systems
PIB	Press Information Bureau
PLF	Plant Load Factor
PLI	Production-Linked Incentive
PM-KUSUM	Pradhan Mantri Kisan Urja Suraksha Evam Utthan Mahabhiyan Scheme
PMFME	PM Formalisation of Micro Food Processing Enterprises
PMKSY	Pradhan Mantri Krishi Sinchayee Yojana
PMP	Phased Manufacturing Programme
PMUY	Pradhan Mantri Ujjwala Yojana
PPA	Power Purchase Agreement
PRC	Peak Rated Capacity
PSA	Power Sales Agreements
PSP	Pumped Hydro Projects
PSPCL	Punjab State Power Corporation Limited
PSU	Public Sector Undertaking
PUDA	Punjab Urban Development Authority
R&D	Research and Development
R&M	Renovation and Modernisation
RCAT	Redirecting Capital for Accelerated Transition
RE	Renewable Energy
REC	Rural Energy Corporation
REITs	Real Estate Investment Trusts
RES	Renewable Energy Sources
RIL	Reliance Industries Limited
RKVY	Rashtriya Krishi Vikas Yojana
RPO	Renewable Purchase Obligation
RPS	Renewable Portfolio Standards
RTC	Round the Clock
RVUNL	Rajasthan Rajya Vidyut Utpadan Nigam Limited
SAUBHAGYA	Sahaj Bijli Har Ghar Yojana
SBB	State Biodiversity Board
SBM-DEA	Slacks-Based Measure-Data Envelopment Analysis
SBTi	Science-Based Target Initiative
SCCL	Singareni Collieries Company Limited
SDG	Sustainable Development Goal

SDP	State Domestic Product
SDS	Sustainable Development Scenario
SEB	State Electricity Board
SEBI	Securities and Exchange Board of India
SECI	Solar Energy Corporation of India
SECL	South Eastern Coal Field Limited
SERC	State Electricity Regulatory Commissions
SEZ	Special Economic Zone
SHG	Self Help Group
SIDBI	Small Industrial Development Bank of India
SIP	Systematic Investment Planning
SJRP	Sector Jobs Resilience Plan
SLB	Sustainability-Linked Bond
SLF	Sustainability-Linked Finance
SLGB	Sustainability-Linked Green Bond
SLNP	Street Lighting National Programme
SMES	Superconducting Magnetic Energy Storage
SOE	State-Owned Enterprises
SPTs	Sustainability Performance Targets
SPVs	Special Purpose Vehicles
ST&D	Sub-Transmission & Distribution
STEPS	Stated Policies Scenario
SWM	Solid Waste Management
SynCON	Synchronous Condenser
TERI	The Energy and Resources Institute
TES	Thermal Energy Storage
TISCO	Tata Iron and Steel Company
TOR	Terms of References
TPI	Transition Pathway Initiative
TPP	Thermal Power Plants
TWh	Terawatt Hour
UDAY	Ujjwal Discom Assurance Yojana
UJALA	Unnat Jyoti By Affordable Led For All
ULIP	Unit-Linked Investment Plans
UN SDGs	United Nations Sustainable Development Goals
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention On Climate Change
UNIDO	United Nations Industrial Development Organization
UT	Union Territory
VPPA	Virtual Power Purchase Agreement
VRE	Variable RE
WCL	Western Coalfield Limited

Introduction

Mritiunjoy Mohanty and Runa Sarkar

Context

That climate change, with all its deleterious effects, is upon us is an undisputed truth. It is also accepted universally that the impact of climate change will be much harsher on the global south rather than the global north. Specifically, it will be harsh on India, given its per capita income level, its geographical latitudinal location, the long coastline of peninsular India, the mountain ranges of the Hindu Kush, and the Himalayas framing South Asia's northern borders. The accumulation of CO_2 and CO_2 equivalent gases in the earth's atmosphere is believed to be responsible for the gradual increase in global temperatures which have led to climate change. One of the indisputable ways to mitigate the impact of climate change is, therefore, to reduce the amount of CO_2 and CO_2-equivalent gases emitted into the earth's atmosphere. The burning of fossil fuels, which are essentially fossilised carbon sinks formed over millennia, is a primary source of CO_2. As a result, the decarbonisation of the energy sector has been gaining increased attention recently, as is evident in the recent Conference of Parties (COP) meetings across the world, with countries making net-zero commitments with respect to CO_2 emissions and updating Nationally Determined Contributions (NDCs) made to the United Nations Framework Convention on Climate Change (UNFCCC).

India, given its vast population and its current trajectory, will be one of the engines of global growth for the next few decades. In general, economic growth is propelled by a greater use of energy. This is even more true for India where one of the objectives of economic growth is to provide access to (electrical) energy to a vast population that still does not have it while making electricity affordable for all. The largest source of electricity generation in India is the burning of coal as it is available easily, and, arguably, the cheapest way to generate electricity as to date. At the same time, India, being the fourth-largest emitter of GHGs in the world (however, 140th in per capita emissions terms), recognises that its involvement in the global decarbonisation effort will be crucial as the major economies of the world move towards net-zero emissions targets by the middle of the twenty-first century. More importantly, green technologies can also be an alternate route to economic growth, development, and job creation as they become more affordable and effective.

While it is commonly acknowledged that the most obvious way to achieve decarbonisation is the use of renewable energy, the complexity of the interdependencies between the secondary energy carriers and end-use energy sectors cannot be underestimated. The entire economic system is locked into fossil fuel (specifically coal)–based energy and transportation systems through path-dependent processes driven by the irrefutable logic

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of increasing returns to scale. These technological systems, established through a co-evolutionary process among technological infrastructures, organisations, society, and governing institutions, create a sense of stability, predictability, and possibly reliability in the system, thereby creating inertial resistance when a change away from fossil fuels is considered. Moreover, these systems support and nurture the economic activity, identity, and sustenance of a large fraction of the population of the country. Therefore, any change must also keep squarely in focus their livelihoods and well-being. In addition, the Ukraine war has prioritised energy security as an area of attention for all countries globally. In that context, it is understandable that India, with its vast resources of coal and ample access to solar energy, would give greater weightage to these two sources in its energy mix, while trying to balance sustainability with energy security. Yet, given the writing on the wall, phasing down coal cannot be ignored.

A review of various government announcements, policies, roadmaps, targets, and scenarios forecast leads to the belief that while the Indian government has set goals and announced targets towards a low carbon future, and made some progress in that direction, there still remains a lack of clarity on both the path(s) and the means of achieving these. Alternate pathways to a low carbon future for India would be a combination of three generic policy approaches which are progressively disruptive of existing technological systems, namely focus on end-of-pipe solutions without too many changes to the source of carbon emissions; modify selected components or processes of the system, but maintain the overall system architecture, that is, fortify the fossil fuel–based backbone of energy systems with incremental improvements and efficiency based interventions; and replace the energy systems entirely with alternative sources of energy such as renewables.

Transition has to be systemic, involving people, technology, and finance. Ensuring sustainability in the energy mix is particularly challenging when it is not directly in consonance with energy security, affordability, and access.

There are many pathways to achieve India's nationally determined contribution commitments, and there has been a lot of research and discussion on the role of coal in shaping these paths. Intellectual and policy contributions on the state of extant power transmission and distribution companies on how to price and promote solar and wind energy and on the concerns of a just energy transition abound. What this volume seeks to do is to employ a cross-cutting approach to weave together occasionally divergent lines of specialised thought into a tapestry that demystifies the challenges of and approach towards moving on to a more sustainable energy path (mix) for India. It takes stock of the current knowledge in this area and identifies the research gaps. It does not intend to replicate existing work but has brought together scholars and policy practitioners working in the area to deliberate on how to go forward and build on each other's research. It has been successful in bringing 57 researchers, policy advocates, and practitioners from 30 different institutions to sit across the table and discuss their perspectives and finally put them together as contributions to the volume.

Most of the contributions in this volume are collaborative efforts of two or more institutions, demonstrating the specialised, yet interdisciplinary nature of both the issue at hand and their own work. It is this cross-cutting, interdisciplinary, and plural approach to conversations around energy transition which we think differentiates this volume from the many excellent offerings available in this area. We hope that the volume will inform deliberations of the G20 as they focus on the decarbonisation challenges of the global south and will be useful to policymakers as they ideate how to fashion India's transition pathway to meet its net-zero goal by 2070.

As climate history tells us, energy transitions are not new to India (or to the world). The move away from bio-mass as the primary source of fuel to coal and oil and gas was a result of demand-side technologies that improved the quality of human life. The transition from gas lights to electrification was also disruptive and demand driven. The current energy transition away from fossil fuels is different for two reasons. First, the transition, driven by concerns over climate change, will be driven largely by policy rather than pulled by demand. The role of policymakers could ensure a more orderly transition, one where the ramp-down of high- CO_2 emitting assets is carefully coordinated with the ramp-up of low- CO_2 emitting ones and which is supported by the appropriate redundancy and resiliency measures. However, there is a fear that in the process it could also decelerate the process resulting in graver economic damage from climate change. Second, from the very beginning, both the notion of and focus on a Just Transition have been built into the process, which was lacking in any of the past energy transitions. Ensuring that the impact of the energy transition on people, both directly and indirectly associated with or affected by it, is considered and ameliorated as part of the transition process is one of the *fundamental principles* enshrined in any energy transition policy followed today. In that spirit, besides being cross-cutting and plural, the other defining feature of the volume is that the concept of Just Transition runs as a common thread through each of the four sections, rather than being addressed in an independent section.

Chapters

In the first section (*A Macroeconomic Analysis of Alternate Pathways*) of the volume, in Chapter 1 (*India's coal and coal-fired electricity needs by 2030*) **Dahiya et al** present a macroeconomic analysis of the multiple pathways towards a sustainable energy mix for India and argue that India's coal needs have been consistently overestimated. After an analytical assessment of India's energy needs and the availability of extant coal to address it, in Chapter 2 (*India's Energy Trilemma and Coal-based Power Generation)* **Basu and Nayak** address the challenges of the trilemma of energy access, affordability, and security faced by India and its impact on transition choices. In Chapter 3 (*Energy Transition and Centre-State Priorities*) **Tirthankar Mandal** explores the role of federalism and conversations between central and state governments in initiating and enabling the transition, its macroeconomic impact, and specifically the social costs involved. **Ray et al** discuss the macroeconomic implications of a coal phase down in Chapter 4 (*Macroeconomic Impacts of Coal Transition*). **Sharma and Loginova** draw on international experience to understand the social costs of a coal phase down in Chapter 5 (*The social costs of India's energy transition*). In Chapter 6 (*Deep Electrification in India*), which concludes Section 1, **Shukla et al** discuss the state of play with respect to deep electrification as a complementary strategy to be implemented alongside the movement away from fossil fuel–based energy.

The next section (*Governance and Policy Perspectives*) brings together discussions on transition from a policy perspective, both normative and positive. **Grover et al** take a normative view in Chapter 7 (*Governance Principles for a Just Energy Transition*) and propose broad principles for a people-centred transition within India's constitutional framework and India's development paradigm. This is followed by **Shukla and Pachauri's** positive analysis in Chapter 8 (*Policy Framework for Energy Transition in India*) of the extant policy landscape in terms of its objectives, governance mechanisms, tools of regulation. **Mohanty et al** in Chapter 9 (*Industrial Policy 2.0*) discuss the resurgence in the use of industrial policy in the context of new evidence about its effectiveness both in terms of technological catch-up, as well as technological change, and its key role therefore in adapting to climate change. **Joshi and Dsouza** draw on international experience to outline lessons for India in charting a just energy transition in Chapter 10 (*International Experiences on Just Energy Transition Planning and lessons for India*). The section closes with Chapter 11 (*Grounded Perspectives on Energy Transition*) where **Pai et al** give us a grounded perspective from Jharkhand, a mineral-rich state of India, making a case for a bottom-up approach by including the voices of the local communities in this discourse.

Systemic transitions will always create opportunities for some industries while presenting challenging circumstances for others. Section three (*Industry: Opportunities and Challenges*) explores some of these. Given the size and impact of the coal-fired power sector in India, which will be at the receiving end of a coal phase-down, the first three chapters of the section analyse how to improve the efficiency of these power plants and their retrofits and repurposing. Chapter 12 (*Retrofit decarbonisation and Reutilization of Thermal Power Plants*) opens this section with an analysis by **Bhattacharjee and Sen** on the possibilities of reuse of resources formerly used by decommissioned thermal plants. In Chapter 13 (*Future-proofing India's coal PSUs*) **Khurana et al** assess diversification strategies of two of India's largest state-owned enterprises, Coal India Limited and NTPC, in terms of their future readiness to continue to dominate in the energy sector where coal may not be the most prominent fuel. **Sabuj Mandal** carries out a state level analysis of thermal power plants in terms of their energy efficiency in Chapter 14 (*An evaluation of energy and environmental efficiency of the Indian Thermal power plants*). In Chapter 15 (*Energy storage and its potential role in electricity transition*) **Thakare and Sreehari** explore the role of and opportunities for the energy storage industry in a successful transition to renewable energy use. Finally, the section closes with **Majumdarr et al** analysing in Chapter 16 (*International Experiences*) experiences and best practices of other large conglomerates from across the world both in transitioning away from coal as well as renewable energy generation.

Concerns around the availability of finance are a recurrent theme in almost all the previous discussions, and the last section (*Investors and Shareholders*) addresses just that. In Chapter 17 (*Financing India's 2030 NDC targets and beyond*) the first chapter of this section, **Singh and Kumar** point out that of the four major debt financing engines, domestic banks, domestic bond markets, foreign institutional funding, and international green bonds, only domestic banks and international bonds are responsible for the flows of funds for the energy transition. Sovereign wealth and pension funds dominate the equity side. In Chapter 18 (*Transition Finance*) **Sikka et al** explore financing transition technologies from the perspective of financial institutions, identifying the lack of an enabling environment, innovative financial instruments, and a high cost of capital as inhibiting flows. These challenges, and possible solutions, are then explored further in the context of domestic institutional investors in Chapter 19 (*Role of Domestic Institutional Capital in Funding India's Energy Transition*) by **Shantanu Srivastava**. In Chapter 20 (*Operationalising Just Transition in India*) **Kumar and Tandon** take a pragmatic approach to managing and augmenting public and private financial flows by mapping issues arising from Just Transition, and its impact across the financial sector, firms, and people. The section ends with Chapter 21 (*International Climate Financing and Just Energy Transition*) where **Swarnakar and Shukla** explore the potential of climate financing to deliver distributive and procedural justice in the Just Transition process.

Each section also has its own introduction, introducing chapters contained.

What the Volume Does Not Cover

When embarking on a quest on a subject as ambitious as the role of coal in a sustainable energy mix for India, it is to be expected that there would be many matters that are germane to the area but which may not have been adequately covered in this volume. Given below is a listing of a few important areas, in our understanding, which needs to be debated and discussed as we chart out a transition path to a sustainable energy future.

For example, while there is some discussion on how large corporate India is doing its bit, benchmarked with the companies from the rest of the world, there is little-to-no discussion on what is happening to the MSMEs or to the proverbial missing middle of India's industry. CDEP's own interaction with MSMEs suggests that this is not necessarily because they are unaware of the challenges or lack interest. MSMEs need to be incorporated into this discussion for two different reasons – first, MSMEs contribute a significant portion of non-agricultural value-added and the bulk of employment, raising the salience of their success (or otherwise) in transition; second, in adopting transition paths, MSMEs will have very different requirements and constraints as compared with large corporates, necessitating a different institutional response. Further, we are aware that an ever-greater number of companies are recognizing how shifting investor preferences, as well as changes in technology, regulation, and consumer behaviours, are changing the basis for competition and are calling for an altogether greater level of global and local collaboration. We have been unable to delve into these aspects in this volume, although there is a rich literature available in this area and several Indian firms have taken commendable strides towards changing their energy mix because of such drivers.

Despite significant declines in poverty levels as a result of rapid growth, in India, a substantial proportion of the population still lives below the poverty line. Using the extended Tendulkar poverty line and NSSO's Employment and Unemployment Surveys for 2011–2012 and 2019–2020 and making appropriate adjustments to ensure comparability, Santosh Mehrotra and Jajati Parida estimate that in 2019–2020 India's headcount poverty ratio stood at 20.8% ('Poor Economics: Has India's Poverty Really Fallen?' Santosh Mehrotra and Jajati Parida, Financial Express, 30.04.2022). Ideally, over the next decade or so India has to grow fast enough not only to ensure that this poverty is wiped out but also that consumption levels, which even after crossing the poverty line remain abysmally low, rise substantially. That is to say, at the lower deciles, consumption should grow faster than GDP, implying a decline in inequality. The implications for CO_2 emissions for a growth path where consumption inequality falls have not been addressed in this volume. Ideally what we should aim for is a decline in the carbon intensity of consumption even as the consumption levels of the poor increase in both relative and absolute terms, allowing CO_2 emissions to decline even as consumption rises.

Another area that has not been touched upon at all in this volume is the linkages of a transition to a sustainable energy mix to climate change adaptation measures. Reliable and affordable renewable energy services could provide a 'greener infrastructure' for the most climate-vulnerable countries or sectors. Specific adaptation needs and potential renewables-based solutions in water, food, agriculture, and forestry; natural disaster response; oceans, coasts, and small islands; and human health, have been explored in a global context, but there is room for further work contextualising this research for India.

On a related matter, there are interventions on the demand side that involve behavioural changes to reduce the extent of consumption of energy. Important as these be, this volume, however, does not deliberate on demand-side energy management ranging from making more energy efficient equipment to responsible consumerism but limits its focus to the supply side. Keeping the objective of raising consumption levels intact, there are several actions that can be taken to shape the "quality of consumption." Questions such as can overall consumption be decarbonised and how to reduce inequality of energy intensity of consumption across different income deciles have not been addressed in the volume. Discussions on other CO_2-releasing activities such as land use and land use change, or transport, or other industry are restricted to only ways in which thermal power plants would be affected by such activities.

India's current savings–GDP ratio is around 30–31%. For India's GDP to grow at a sustained rate of 7.5–8% (and assuming declining carbon intensity of production and consumption), an average investment ratio of around 35% and a savings ratio of around 33% would be needed. This would imply an increase in the savings ratio of about 2–3% from current levels. Assuming that the financial savings ratio grows in tandem with the gross savings ratio, this would imply an increase in household financial savings as well and therefore increasing intermediation through the banking system, potentially increasing the level of resources available to finance decarbonisation strategies and pathways. We feel adequate attention has not been paid to this aspect in discussions around resource mobilisation for decarbonisation.

There is also very little discussion on what is the appropriate social discount rate at which we, collectively as a society, discount the future. This is critical for inter-generational equity. The lower the discount rate, the more we care about future generations; the higher the discount rate the more we value the current generations. For example, the Biden Administration used a social discount rate of 2% to justify clean energy subsidies granted under the USA's 2022 Inflation Reduction Act (*The obscure calculation transforming climate policy*, Ula Chrobak, 12.06.2022, Knowable Magazine). The social discount is a policy variable, and it is important to have a transparent debate around it because it will critically shape the transition path we adopt.

Detailed discussions on the proverbial elephant in the room – the distribution grid – has been deliberately avoided. Delving into these debates could fill an entire volume and, equally importantly, we ran the risk of losing focus by getting lost in the intricacies of the challenges faced by distribution companies. There is a lot to learn from international experiences of energy transition in South Africa, the USA, and the EU, and only limited examples have been touched upon in the chapters for similar reasons.

Finally, and perhaps most importantly, we have not devoted enough discussion to the increasing costs of delaying or slowing the pace of the transition. While it is important to have a deliberated time horizon for transition, taking all stakeholders into account, it is also important to stress the need to act and commit now to a decarbonisation path so as to avoid an unrelenting accumulation and compounding of physical risks in the future. This would require a different time horizon and discount rate from those currently guiding decisions. Actions to secure the transition are often perceived as costs incurred today, rather than investments in humanity's collective future.

Taking the Discussion Forward

The volume is an attempt to create a knowledge base by putting together findings from extant literature and practices under a common framework to facilitate collective reflection and work towards making the research on decarbonisation in its various dimensions more mainstream. Achieving net zero is, in its essence, solving an equation that balances sources and sinks of emissions by reducing GHG emissions as much as possible while increasing GHG stores to remove any remaining emissions from the atmosphere. This is not a single equation but a system of equations. The emissions equation is coupled with a capital and a labour equation. The demand for capital and labour in a net-zero economy must match with supply, over time and across regions. And these equations must be solved simultaneously or concurrently while pursuing economic development and inclusive growth. Moreover, a lot depends on what is happening in the rest of the world.

Enablers to arrive at a sustainable energy mix include technological innovation that can be scaled up, creation of supporting supply chains and infrastructure, availability of necessary natural resources, effective capital reallocation and financing structures, compensating mechanisms to address socioeconomic impacts, governing standards and effective institutions, political commitment, and support from citizens both as producers and as consumers.

As eminent historian Peter Frankopan establishes in his recent book on climate history (*The Earth Transformed: An Untold History*, 2023, Bloomsbury and Knopf) civilisations past have faced both exogenous as well as man-made climate shocks. Some adapted while some didn't. There are lessons to be learned from the past and, if we put our collective energies into it, we can successfully adapt too. What Professor Frankopan's work underlines very clearly, however, is that there is no room for complacency. Business as usual is not an option. We hope this volume contributes towards taking the options forward.

Part 1

A Macroeconomic Analysis of Alternate Pathways: an Introduction

Mritiunjoy Mohanty and Runa Sarkar

As we examine the role of coal in a sustainable energy mix for India in the context of a global push towards transitioning away from it, one has to recognise the systemic, interlinked, and complex nature of how coal is intertwined with the political economy of the country. In addition to powering the nation, coal is the source of direct and indirect employment for millions of people, responsible for a huge contribution to the public finances of the country through tax and other measures and responsible for being the largest customer segment for critical transportation infrastructure. In addition, the need to continue to focus on India's growth cannot be disputed. Hence, any discussion on balancing the energy mix of the country away from coal must first take a macroeconomic view of the implications of such a change. The remit of this section is to first understand the needs of India's power sector, keeping in mind its priorities, examine the implications and necessity of a transition away from coal, and identify the changes required to enable a just energy transition.

There are few disagreements over the global imperative of a transition to a cleaner energy mix over time. However, there are divergent views on the pace and nature of the transition for India, given the need to balance the need for economic growth which, historically, has been carbon intensive, and decarbonisation strategies. It is in this context that the contributions in this section view India's transition pathways. Thus, while an assessment of how accurate India's projected coal needs are for the near future is viewed from a technology lens, a more pragmatic approach is taken to balance the national priorities of equitable growth with India's international commitments of decarbonisation. A political economy lens is then used to situate the energy transition within India's federal system, balancing central priorities with those of individual states. From a purely economic view point, one must be able to make a judgement of the impact of a transition away from coal on macroeconomic parameters such as GDP, employment, and public finances. The spatial impact of a transition away from coal on certain geographies of the country and the uneven manner in which different strata of society would get affected also has to be addressed. A Just Transition, that respects social identity and dignity, is the only humane way of initiating a tectonic change in the energy mix of the country. The transition would be incomplete if it was not concomitant with a deep electrification of all the sectors of the Indian economy, and this aspect is considered in the last chapter of this section.

In the first chapter, *Dahiya, Lolla, Gupta, and Sivalingam* clear the haze over India's projected energy requirements till 2030 to arrive at a realistic assessment of India's need to mine additional coal. The authors demonstrate that India's electricity demand has, for

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the most part, been over-projected over the past two decades leading to surplus assets both in coal power generation as well as in the coal-mining sector. While the most recent Electric Power Survey has tried to correct this, the gap between projected electricity demand and actual demand has continued to grow. Using even the most conservative estimates from the projections, they arrive at 1194 MT coal requirement at a 6% average annual electricity demand growth rate for 2030. At the same time, based on announcements and data on the addition of operational and mineable reserves with Coal India Limited and captive operational reserves with private and other public sector entities, India will have a cumulative coal-mining capacity of more than 2200 MTPA by 2030. Not only would this lead to stranded assets but also the development and allocation of these surplus assets sink investments without substantial contribution to economic development while damaging the pristine forest, wildlife, ecosystem, and livelihood of vulnerable communities. In addition, the continued focus on allocating new mines beyond the requirement could have important ramifications by delaying India's energy transition, creating widespread changes to the industry structure and sending confusing signals to all stakeholders. The authors advocate investing in grid modernisation, better infrastructure for renewable energy integration and real-time demand management rather than in a sunset industry. In a box (*Tracking Government Support to the Coal Sector in India*) *Raizada et al* demonstrate support to the coal sector through direct and indirect subsidies, capital spending of public sector units and concessional and state guarantees.

Basu and Nayak focus on India's energy trilemma, which tries to balance energy security with increasing energy access and affordability and reduce carbon emissions, as a complex problem in India's energy transition process in Chapter 2. Even as variable renewable energy proliferates, India's population and growth ambitions are too deeply entrenched in its coal ecosystem to consider a just energy transition without any coal in the energy mix. They navigate the maze of often conflicting objectives of access, security, and sustainability when determining short, medium, and long-term pathways for energy transition. The authors opine that the thrust on renewable energy (RE) development in India was initially motivated by the energy trilemma, as it was believed that RE would provide energy access and improve the life and livelihood of a large number of energy-poor people in rural and remote areas. Further, it was assumed that RE, being a natural resource, would address energy security and the challenges posed by a growing population, urbanisation, transportation, and self-sufficiency that may affect the pace of decarbonisation with the development of grid-connected RE. However, the large upfront investment costs for RE, its material intensity, the true cost of firm power, and state of transmission grids in the country are some of the reasons why this was too optimistic. The authors underline that "It is time to recognize that *energy transition is not the same as technology transition*. Technology penetration can be disruptive and rapid, but energy transition is a gradual process that should balance socio-economic and environmental implications in an equitable manner." The transition in a coal-dominant country like India should involve Just Transition, clean coal and green coal technologies, High Efficiency, Low Emission Technologies, and a Phase down of unabated coal (use in such industries) through fossil-based hydrogen and carbon capture and storage.

The (mis) alignments of policies between the centre and the state and their implications for energy transition constitute the subject matter under discussion in Chapter 3 by *Tirthankar Mandal*. While there is no lack of political will regarding clean energy transition at the centre, this process has recently experienced push-back from state governments. This is primarily because state governments see it as an attempt to reimagine the concurrent nature of power sector legislative rule-making and decision-making. In addition, setting such national targets often overlooks the priorities of the states. In light of RE development, while the targets are set at the national level, the resources exist only amongst a handful of states, with the remaining states at the fringe. The notion of a common state-driven RE pathway is not in the offing as the priorities for the RE resource-rich states and the RE resource-deficient states are at variance. This explains why the central government took the onus to set the agenda for the RE-based growth for the power sector, which has structural implications for cross-cutting state policies, especially in the area of agricultural subsidies and the operation of the electricity distribution companies. The social contract of the power sector in India, that is, providing affordable power to the residential and agriculture sector while making power accessible to industry and commerce is adversely affected in the current central policy-setting context. Striving for efficiency and bringing more RE into the energy mix to address electricity demand is a simplistic solution to a far more complex problem. The importance of using the plurality and diversity of states in this journey cannot be emphasised enough.

The objective of *Ray, Majumder, and Thakur* in Chapter 4 is to examine the implications of energy transition for India, in terms of broad macroeconomic indicators. The authors analyse the importance of coal in terms of GDP, share in mining, and revenue generated for the economy in addition to how coal affects air quality and emissions. The linkages of other sectors with the coal sector and spillover effect of the coal transition into other sectors are also examined, as are costs associated with phasing out coal and bringing in renewables. The authors pay special attention to Just Transition by highlighting the spatial dimension of the transition process across Indian states. They study the detailed energy composition of the two major coal-producing states of India – viz Jharkhand and Chhattisgarh – and identify the potential alternative energy sectors for them. They conclude with the observation that in addition to factors such as resource base, topography, human capital, and infrastructure, the linkage of coal in the economy of a state and its political economy plays a critical role in determining the pace and nature of energy transition. Appendix 4B by *Grover and Swami* is a qualitative assessment of the capability and resilience of workers at the Kota Super Thermal Power Station to deal with the impact of the loss of livelihood by mapping their social and economic capital.

Chapter 5 addresses the socio-economic dependencies of an energy transition from a macroeconomic point of view and uses international experiences to suggest suitable interventions. *Sharma and Loginova* highlight four aspects of the uniquely complex character of India's energy transitions, namely, its political economy, its vulnerability to climate change, its rapid rate of economic growth, and a history of socio-economic disadvantage and marginalisation. These explain the dichotomy underlying India's current and future choice of energy systems. While acknowledging that the choices made are right, they caution that transitioning into different energy systems requires careful, pro-active planning and governance to ensure impacts – and their outcomes do not cause further marginalisation and inequity. Drawing from experiences with energy transition across five different countries, they suggest three interventions that respond to growing calls to address gaps in India's approach to long-term policy and decision-making. The first is to develop a knowledge base commensurate with the pace and scale of development to ensure optimal transition plans are designed and implemented. The second emphasizes social dialogue, with a focus on consensus-building to counter India's historically poor record of community engagement and social inclusion, particularly in the context of large-scale industrial activity. A multi-pronged approach, with a focus extending beyond jobs, is advocated as the third intervention to ensure a Just Transition. Extending innovation into transitions thinking is likely to ensure outcomes are economically sound and socially fair and equitable as well as accepting of hard-fought international environmental standards. *Grover and Gudela* map different scenarios with respect to pace of decarbonisation with transition management for Rajasthan Vidyut Utpadan Nigam Ltd in Appendix 5A. In Appendix 5B *Gopal et al* analyse and explore an instance where community initiatives led to a smooth transition away from coal in Nandgaon village in Maharashtra.

In the last chapter of this section, *Shukla, Thakare, and Pachouri* delve into the importance of deep electrification in key demand sectors including residential, industrial, transport, and agriculture. With the emergence of supplementary electricity demand including electric vehicles, green hydrogen, and electric cooking, through direct or indirect electrification, they explore the impact of deep electrification pathways on the Indian economy. After an assessment of extant policies supporting deep electrification, collaborations supporting deep electrification in the international context for industries and the transport sector are studied. Finally, a four-pronged approach is suggested for deep electrification in India. First, instead of focusing heavily on addressing the supply-side issues for low-carbon electric-based technologies, due importance and policy emphasis must be given towards resolving demand-side bottlenecks as well. This implies that the hesitation amongst the end-users towards the adoption of electrified technologies, including behavioural factors, needs to be adequately addressed. Second, making the adoption of the electrification technologies conditional upon financial incentives and subsidies can create more problems than it solves and need to be thought through. Third, before a regulatory framework towards the governance of any electrification initiative is announced, it may be put into a sandboxing text which can help the policymakers identify key challenges that may come up at the implementation stage. Finally, deep electrification strategies and initiatives need to be converged and aligned with decarbonisation initiatives, in letter and spirit. In other words, deep electrification must go hand in hand with deep decarbonisation for a smooth and effective transition. In a box, *Chatterjee and Jaju* discuss the PM KUSUM programme and its comprehensive approach towards solarizing energy use in agriculture.

1 India's Coal and Coal-Fired Electricity Needs by 2030

Clearing Vision beyond Black Coal and Hazy Skies

Sunil Dahiya, Aditya Lolla, Priyanshu Gupta, and Nandikesh Sivalingam

Introduction: Need for a Downward Revision of Electricity Demand Projections for India

How much coal production capacity is India likely to need by the end of this decade? The answer to this question depends mainly on one key variable – electricity demand growth.

India's power sector is the biggest consumer of domestic coal, currently accounting for more than 85% (MOC, 2022) of total coal use in India, while coal-fired generation accounts for almost 75% of the country's total electricity (EMBER, 2022). So India's future coal requirements will depend upon how its power sector grows going forward. The country's ambitious 500 GW non-fossil capacity (PIB, 2022a) and 450 GW renewable energy (RE) capacity targets (CEA, 2019) for 2030 will certainly help its power sector reduce its reliance on coal, but how much will depend upon the rate at which its total electricity demand grows.

In the last 10 years, India's electricity demand (ex-bus)[1] grew at a compounded annual growth rate (CAGR) of 4.9% to touch 1401 TWh in FY 2022. However, in recent years, electricity demand growth has been unpredictable due to various reasons – it slowed down in FY 2020 due to an economic downturn growing by just 1%, fell by 1% in FY 2021 due to the disruption caused by COVID-19, and rebounded by 8% due to post-pandemic economic recovery. In the short-to-mid term, electricity demand growth remains uncertain due to various macroeconomic factors such as the war in Ukraine, volatile energy prices, global inflation, and how they influence consumer behaviour (IEA, 2022). As such, India's power sector has now entered a new paradigm.

With India's peak demand reaching 216 GW in the second week of April 2022 (Rajya Sabha, 2022) against 239 GW projected in the 19th EPS (Electric Power Survey) by CEA (Central Electricity Authority), the gap between projected electricity demand and actual demand has been growing and needs immediate attention to stop unsustainable investments into coal power generation and coal mining. Finding the widening gap, the CEA further revised the power projections for 2030 in its 20th EPS wherein both the normal and moderate scenarios have a reduced quantum of electricity demand as compared to EPS 19 as shown in Figure 1.1.

While India's electricity demand is expected to see a strong average annual growth rate between 4% and 6% in the long run, electricity demand in FY 2030 is likely to be much lower than previously anticipated. In the recent draft of National Electricity Plan 14 (NEP14) published by the CEA, the electricity demand is projected to grow at 6.1% on an average every year in the next 10 years (CEA, 2022a). This would result in electricity

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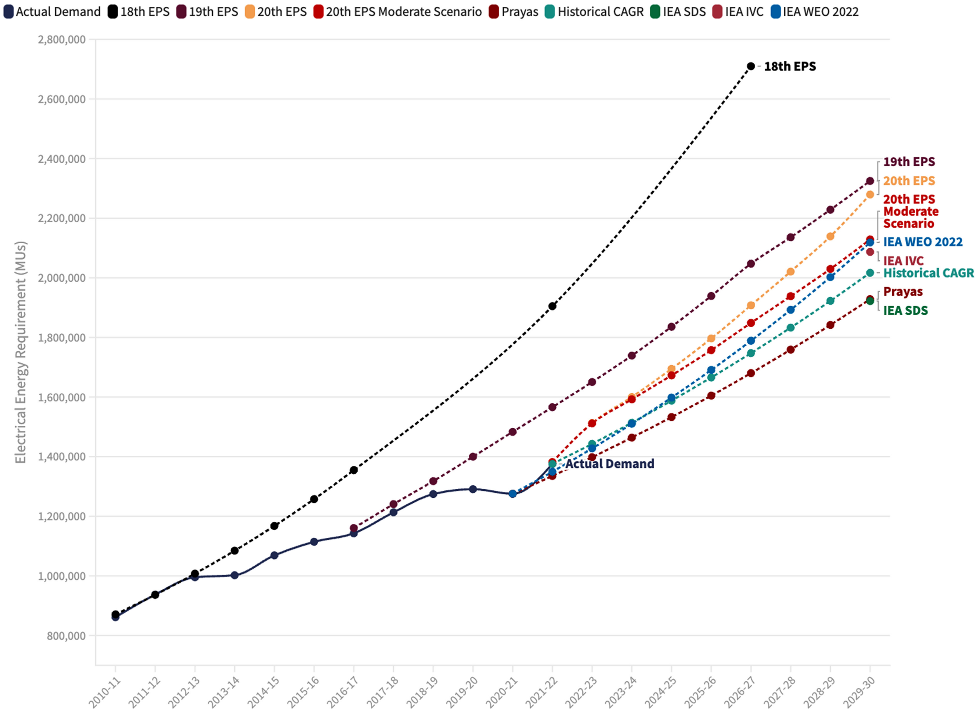

Figure 1.1 India's electricity demand in FY 2030 based on different forecasts.
EPS, Electric Power Survey; IEA, International Energy Agency; WEO, World Energy Outlook; IVC, India Vision Case; SDS, Sustainable Development Scenario.

Source: Compiled and drawn by authors.

demand (ex-bus) of 2250 TWh in FY 2030, which is about 10% lower than what CEA projected in its Optimal Generation Capacity Mix report published in 2020.

Further, projections made by other organisations suggest that even the NEP14 forecasts may be a little optimistic. The International Energy Agency's (IEA) recent World Energy Outlook 2022 reports project India's electricity demand to grow at a CAGR of 5.8% between 2021 and 2030, which would mean approximately 2120 TWh of power demand in FY 2030 (IEA, 2022). IEA also published India Energy Outlook 2021 where its electricity demand CAGR ranged between 4.3% and 5.4% across different scenarios between 2019 and 2030 (IEA, 2021). At these growth rates, electricity demand in FY 2030 will be between 1922 and 2087 TWh. Prayas Energy Group, in July 2022, forecasted a CAGR of 4.7% between FY 2021 and FY 2031 (Prayas, 2022). This would result in an electricity demand of around 1930 TWh in FY 2030. Finally, if India's electricity demand growth follows the growth rate seen in the last decade, i.e., 4.9%, it will touch approximately 2020 TWh by FY 2030. All these estimates suggest that India's electricity demand in FY 2030 will be in the range of 1950–2120 TWh.

Now that various organisations, including the CEA, are revising the electricity demand growth estimates for FY 2030, there is a need to reassess the coal generation and the subsequent coal production requirements going forward.

Implications for Coal-Fired Power Generation

India has started pivoting towards a renewable energy (RE)–based power sector. As of September 2022, India has installed 165 GW of RE capacity (including large hydro), up from 101 GW by the end of FY 2017 (CEA, 2022b). As a result, RE capacity currently accounts for 40% of India's total installed capacity. This gradual growth of RE in India and the country's ambitious RE targets for FY 2030 mean that India might not need as much coal as previously estimated.

Interpolating the government's latest long-term power generation forecasts for FY 2027 and FY 2032 from the CEA's draft NEP14 to FY 2030, we find that non-coal power generation in FY 2030 would be about 1105 TWh (960 TWh RE, 110 TWh nuclear and 35 TWh other fossil generation). Coal-fired generation would be needed to fill the gap to meet the total electricity demand in FY 2030.

Now, if electricity demand grows at an average annual rate of 4.5% from now till FY 2030, the ex-bus electricity demand in FY 2030 would be around 1992 TWh. Assuming the auxiliary power consumption to be 6.5% based on the draft NEP 2018's assumption of projected auxiliary consumption for coal-based power stations, the total generation in FY 2030 would be 2122 TWh. This would mean coal-fired generation in FY 2030 would be 1017 TWh. Similarly, from average annual demand growth rates of 5%, 5.5%, and 6%, coal-fired generation in FY 2030 would be 1099 TWh, 1185 TWh, and 1273 TWh. To put these into perspective, coal-fired generation in FY 2022 was 1079 TWh. So even in the most optimistic 6% growth rate scenario, coal-fired generation is likely to increase by just 18% in the next 8 years.

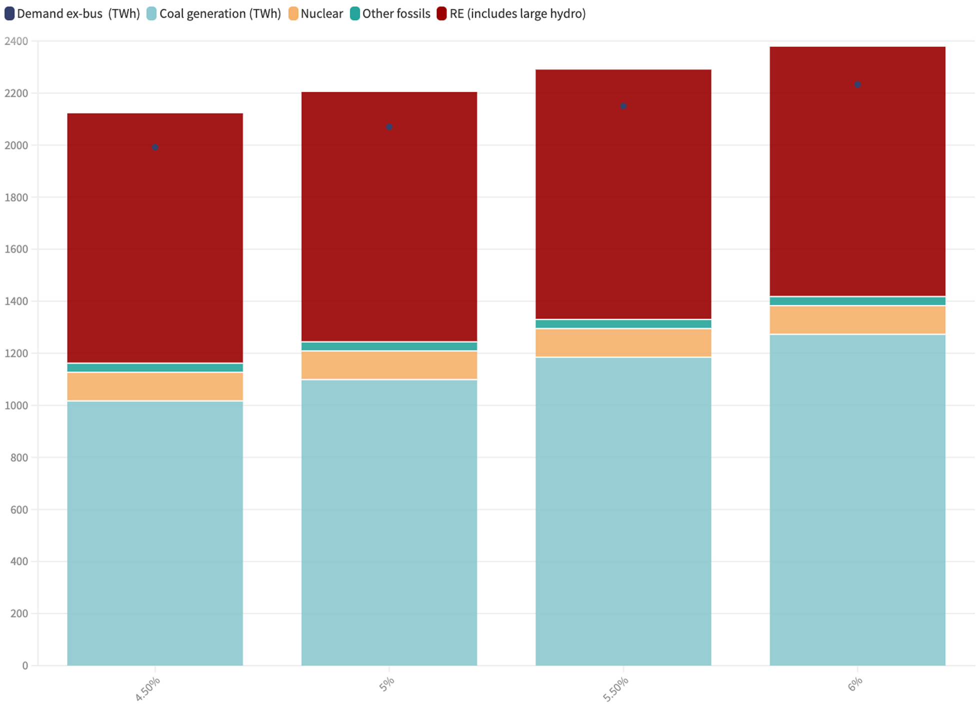

Figure 1.2 Coal-fired generation in FY 2030 under different electricity demand growth scenarios.

Source: Author's calculations based on CEA data.

This further substantiates recent studies which have shown that if India delivers on its RE targets, its coal-fired generation will likely peak by the end of this decade (CREA, 2021), (EMBER, 2021a), (IEEFA, 2021).

The estimated level of coal-fired generation in FY 2030 would mean that India may not even need to build any more coal power capacity beyond what is already under construction, even after the planned retirement of older units. India currently has an operating grid-connected coal fleet of 211 GW, which is already running at a low plant load factor (PLF) of 54% (in FY 2022). Further, India's overall coal power PLF has been falling year-on-year in the last decade (70% in FY 2012 to 54% in FY 2022) (MOP, 2022). This is unlikely to significantly improve in the future too as India has about 27 GW of new coal power plants under different stages of construction (CEA, 2022c), which is more than enough to meet the additional coal-fired generation expected by the end of this decade. What is clear is that India is building new coal power capacity only to ensure it has sufficient capacity to meet peak (instantaneous) demand and any new capacity addition over the current level wouldn't change the overall coal-fired generation and coal requirement by FY 2030. Increasingly, studies are showing that a better way to plan for peak demand for a few hours a day would be to invest in various RE and storage options and grid modernisation providing more flexibility and better utilisation of increasing RE capacity (EMBER, 2021b).

Implications for the Coal Mining Industry

India's coal-fired generation in FY 2030 for different scenarios of average annual demand growth rates of 4.5%, 5%, 5.5%, and 6% from FY 2022, would be 1017 TWh, 1099 TWh, 1185 TWh, and 1273 TWh, respectively. The above projections for 2030, assuming 0.65 kg/kWh specific coal consumption with 1% loss during transportation, would translate into approximately 668 MT, 722 MT, 778 MT, and 836 MT of coal requirement for power generation, respectively.

Contrary to this, Coal India Limited's (CIL) draft Coal Vision 2030 in 2018 predicted a minimum thermal coal demand of 1150 MT if 85% (977 MT, based on past trends) of it is assumed to be consumed for electricity generation. That would translate to greater than 1500 BUs (much higher than the most conservative estimate of 1248 BUs[2]) including 1% coal loss during transportation.

Non-power sector coal demand (coking + non-coking coal) is expected to grow at a higher rate than the coal demand in the power sector. CIL, Coal Vision 2030, predicts that non-power sectors will contribute to nearly 30% of total coal demand in the year 2030.

Assuming a coal requirement of 358 MT for the non-power sector (30% of total coal consumed in 2030 at the most optimistic 6% growth), the total coal requirement in India will be 1194 MT in 2030.

CIL is the biggest coal miner in India and is responsible for mining more than 80% of domestic production. This is followed by approximately 10% production both by Singareni Collieries Company Limited (SCCL) and captive producers.

From a compilation of environmental clearance granted capacity data for individual coal blocks (producing), it is estimated that the total mineable capacity with CIL as of FY 2020–2021 was over 1040 MT compared to the total production of 596 MT illustrating a surplus minable capacity of 444 MT (MOC, 2021). Apart from the existing operational mining capacity, 68 mines with a total additional minable capacity of 350 MTPA (868 MT/year total capacity through enhancement of current operational mines; i.e., 518 MTPA and opening up of new mines) are under different stages of development

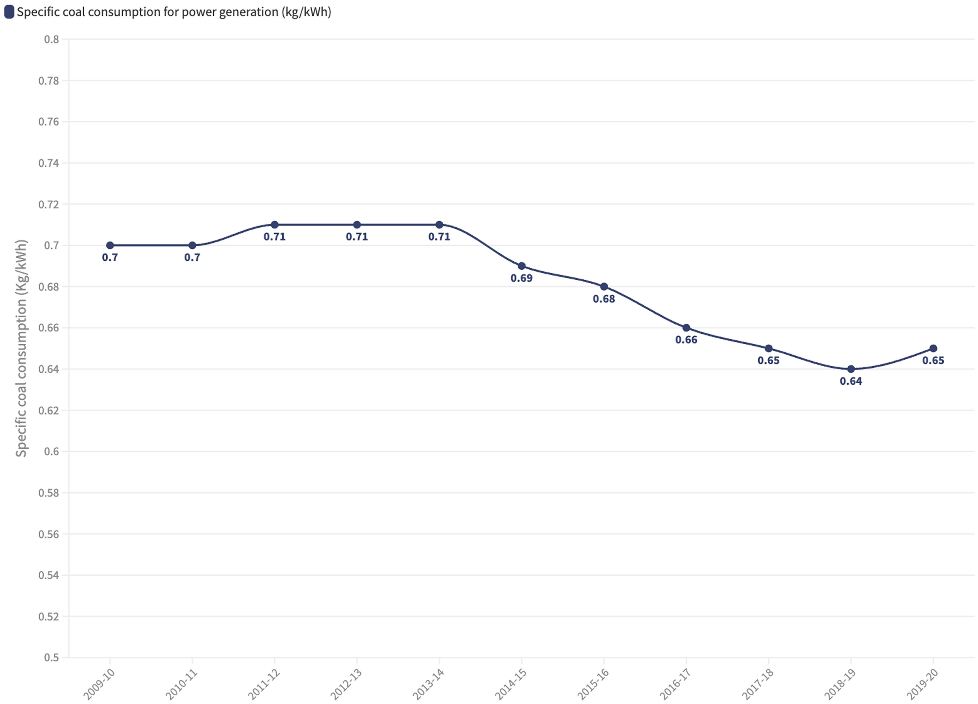

Figure 1.3 Specific coal consumption by coal-based power stations in India.

Source: Authors based on data from CEA (2021)

Table 1.1 Electricity demand, coal-based power generation, and total coal requirement under different growth rate scenarios in FY 2030 in India

S. No.	*Annual power demand growth rate for FY 2022-2030 (%)*	*Total power requirement in FY2030 (TWh)*[6]	*Coal-fired generation in FY2030 (TWh)*	*Total coal requirement (MT)*[7]
1	4.5%	2122	1017	668
2	5.0%	2204	1099	722
3	5.5%	2290	1185	778
4	6.0%	2378	1273	836
5	Coal Vision, CIL estimate for 2030		1500[8]	1300[9]

Source: Authors' own, compiled from various sources.

with CIL according to monthly statistical reports of the Ministry of Coal (MOC). On top of these, six additional mines were auctioned to CIL which have a total annual minable capacity of 144 MT. If all the capacity comes into operation by 2029, CIL alone will have a minable capacity of more than 1500 MT.[3]

CIL is the largest coal producer and has a total mineable/environmental clearance capacity of more than 1040 MT in 2020–2021, but coal production for the same year stood at 596 MT, indicating around 60% utilisation of the mines.

Table 1.2 Coal production by CIL subsidiaries from 2016–2017 to 2020–2021 and permitted Environment Clearance (EC) capacity for FY 2020–2021 (MTPA)

Company	*2016–2017*	*2017–2018*	*2018–2019*	*2019–2020*	*2020–2021*	*Permitted production (FY 2020–2021)*	*% Utilisation*
ECL	40.52	43.57	50.16	50.40	45.03	122.00	37%
BCCL	37.04	32.61	31.04	27.73	24.66	128.00	19%
CCL	67.05	63.41	68.72	66.89	62.59	84.00	75%
NCL	84.10	93.02	101.50	108.05	115.05	128.00	90%
WCL	45.63	46.22	53.18	57.64	50.27	129.00	39%
SECL[a]	140.00	144.71	157.35	150.55	150.60	226.00	67%
MCL	139.21	143.06	144.15	140.36	148.01	222.00	67%
NEC	0.60	0.78	0.78	0.52	NA	1.60	
CIL	**554.14**	**567.37**	**606.89**	**602.13**	**596.21**	**1040.60**	**57%**
SCCL	61.34	62.01	64.40	64.04	50.58	68 (Coal-India, 2018)	

[a]*This includes total production by captive and others.*
ECL, Eastern Coalfield Limited; BCCL, Bharat Coking Coal Limited; CCL, Central Coalfield Limited; NCL, Northern Coalfield Limited; WCL, Western Coalfield Limited; SECL, South Eastern Coal Field Limited; MCL, Mahanadi Coalfield Limited; NEC, North Eastern Coalfields; SCCL, Singareni Collieries Company Limited.

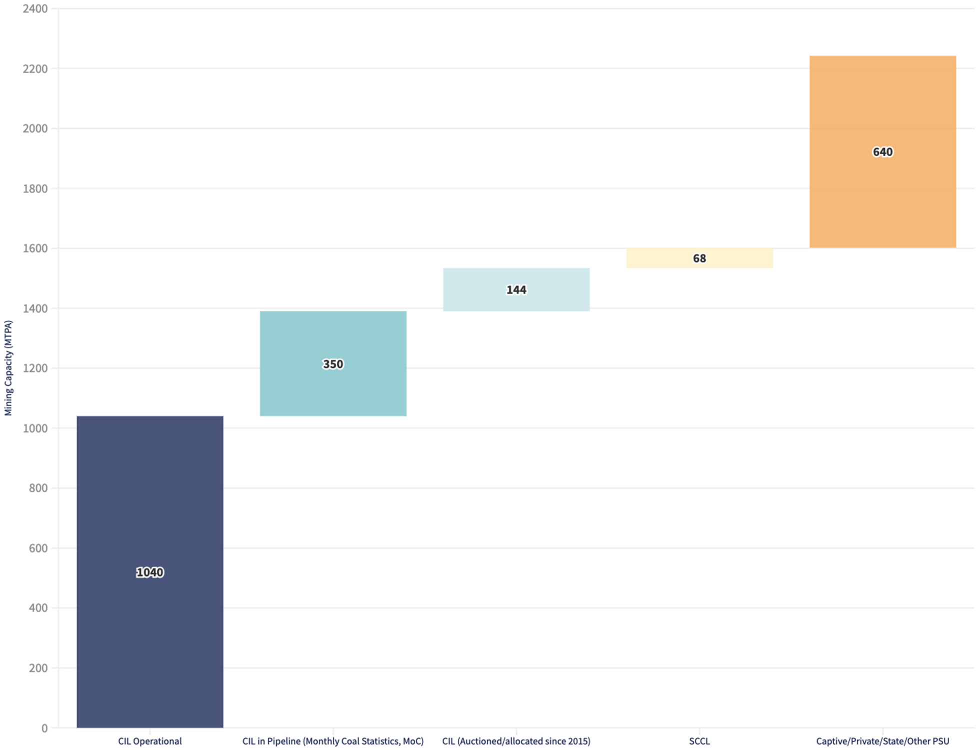

Figure 1.4 Minable coal capacity in India for FY 2030 from operational and in-pipeline coal mines.
Source: Ministry of Coal.

Apart from this, SCCL also has about 68 MTPA mining capacity and approximately 120 mines with 640 MTPA capacity were allocated/auctioned to captive/private companies/state sector entities since March 2015 under various coal auction/allotment trenches.[4] Out of the 120 mines auctioned since 2015 only 27 are operational and 99[5] still remain non-operational.

If we add all operational and mineable reserves with CIL and captive operational reserves with private and other public sector entities, India will have a cumulative coal mining capacity of more than 2200 MTPA by 2030. This is higher than even the most conservative estimates of 1194 MT coal requirement at a 6% average annual electricity demand growth rate, which form the outer limit.

Our estimates incorporate the effects, if any, of marginal impacts of mine closures. There are 49 big mines under CIL, captive, and others (FY 21) with a joint minable capacity of more than 720 MT (612 under CIL). Of these more than 35 mines with a total production capacity of 571 MTPA have more than nine years of life left at the current rated capacity. Further investigation of the retirement potential of the existing mines found that mines with an existing capacity of more than 500 MTPA are already planned to go for capacity extensions, leaving very few big mines with a relatively small total mining capacity to opt for shutdown till 2030.

Table 1.3 Status of Operationalisation of Coal Blocks Allocated since 2015 (as of 31 March 2022, MOC)

Allocation Route	*Production Status*	*2015*[10]	*2016*[11]	*2017–2020*	*After 2020*	*Total*
Allotment[a]	Operational	11	2	–	–	13
	Not Producing	25	14	5	–	44
Auctions	Allocated	31	–	6	43	80
	Terminated	9+3[b]	–	2	–	14
	Operational	14	–	–	–	14
	Non-producing	5	–	4	43	52
Total	Operational	25	2	0	0	27
	Non-producing	30	14	9	43	96

Note: [a] Data for terminated coal blocks via the allotment route is not available
[b] Termination underway; matter sub-judice.

Discussion

Based on the estimates of future coal-powered generation capacity and coal requirements, it is evident that a substantially higher coal mining capacity has already been allocated to meet the medium-to-long-term demand even in the most conservative case. Yet, on 3 November 2022, the Finance Minister launched the biggest-ever coal mine auction of 141 coal mines that, if operationalised, would add another 305 MTPA of coal-mining capacity (PIB, 2022b). The continued focus on allocating new coal mines implies that there is likely to be more than 50% surplus mining capacity relative to foreseeable demand. Presumably, the surplus mining capacity will likely account for any delays, terminations or withdrawal of coal mines once allocated – as has been the fate with the mines allocated between 2015 and 2019 where only 27 of the 80 coal mines (approximately 33% – Table 1.3) accounting for ~15% peak rated capacity could be operationalised as of March 2022 (RTI, 2022).

The continued focus on allocating new mines beyond the requirement could have important ramifications for (i) delay in India's pace of energy transition; (ii) influence widespread changes to the industry structure sending a confusing signal to the industry, public, and international stakeholders; (iii) exacerbate pile-up in the stressed mining assets; and (iv) adversely affect environment and social justice. An analysis of the trajectory of allocation of subsidies to the coal sector in India as compared to those allocated to renewables over time is also not in line with the publicity around India's commitments of a net zero target by 2070.

Tracking Government Support to the Coal Sector in India

Swasti Raizada, Balasubramanian Viswanathan, and Christopher Beaton (International Institute for Sustainable Development)

Historically, government support at the central and state level has played a crucial role across the coal value chain, making it a powerful tool in shaping India's future energy mix.

Based on 18 subsidies that could be identified and were provided by the central government to both coal mining and coal consumption, predominantly in power generation, government subsidies for coal amounted to Rs. 15,933 crores (USD 2.1

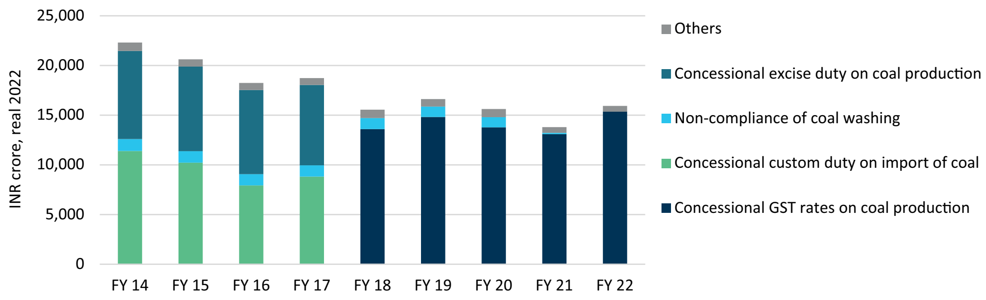

Figure 1.5 Total coal subsidies in India, FY 2014–2022 (real 2022).

Source: Mapping India's Energy Policy 2022, December 2022 Update (2022). International Institute for Sustainable Development.

billion) in FY 2022 (Raizada et al., 2022). Provided through GST concessions on coal sales, coal subsidies have largely stagnated. Other fiscally smaller policies cover a range of objectives, including regional exploration, conservation and safety of coal mines, exploration in difficult areas, and special benefits to employees. Direct budgetary transfers accounted for less than 4% of the total subsidy amount in FY 22. Also, government subsidies for coal continue to be higher than RE subsidies in FY 2022.

Further, state actors like coal-dependent SOEs – namely CIL, SCCL, NLC India Limited, and NTPC Limited – play a critical role in channelising government support to the coal sector (Viswanathan et al., 2022). In FY 2022, the combined capital expenditure for these SOEs was at least Rs. 42,500 crores (USD 5.2 billion).

Government support can also take the form of concessional financing and state guarantees. Known international public finance for coal projects in India totalled Rs. 7,356 crores (USD 987 million) between 2019 and 2021 (Oil Change International, 2022). Data on domestic public finance for coal remains sparse with only one coal power project known to have received a standby credit facility of Rs. 1,024 crores (USD 0.1 billion) from three banks in 2021. Domestic state-owned financiers are increasingly emerging as the lenders of last resort for the coal sector in India (Centre for Financial Accountability & Climate Trends, 2022).

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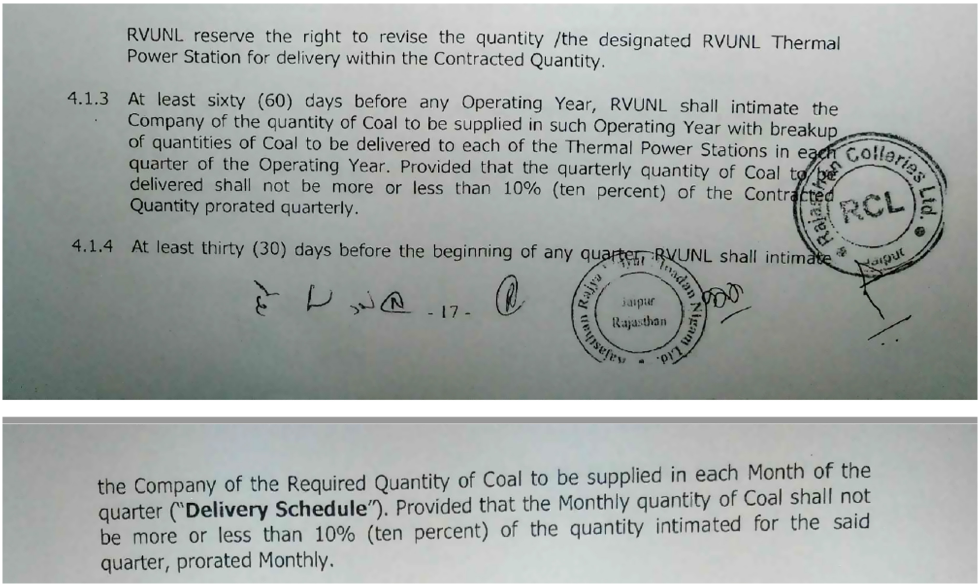
RVUNL reserve the right to revise the quantity /the designated RVUNL Thermal Power Station for delivery within the Contracted Quantity.

4.1.3 At least sixty (60) days before any Operating Year, RVUNL shall intimate the Company of the quantity of Coal to be supplied in such Operating Year with breakup of quantities of Coal to be delivered to each of the Thermal Power Stations in each quarter of the Operating Year. Provided that the quarterly quantity of Coal to be delivered shall not be more or less than 10% (ten percent) of the Contracted Quantity prorated quarterly.

4.1.4 At least thirty (30) days before the beginning of any quarter, RVUNL shall intimate

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the Company of the Required Quantity of Coal to be supplied in each Month of the quarter ("**Delivery Schedule**"). Provided that the Monthly quantity of Coal shall not be more or less than 10% (ten percent) of the quantity intimated for the said quarter, prorated Monthly.

Figure 1.6 Illustrative clause from MDO agreement.

Source: Ministry of Coal.

Potential Delays in Energy Transition

Even as India has announced significant energy transition targets at COP 26 from coal to a majority share of renewables in power generation, the excess coal-mining capacity may threaten to put a spanner if the entire capacity were to come onboard. Given that state PSUs (mostly state power generation companies and mineral development corporations that are usually responsible for ensuring adequate power supply in the states and also own large thermal power plants) command nearly 40% of the peak rated capacity (PRC) of mines allocated between 2015 and 2022 (Figure 1.5), these companies may also face a vexed dilemma – should they repurpose existing thermal power plants: (see Chapter 12 in Section 3 for a discussion on repurposing) and invest in renewable power sector which would leave their coal mines as 'stressed assets' OR continue to utilise mineral resources from the already allocated mines which in turn would delay their energy transition?

Needless to say, if they choose the latter, much of India's energy transition might get delayed. Further, many of these state PSUs have entered into Mine-Developer-cum-Operator (MDO) agreements with private companies that have specific contractual performance agreements wherein the PSUs cannot vary their coal purchase quantities beyond a certain amount, lest they incur default and potential litigation (Figure 1.5). Such contractual conditions are likely to further bind the state PSUs to onboard and sustain significant coal production volumes, potentially increasing the share of thermal power in the production mix.

Changes to the Industry Structure

It is evident that after 2015, the newly allocated coal mine capacity and the capacity embarked for allotment are larger than the current mining capacity with CIL, and the

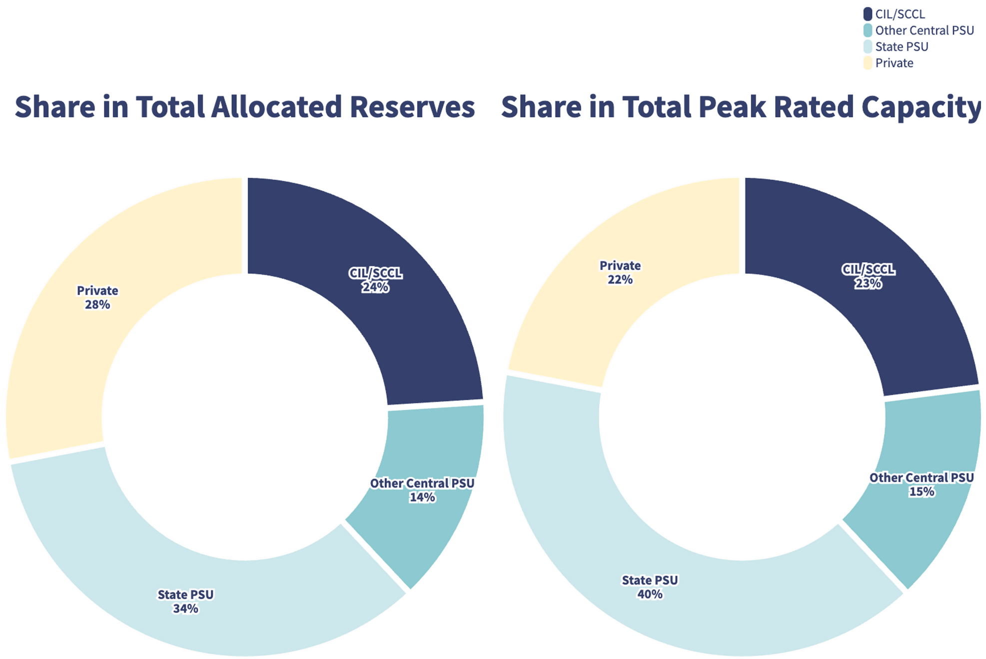

Figure 1.7 New captive coal mines allocated between 2015 and 2022.

Source: Ministry of Coal.

total allocated capacity stands approximately three times the current annual production volume. Further, the hitherto dominant CIL has been allocated less than a quarter of the new mining capacity, while state PSUs have taken up the lion's share of new mine allocations. Given the surplus mining capacity present in India, not all of these newly allocated/auctioned mines are likely to become operational given the projected demand. It remains to be seen which of the mines will become operational and which ones will be likely scrapped. Depending on the dilemmas of operationalisation of these new mines, the coal-mining industry structure can undergo a radical transformation from being dominated by a central PSU (CIL and its subsidiaries) to being led by private mining or state PSUs along with their private MDO operators. Such radical transformation of the industry structure in periods of uncertainty (owing to uncertainty around the pace of energy transition) can throw up significant challenges. The state could have substantially less control on the production and distribution of coal resources to power plants across the country. There could be significant price volatility in the interim period leading to abandonment of select coal mines, jeopardising investments in them and associated businesses dependent on them. *The planning for a Just Transition of mine-affected workers and communities would require including specific plans for transitioning from new assets beyond CIL and would look very different when the responsibility for transition shifts from the public sector to the private sector.*

This uncertainty is also likely to send confused signals to the stakeholders and market participants – including mining companies, thermal power producers, banks and investor community, and state and local government. This is already manifesting in the tepid

Table 1.4 No. of bidders for successfully auctioned mines – Tranche 11–14

Successful auctions (# of blocks)	*1*	*2*	*3*	*4*	*>4*	*Total*
11th Tranche	–	3	5	6	5	19
11th Tranche– 2nd attempt	1	–	–	–	–	1
12th Tranche	-	4	2	1	1	8
12th Tranche– 2nd attempt	2	1	1	–	–	4
13th Tranche	–	2	3	2	3	10
14th Tranche	–	-	2	–	3	5

response to coal mining auctions where only a few bids were received for the newly auctioned coal mines i.e. Tranche 11–14 of the coal mining auctions that took place during the period 2020–2022 (Table 1.4). Twenty-eight per cent of the auctioned blocks saw less than 3 bidders while 18% saw only 3 bidders.

Piling of Stressed Assets

The surplus mining capacities may likely become stressed assets as was seen in the case of thermal power plants allocated between 2008 and 2014, much of which became stranded as thermal power demand failed to keep pace with capacity. This had widespread consequences as the investments become non-performing assets (NPAs) for the banking sector and result in distress sale of stressed assets at a significant economic loss. The overcapacity became critical in 2018 when the government identified 34 power stations with a total capacity of 40 GW and bank exposure of 1.7 lakh crore as stranded/stressed assets. These assets were put up for insolvency under the bankruptcy code through the National Company Law Tribunal (NCLT) later. After four long years of trying to resolve these stranded assets through the insolvency process, there are at least 10.5 GW or 25% of these assets which stand at the juncture of being sold as scrap as of date because they did not find any buyers and couldn't be resolved (ET, 2022). In the case of coal mines, this problem could become even more acute given that the lion's share of new mine capacity lies with state PSUs that typically have relatively weaker financial health.

Adverse Environmental and Social Justice Consequences

It is clear that not all of the allocated coal mines are likely to get operationalised. However, given the lack of clarity around which of the mines may fail to come under production, a much larger set of mines is likely to pursue mining clearances (environmental clearances and social consent), acquire land and cut forests (wherever mining area includes forest cover), and even set up mining infrastructure – only to become redundant. Not only is this likely to result in financial stress to the mining companies, but it is also likely to be a deadweight loss to the economy diverting precious economic and natural resources from other pressing requirements. At the same time, any unnecessary social and environmental costs incurred will threaten India's commitments to environmental and social justice and the agenda for Just Transition. This is particularly critical given the recent attempts to move towards faster clearances for coal mines (News-Click, 2022).

Conclusions and Recommendations

Ostensibly, the rapid expansion in coal-mining capacity over the past decade has proceeded on the pretext of implications of India's energy security and imperative for sustaining rapid economic growth (MOC, 2022). However, as the analysis presented in this chapter indicates, India can be confident that current coal power capacity and coal mining capacity are more than adequate to serve the country's growing electricity demand needs. Even as there remain repeated thermal power shortages and outages across the country leading to questions on the adequate supply of coal in the country (The-Hindu, 2022), it is clear that there is surplus capacity currently in the coal-mining sector. The same is even averred by the Coal Minister's statement in the parliament where he mentioned that

> In 2022-2023 (April, 2022 to June, 2022), all India average gap between the Energy Requirement and Energy Supplied was only 1%. Gap between energy demand and supply is generally on account of factors other than inadequacy of power availability in the country, e.g. constraints in the distribution network, financial constraints, commercial reasons, forced outage of generating units, etc. There is no shortage of coal in the country.
>
> (PQ-MOC, 2022)

In a separate analysis, the Centre for Research on Energy and Clean Air highlighted that the coal shortages in the first half of 2022 weren't a shortage of coal-mining capacity but a lacuna in managing the resources, supply, and aligned infrastructure to be able to supply to the predicted needs of coal for the period (CREA, 2022). The analysis found that the coal shortage at respective power stations occurred due to mismanagement in mining, coal evacuation from coal mines, lack of stock build-up by the power stations, and the regulator failing in ensuring the efficient function of the coal supply chain. It confirmed that India has more than enough domestic mining capacity to meet the existing demand comfortably.

Thus, the continued allocation of new coal mines does little to add to India's energy security, rather it delays the transition to renewables sending a mixed signal to the market on the pace of India's energy transition. It must be noted that the timely implementation of renewable power is critical, even for energy security, since diversification indemnifies against energy risk. At the same time, the allocation of excess capacity threatens a potential situation of stressed assets and significant avoidable economic, environmental, and social costs to the economy. There is, thus, a need for revisiting the coal mining allocations and bringing them in line with the medium- to long-term demand projections. There is also an opportunity to look at a Just Transition from the lens of social and environmental justice in the opening of new mines wherein considerations of justice can permeate the opening of new mines in densely forested, ecologically sensitive areas.

Rather than investing in a sunset industry, it will be beneficial to focus on things like grid modernisation, better infrastructure for RE integration, and real-time demand management and ensuring that the country meets its commitment of 500GW non-fossil energy capacity by 2030.

Notes

1 Ex-bus demand doesn't include auxiliary consumption.
2 Billion Units.
3 Mineable capacity from SCCL and captive mines is excluded from this figure.

4 The total annual capacity is assigned for mines which didn't have MTPA capacity using the average minable reserves for those mines and trajectory average for other mines for which this data is available.
5 Including 6 mines under CIL and its various subsidiaries.
6 The demand assumes 5.4% auxiliary consumption on top of ex-bus power demand, based on draft NEP14 projections.
7 Specific coal consumption of 0.65 kg/kWh, which is a conservative estimate as with updated technology and improving coal quality specific coal consumption might decrease further following past decades trend.
8 Coal Vision, CIL estimates minimum thermal coal demand to be 1150 by 2030, back calculation from which assuming 85% thermal coal consumption for electricity generation shows that this much coal alone can generate 1500 MUs in 2030 (including 1% transportation losses).
9 1150 MT non-coking (thermal) coal demand for power and other sectors + 150 MT coal demand for coking coal.
10 Allotment to PSUs under Coal Mines (Special Provisions) Act 2015 as well as Auctioned by Competitive Bidding Rules 2013.
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2 India's Energy Trilemma and Coal-based Power Generation

Sambit Basu and Soumya Prakash Nayak

Introduction

The Indian economy is one of the fastest-growing economies and, in nominal terms, has become the world's fifth largest economy behind the USA, China, Japan, and Germany. The economic growth in India was catalysed by sustained infrastructure development and was largely driven by the high-value-added services sector. However, the sectoral shift largely skipped the usual phase of rapid industrialization where manufacturing picks up (as in most other emerging and developed countries).

During this period, energy requirements increased manifold, and the composition of energy also transited towards modern energy forms. The use of coal, petroleum products (oil and gas), and biomass experienced a steep increase, largely driven by the transport, services, urbanisation, and consumption requirements of a growing population with rising per-capita income. As more efficient and commercial energy forms gained importance in the energy basket, electricity use, and generation saw massive growth. Over the last two decades, India made remarkable progress in providing access to electricity and clean cooking supported by a range of energy market reforms. While energy intensity has seen a steady decline over the years, due to high value-added economic growth coupled with increasing provisioning of efficient and clean energy, the per-capita energy consumption increased sharply. However, per-capita energy consumption remains far below the world average. In 2019, India achieved a historic landmark of universal household electrification and, since then, it has made significant progress in providing access to clean modern energy to all. The mission of providing adequate, affordable, secure, and sustainable energy continues.

The energy transition and transformation in India, as in the rest of the world, is being driven by megatrends – be it technological breakthroughs, improved efficiency with existing technology, climate commitments, rise in renewable penetration, sustainable transportation, and digitalisation. India has been at the forefront of the fight against climate change and has made considerable progress in adopting clean energy (like solar and wind) in its overall energy basket. Renewable energy (RE) capacity has increased seven times over the last decade, a continuance of India's long-standing sustainable development agenda.

India, to stay steadfast on a decarbonisation path committed to five goals in 2021 at the 26th session of the Conference of the Parties (COP26) to the United Nations Framework Convention on Climate Change (UNFCCC) held in Glasgow, United Kingdom. However, it does not want to compromise its growth under any circumstances. Climate change is a global commons problem, and unless all large polluting nations with large cumulative

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emissions reciprocate to take action with equal conviction, the climate will change for the worse. Thus, India carefully chose not to be part of the Non-binding Agreement designed to phase out coal by 2030 for rich countries and 2040 for poor countries at COP26 along with other large coal-using nations like China, the USA, and Australia.

The country has ambitious plans to ensure energy security, increase energy access and affordability, and reduce carbon emissions, thus balancing an energy trilemma, which makes the transition process complex. The road to India's net-zero commitment in 2070 and other climate actions must be aligned with the real aspirations of a large population deeply tied to a coal ecosystem (also see Chapter 5). A country like India with strong growth and development ambitions cannot replace fossil fuels (i.e., coal, oil, and gas) any time soon. Since India does not have enough oil and gas, coal cannot be wished away as the mainstay for a Just Transition, even as variable renewable energy proliferates.

This chapter discusses the challenges of navigating the maze of the energy trilemma – Access, Security, and Sustainability – as India aspires to rapidly grow and develop. The paper also charts out a strategy for an energy transition taking into consideration the imperatives of the role of coal and fossil fuels, alongside clean energy technologies and demand management, in achieving the growth objectives in a sustainable manner.

India's Growth Aspiration and Energy Trilemma

India aspires to be a developed country by 2047, when it celebrates its hundredth year of political independence. This includes achieving high per-capita income with improved living standards, independence from want of basic amenities, eliminating energy poverty, ensuring self-reliance, and jobs for the working-age population.

India, by some estimates, home to more than 1.4 billion people or about 17% of the world's population, is set to become the world's most populous country. A rising population combined with the twin forces of urbanisation and industrialisation, underpins growth in energy demand. At the same time, despite an increased energy demand over the last three decades and a change in the composition of primary energy supply, India (in 2021) constituted only 6.3% of the global primary energy demand.

Further, driven by the imperatives of self-sufficiency and ensuring resilience to external shocks, India's growth, development and rise in consumption demand may soon be led by manufacturing in the near future. This manufacturing led growth will be accompanied by transformative changes in infrastructure and energy. India's share in global primary energy demand is expected to rise to 7% in 2030 and 9% in 2050.[1]

To meet its development goals, with competing requirements, from its constrained budget, India is faced with the trilemma of balancing access to affordable energy, security of energy, and environmental sustainability. This involves simultaneously (1) providing affordable access to modern energy, i.e. electricity and cooking gas, to all, (2) ensuring security of energy supply, i.e. curbing oil and coal imports, while not compromising adequacy and reliability of energy supply for economic activities, and (3) controlling emissions to achieve social and climate objectives. A decarbonisation trajectory for a fossil fuel-dependent economy with massive developmental gaps, like India, can have severe social and economic knock-on effects.

The thrust on renewable energy (RE) development in India was initially motivated by the energy trilemma, as it was believed that RE would provide energy access and improve the life and livelihood of a large number of energy-poor people in rural and remote areas. Further, it was assumed that RE, being a natural resource available in abundance, would address energy security concerns and reduce India's energy import bill. A push for RE was meant to mitigate local emissions from oil and coal and reduce India's carbon footprint as well.

India, between 2011–2012 and 2021–2022, witnessed a rise in electricity power demand from 995 BUs to 1380 BUs, and the peak demand has grown at a CAGR of little over 4%[2]. To meet this demand, generation capacity has grown to about 404 GW, with RE (excluding large hydro) contributing about 29%. The rapid expansion of solar and wind capacity in India has been an outcome of the increasing cost competitiveness of available technology and government policy support. Coal-based capacity addition has decelerated over the last decade, but coal-based capacity still accounts for 50% of the total installed capacity, and 86% of the total fossil fuel-based capacity.[3]

The experience of high economic growth coupled with phenomenal growth in RE over the past decades has led to the perception that green growth initiatives will enable significant economic opportunity. However, going forward, the challenges posed by a growing population, urbanisation, transportation, and self-sufficiency may affect the pace of decarbonisation with the development of grid-connected renewable energy.

The Challenges of Decarbonisation

Motivated by its achievements with RE capacity addition, India in COP26 unconditionally pledged the following five commitments as climate action targets:

a) Increase non-fossil fuel energy capacity to 500 GW by 2030.
b) Meet 50% of energy requirement from renewable energy by 2030.
c) Reduce the total projected carbon emissions by 1 billion tons by 2030.
d) Reduce the carbon intensity of the economy by less than 45% by 2030.
e) Achieve net-zero carbon by 2070.

Subsequently, the Cabinet approved the following Nationally Determined Contribution (NDC) that was communicated to the UNFCCC:

- Reduce Emission Intensity of GDP by 45% by 2030 from 2005 level (item d above)
- Achieve 50% cumulative electric power installed capacity from non-fossil fuel-based energy sources by 2030 (item b, with the focus on capacity rather than requirement and change from renewable to non-fossil fuel based).

While rapid penetration of green technology over the last decade has helped contain energy intensity, including electricity intensity, and supported reduction in emission intensity, it had the blessings of high value-added services sector-led growth. India's growth story is just unfolding from a low base of per-capita income and emissions. It is faced with the complex task of navigating a maze of challenges posed by energy access and affordability, energy security, and sustainability.

For sustaining economic growth, India's energy requirements would be substantial that RE, with low-capacity utilisation factors, may not be able to deliver. India's projected economic growth depends on sustaining the growth momentum of several key sectors such as infrastructure and manufacturing, which in turn are dependent on energy-intensive sectors such as steel, cement, aluminium, and refining. According to Central Electricity Authority (CEA), at the very least, the country's electrical energy requirement is expected to grow about one and a half times from 1566 billion units in 2021–2022 to 2325 billion units in 2029–2030 (Mitra et al., 2021). This implies that all applications in all sectors, including industry, transport, and urbanisation, will require electrification from clean energy sources. Two-thirds of the installed capacity would be from zero-carbon sources, while 267GW of coal and 25GW of gas plants would remain in the mix in 2030,[4] which implies that carbon emissions would continue to rise. A gross electricity generation of 2518 BU in 2029–2030 is projected of which the contribution of non-fossil fuel generation is about 44.7%. This appears to be too optimistic for the following reasons:

1. *Financing and attracting investment for RE*

   Annual RE capacity addition will have to accelerate to about 35–40GW to meet the mega target of 450GW of RE capacity (500GW including large hydro) by 2030. A recent BNEF-PFI study has estimated an investment requirement of about $363 billion between 2020 and 2029 to build new RE projects and batteries, which includes $223 billion towards solar and wind. This implies an annual requirement of $27.9 billion on solar and wind alone over the next 8 years. An additional $175 billion total investment is required for RE-associated transmission and distribution infrastructure. Thus, the total investment requirement till 2030 is to the tune of about $500 billion. This appears a tall order considering that in 2020–21 investment in RE totalled a record $14.5 billion, and an average annual investment to the tune of about $9.8 billion between 2019–2022.[5]

   RE investment in India depends on foreign funds, which accounts for 50% of the total debt (39% from foreign banks, 10% from foreign development agencies, and 1% from foreign investment funds).[6] Besides the huge investment requirement, the Inflation Reduction Act recently introduced in the USA authorizing $369 billion in climate spending makes investment there extremely attractive. This may put India at a competitive disadvantage to borrow from foreign lenders (see Section 4 on RE financing).
2. *Higher material intensity of RE makes their costs vulnerable to global market cues*

   Solar capacity addition picked up on the back of competitive bidding in 2017 and continuous progress in solar technology, resulting in a steady cost decline. Competitive bidding, initially introduced by the central government,[7] and followed by the states, led to attractive price discovery against a high Feed-in Tariff. The introduction of competitive bidding resulted in a sharp fall in wind tariff from Rs. 5.40/kWh in 2017–2018 to Rs. 2.83/kWh in 2018–2019. Solar tariff plummeted from Rs. 6.17/kWh in 2014–2015 to Rs. 1.99/kWh in 2020–2021[8]. However, developers who won these bids may find it difficult to meet these rates given the dependence of these rates to input prices and availability.

   RE and battery storage development is extremely material intensive. Generating one terawatt-hour of electricity from solar and wind could consume, respectively, 300% and 200% more metals than generating the same number of terawatt-hours from a gas-fired power plant, on a copper-equivalent basis (Mckinsey, 2022). Moreover, most of the critical raw materials (such as Copper, Nickel, Cobalt, Lithium, and Rare Earth Minerals) are processed in China and produced in several other countries (such as Chile, Congo, Indonesia, Mongolia, Australia, Peru, and the USA). Availability of raw material at a competitive price may be a challenge, given the rise in global demand for raw materials. India is dependent on the import of raw materials and is thus exposed to commercial. Downside risks arise from supply change challenges for procuring wind turbines and solar modules at competitive prices. The average price of solar modules has increased by about 35%[9] and is likely to remain high as raw material costs are skyrocketing. This would impact the RE developers and domestic manufacturers alike and would be a major hindrance in achieving the targets.

3. *Financial health of the State and Electricity Distribution Company (DISCOMs)*

   The viability of RE in the face of rising raw material and input costs is contingent on developers' ability to secure modules within budget and raise debt fund at reasonable costs (say less than 8.5%). However, the risks faced by the developers, particularly with high amounts of receivables from DISCOMs, impact their costs of borrowing. The overall dues of DISCOMs to RE independent power producers was about Rs. 21,000 crores (as per PRAAPTI portal) putting pressure on the working capital and debt servicing of the developers. This is true for most of the RE-rich states, including Andhra Pradesh, Rajasthan, Madhya Pradesh, Karnataka, and Telangana, which have high revenue deficits, large outstanding liabilities, and large outstanding contingent liabilities. These make the states suspect in terms of extending credible counter guarantees for RE development. Moreover, DISCOMs are stressed for liquidity, arising from operational inefficiency, revenue cost gaps arising from inadequate tariff revisions, outstanding subsidy receivables from the government and receivables from government departments for electricity consumed. All of these add to commercial risk and costs of borrowing for the developers (also see chapter 3).

4. *True cost of RE*

   The cost of RE also depends on the location of the generation and utilisation, as the landed cost of RE at place of use may be very high after all transmission costs and losses are stacked up. Thus, it is not just the RE potential that indicates the cost, but also location and use. Discovered tariffs through bidding process do not reflect the true cost of RE, which may burden power procurement costs if RE is mandated to be a must run.

5. *Conflicting policies*

   The impact of Basic Custom Duty (BCD) of 40% on modules and 25% on solar cells, while protecting domestic manufacturing will adversely affect the tariffs offered by the developers[10] and would slow down the process of capacity addition in the solar sector.

   Apprehensions on the applicability of BCD have been expressed by manufacturers housed in the Special Economic Zones (SEZs), as they are regarded as international territory for trade and commerce, given that local raw materials bought by producers are treated as exports and goods produced in the SEZs and sold in Domestic Traffic Area are regarded as imports. Nearly 40% of module manufacturing and 60% of the cell manufacturing capacity is in SEZs.

6. *Increasing penetration of variable RE renders the grid unstable*

   RE (without storage) poses a huge challenge to the grid operator, as compared to dispatchable fossil fuel plants, owing to their variable and intermittent nature. There is always an element of uncertainty in the output of solar and wind availability forecasts and is very location specific. The capacity utilisation factor of renewables (for solar: 18% and for wind: 22%) is substantially lower than that of conventional power plants. Moreover, with solar and wind plants having a must-run status, the plant load factors for conventional power plants are on a downward trend, leading to higher generation costs. Variable RE, in the absence of cost-effective and adequate energy storage systems (also see chapter 3), poses a challenge in ensuring grid stability.

7. *India is predominantly a coal-dependent economy*

   India's growth aspirations cannot be achieved through RE and energy efficiency alone. Even battery storage and emerging technologies, like green hydrogen and fusion, are neither cost-effective nor commercially ready yet. Therefore, fossil fuels would have to power India to fulfil its development objectives. While environmental sustainability and emission intensity will be addressed through the continued deployment of renewables and increasing penetration of new clean technologies as well as energy storage, coal will continue to play a major role along the energy transition landscape. While we do not have enough gas and harnessing nuclear energy in a densely populated democratic country can be slow, we sit on huge reserves of coal. Besides, we are locked into coal-related infrastructure and investments. Thus, in view of the above and as discussed below, phasing down of the coal-based power generation will be extremely difficult considering the role of coal in India's socio-economic development and its energy resource availability.

It is time to recognise that *energy transition is not the same as technology transition*. Technology penetration can be disruptive and rapid, but energy transition is a gradual process that should balance socio-economic and environmental implications in an equitable manner[11].

Importance of Coal in India's Energy Transition

It took an uncertain and disruptive event like the Russia–Ukraine war to demonstrate the importance of energy security for a country. Energy security implies adequate and reliable supply, and this entails looking inward for energy resources reducing external dependence across the entire value chain. The recent events underscore that the importance of fossil fuels, and nuclear energy cannot be wished away easily in favour of clean and safe energy, even for the developed countries like Germany, UK, France, and the USA. Many of these countries, particularly the European nations that have been vociferous against environmentally dirty fossil fuels, and stopped expansion of nuclear power capacity after the Three Miles Island accident (1979), the Chernobyl disaster (1986), and Fukushima nuclear calamity (2011), are once again trying to revive mothballed thermal plants and re-plan nuclear power development. Reality has dawned on all nations, developed and developing alike, that rapid decarbonisation through phase-out or phase-down of coal plants is an unachievable dream. The recent attempts across the globe to revive conventional power generation seals the discussion on whether coal should continue to figure amongst the transition fuel mix along India's development trajectory, despite having declared ambitious renewable energy targets.

The challenges of expanding variable RE (VRE), as discussed above, are compounded by its adverse impact on energy security. Thus, the onus of energising development in India with reliable and affordable energy rests on conventional fossil fuels, major hydro, and nuclear. Major hydro and nuclear development in India have been quite slow so far, with their share in total generation remaining stagnant for decades. India does not have enough gas which has resulted in 14.3GW of stranded gas-based capacity across 31 plants, out of a total installed gas-based capacity of 24.82 GW (Baruah, 2023). However, now with increased penetration of RE in the grid and resulting grid instability and the need to meet a rapidly growing peak demand during high-demand seasons, experiments are being explored to use the stranded gas plants using imported liquefied natural gas

(LNG) to meet the demand and balance the grid. This may be financially manageable considering that during the peak season of summer in India the global gas prices are relatively cheaper and medium-term future contracts may yield attractive deals. Studies have observed that even with volatile global LNG prices, gas-based power generation as a relief to peaking requirement during summer season may be more economical than short-term market options, including purchases over power exchange, bilateral trade, and deviation settlement mechanisms (Baruah, 2023). Thus, blessed with large domestic coal reserves and the importance of electricity to balance India's energy trilemma, coal will play a critical role in its development trajectory over the next couple of decades with additional support from other conventional fuels.

A *coal transition exposure index* introduced by International Energy Agency (IEA) taking into consideration a country's coal – (i) energy dependence, (ii) development gap, (iii) lock-in, and (iv) economic dependence, indicates that Indonesia, Mongolia, China, Vietnam, India, South Africa, and Botswana have very high indices of coal exposure in transition (Tachev, 2022). India's exposure is high on account of the development gap, lock-in, and coal dependence.

India's coal consumption has doubled since 2007, growing at an average annual rate of about 6% and is led by electricity generation. Coal-based electricity generation accounts for more than 73% of India's electricity needs and is likely to remain the major source over the next couple of decades. Coal-based capacity at about 204 GW accounts for more than 50% of the overall grid-connected power generation capacity, with a notable additional coal-based capacity under construction. According to a CEA Report,[12] of the total 53.24 GW of thermal power plants (TPP) in the pipeline, about 24.4GW of the TPPs have been put on hold or are unlikely to be constructed and about 28.87GW TPPs are likely to be included in the national capacity between 2022–2023 and 2026–2027. The TPPs unlikely to be constructed are mostly in the private sector (about 23.21GWs) and are not finding financing or going through liquidation. The private sector has been facing difficulty in financing coal-based projects as banks and financial institutions around the world are staying away from coal mining and coal TPP projects. The public sector, however, has been able to raise finance from government finance companies. State and central sector projects account for the entire 28.87GW of the projects under construction and likely to be added. Over the next decade the coal demand by TPPs, operating at relatively low utilisation levels in recent years, around 58.87% in 2021–22 when in 2008–2009 it was 77.7%, due to rapid penetration of RE, is likely to go up substantially.[13] Thus, despite no new capacity of coal TPP being added, coal shall continue to dominate electricity generation and the energy scenario in the short-to-medium term.

Further, phasing out of existing coal TPPs and rapidly replacing them with clean energy resources is not a likely strategy in the immediate future. This is because the Indian power sector is locked into a basket of young coal-based power plants, where the average age of a plant is just about 13 years, while its economic life is 40 years.[14] Compared to this, the average age of coal plants in South Africa is 30 years, and 41 years for Russia and the USA. The locked-in investment of the Indian TPP portfolio exceeds Rs. 8 trillion,[15] and TPPs under construction would further add to the locked-in investments. If coal production, transportation, and associated infrastructure to coal TPPs are considered, then the investments locked into would be massive and it would be very costly to phase out much before the completion of their economic life.

India was the world's second-largest producer of coal in 2017, according to the IEA, while China topped the list. India produced about 780–800 million tons of coal in 2022, according to the Ministry of Coal (MoC), but consumption still exceeded by about 200 million tons that was imported from Indonesia, South Africa, and Australia. Around 87% of India's proven coal reserves of nearly 150 billion tonnes is non-coking coal, yet, a fifth of the thermal coal requirement is imported. In comparison, China, which consumes four times more coal than India, also imports about 200 million tons annually. Considering that various studies conclude that the future of coal is secure in India for another 20–30 years, even as VRE proliferates, large coal imports is a matter of concern given its vulnerability to high global prices[16] and energy security issues.

BP Energy Outlook 2019[17] projected the coal's share in India's primary energy consumption to be 48% in 2040 despite a decline from 56% in 2017. Likewise, IEA (in India Energy Outlook 2021) has observed that coal in the power sector will be 67% (in MTOE[18] terms) of share in 2030 and 50% in 2040 under a Business-as-Usual scenario. Further, according to the MoC, the requirement of coal by 2029–2030 has been estimated at about 1.45–1.5 billion tonnes, for which domestic production will have to go up substantially to meet the demand and bring down coal imports, although it may remain about 170MT.[19,20]

Thus, the coal companies in India will be ramping up coal production to meet the MoC's projected 63% higher targets of about 1.5 billion tons of coal by 2030. In view of this, the MoC has been amending mineral concession rules, introducing policies and guidelines and carrying out auctions for coal mines, which include commercial and captive mines. Supply to the power sector, at about 85% of total dispatches, remains very high and will grow as demand from coal-based TPPs remains high to meet India's electricity needs. Opening of new mines and rise in production will lock into coal as a fuel source for a long time. Notwithstanding the expected growth in coal production, coal demand is likely to outstrip domestic supply, though the share of imports is likely to substantially reduce over the next couple of years. The gap between domestic demand and supply of thermal coal cannot be bridged as India has very limited reserves of high-grade thermal coal and imported coal blending is required for efficient combustion and reduced ash generation. Besides, thermal coal imports will continue to cater to imported coal-based coastal thermal plants for the entire economic life of these plants.

India's socio-economic dependence on coal is extremely high (also see chapter 3). Several states are extremely dependent on coal, particularly 6 states covering 33 districts of the 284 coal-dependent districts as estimated by a study (Pai, 2021). A study finds that more than 3.6 million people are either directly or indirectly employed in the coal mining and power sectors in 159 districts in India. Of the 3.6 million people, nearly 80% of the jobs are linked to coal mining located across 51 districts, while the rest of the jobs are linked to coal power plants (Aggarwal, 2021). Coal is a source of huge revenue for the States and Centre through taxes, royalties, District Mineral Foundation (DMF) funds and Corporate Social Responsibility (CSR) funds. Most of the States having large coal resources are economically disadvantaged and underdeveloped, making them extremely vulnerable to the revenues from the mining sector and dependent for creation of livelihood and infrastructure both physical and social. Further, Indian Railways (IRs), which is one of the largest employers in the country with daily passenger traffic of more than 20 million and an annual freight loading exceeding 1400 million tons, has coal transport making up more than 47% of the IRs freight revenues and has even higher share in its profits (Khan, 2022). Therefore, the importance of coal sector for the socio-economic imperatives and development of the country is well recognised and deeply entrenched.

Coal Strategy for India's Decarbonisation Trajectory

As discussed earlier, energy transition along a decarbonisation trajectory in India is extremely complex on two counts – (i) balancing the energy trilemma to secure high economic growth and sustainable development with universal energy access at affordable rates and (ii) difficulty of moving away from coal given its abundance, affordability, lock-in and deep socio-economic dependence. Transition is mainly about people, technology, finance, and environment and is systemic in nature. While there is no debate that India will stay committed to a sustainable energy transition with characteristic green, clean, and efficient energy use, the key issue is about the pace of this transition defined by the challenges and context discussed earlier.

India will continue to push for RE and several emerging clean energy technologies, but the importance of coal in the energy basket is likely to remain significant for another two decades. NITI Aayog and IEA assessed that even around 2035–2040 the overall demand for coal remains strong, although there may be a drop in the share of coal in primary energy supply (Niti Aayog, 2022). A well-planned strategy for coal-based development, particularly over the next two decades, would nudge the economy on a desired sustainable growth path. So, in the transition strategy proposed next, any phase out or phase down in coal is not envisaged both in the short and medium term. Rather, it considers the opening of new coal mines to meet energy and coal demand. Under-construction coal TPPs will come on-stream and existing old inefficient coal TPPs will be renovated, modernised, and receive economic life extension. Although India's climate commitments could mount pressure on coal TPPs for early retirement, techno-economic considerations and the need for economic growth would dominate decisions. Also, in the long term, there may be significant coal demand for projected adoption of clean coal technologies such as coal gasification, coal liquefaction etc. Further, one has to find ways to equip coal-based and other technologies for maintaining grid balance being threatened by greater penetration of variability in the system and energy demand management and conservation. Figure 2.1 presents a schematic of the coal strategy for India's decarbonisation trajectory in a phased manner.

The immediate requirement is to improve the operational and financial performance of the DISCOMs (see chapter 3). Efforts at reforming the distribution segment of the electricity sector have been continuing for a long time, but despite some improvements in several areas the sector continues to be the weakest link. DISCOMs performance improvement help mitigate the commercial risk and financial position along the entire value chain, as the financial performance of coal TPPs and coal producers ultimately depend on the financial health of DISCOMs. DISCOM initiatives to bring down operational losses and demand management would also have significant implications for electricity and hence coal demand. Besides ensuring resource adequacy, supporting generation companies for renovation, modernisation, efficiency improvement and flexibilisation of plants, and supporting hybridisation of coal TPPs with renewables as well as repurposing of plants, are all linked with the financial and operational situation of the DISCOMs.

Considering that 28.87GW of under-construction coal TPPs are likely to be added to a young portfolio of thermal plants over this decade and that the capacity utilisation of the plants will rise significantly with rising demand, it is imperative to ensure that all the new plants are highly efficient, with state-of-the-art emission mitigation equipment, both *in situ* and end-of-pipe. To this effect, the draft National Electricity Policy 2021 lays down a vision of a financially viable and environmentally sustainable power sector furthering

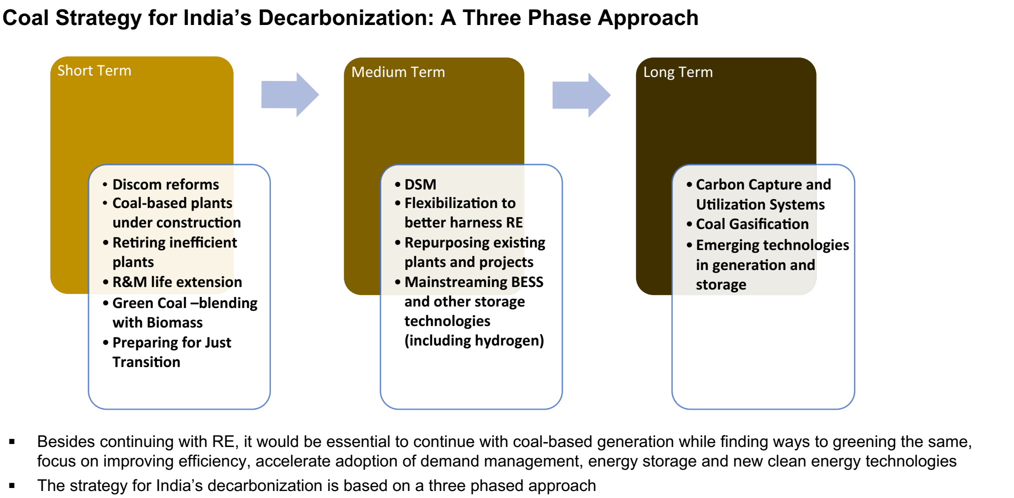

Figure 2.1 Coal strategy for India's decarbonisation trajectory in a phased manner.

Source: Author's own.

energy security and providing reliable 24 × 7 power at a reasonable price. Stringent emission norms have been notified by the Ministry of Environment, Forest & Climate Change (MoEFCC) for SO_2, NO_x, mercury and water, which are required to be achieved within a specified time schedule and have cost implications on the operation/design of coal-based plants. In addition to the equipment cost, they also entail auxiliary electricity consumption. The policy proposes that efforts must be made to meet the compliance norms in the most cost-effective way to minimise cost to the consumers. It further suggests that the regulator should allow this under sections 62 and 63 of the Electricity Act 2003. The draft policy also provides that all future coal-based plants should deploy ultra-super critical less-polluting technologies or other more efficient technology.

Indian coal is of very low grade having very high ash content (30–45%), which produces large quantities of fly-ash and bottom ash in coal TPPs, the disposal of which poses an environmental challenge. As coal combustion in TPPs over the short to medium term grows, the need to prioritize utilisation of ash and byproducts of combustion is paramount. The MoEFCC has issued a notification on 31 December 2021 mandating all TPPs to utilise 100% fly-ash in an environmentally friendly manner for making construction material, reclaiming low-lying areas, mine filling, agriculture and wasteland development, etc. While the focus so far is on known areas of commercially viable applications, in the long term more value-added use of emerging applications and technologies would gain importance.

Recognizing strong growth in electricity demand, the Ministry of Power (MoP) has recently issued an advisory, through the CEA, asking power generation utilities to not retire coal-fired power plants till 2030, and also ensure availability of units through renovation and modernisation (R&M) activities.[21] With appropriate spending on maintenance, R&M and life extension (LE) plants can operate for 35–40 years. This comes close on the heels of an MoP advisory that coal-based power plants older than 25 years should be closed as part of the country's decarbonisation strategy a few years back and a recent slowdown in RE capacity addition. This was on the basis of plant life assessments that about 58% of the capacity of the 204 GW coal plants in operation are less than a decade old and another 21% of the capacity is 11–20 years old. The remaining 9% of the capacity is about 21–30 years old, 11% is about 31–40 years old, and 2% of the capacity is more than 40 years old.[22] It was assessed that about a fifth of the total coal TPPs (mostly sub-critical) capacity could be taken out for decommissioning immediately. However, the recent MoP advisory disallows the previously estimated retirement of about 50–60 GWs coal TPPs over the next eight years and needs to revisit expected retirements of TPPs from 2031 onwards.[23] Responding to environmental concerns of coal generation expansion, CEA has issued revised guidelines for R&M to facilitate compliance with environmental norms, facilitate biomass co-firing, lower water consumption, and enhance flexibility in addition to achieving higher efficiency levels, life extension and raising operative capacity. The MOEFCC issued stringent emission norms and notified "Environment (Protection) Amendment Rules, 2015" for thermal power stations on 07.12.2015, the timeline for meeting which has been revised (vide gazette notification dated 31.03.2021, with extensions ending in December 2024) along with compensation for non-compliance. The draft NEP proposes that regulators recognise these costs and allow them to be recovered through tariffs.

Greening of coal or co-firing biomass pellets blended with coal in TPPs in the short to medium term has a dual importance of a net reduction of the greenhouse gas (GHG) from coal burning and curtailment of environmental pollution due to burning of crop residue. India has been harnessing biomass-based electricity generation, using diverse feedstock like bagasse, rice husk, straw, cotton stalk, coconut shells, soya husk, coffee waste, jute wastes, groundnut shells, sawdust, etc, and has exceeded the target installed capacity of 10GWs. The MoP, in 2017, notified "Biomass Utilisation for Power Generation through Co-firing in Pulverised Coal Fired Boilers, and this was followed by CEA in 2018 issuing an advisory "Technical Specification for Agro Residue for Agro Biomass based Pellets (Non-torrefied/Torrefied) for Co-firing in Coal Based Thermal Power Plants." The Government of India (GoI) has made it mandatory for thermal power plants to use a 5% blend of biomass pellets and coal, with a requirement to increase the blend to 7% within two years. The co-firing policy will be in effect for 25 years or till the useful life of the thermal power plant, whichever is earlier. Biomass pellets may have equivalent calorific value to that of Indian coal, based on estimates from the CEA. However, there are presently some challenges that should be addressed. The first challenge is with the bio-pellet supply chain – production, collection, processing, transportation, and storage. Second, the distributed nature of the biomass arising from diverse agro-climatic regions and hydrology, soil, and cropping patterns could be a problem for pelletisation. Third, all types of TPP technology is not compatible with biomass pellet co-firing and the chemical composition of the biomass (with high silica content) may also pose problems requiring TPP R&M to make it suitable. Yet, another challenge is the landed cost of pellets compared to coal prices. Landed cost of bio-pellets (3800 KCal/Kg) is Rs. 7193/MT, while coal (3600KCal/Kg) is Rs. 4560/MT therefore significantly pushing up cost of power.[24]

The transition away from coal along the decarbonisation trajectory may happen over decades, with some coal mines closing down in the short-to-medium term due to exhaustion of reserves, while others may take a very long time. Similarly, over the medium to long term, once the economy has sufficiently developed and alternate fuel technologies in the supply basket are large enough to meet the demand requirements, the sufficiently old, inefficient and costly coal TPPs will also be decommissioned. Such closures and decommissioning, whether over short-to-medium term or long term, will impact the livelihood and health of the community, create social disruptions, adversely affect physical and social infrastructure, raise concerns for repurposing the resources to restore environment and ecosystem, and severely impact public finance. Repurposing of retired coal TPPs may have an important role in harnessing emerging energy technologies like production of hydrogen, as the plant site provides for land, water availability, logistics, and connectivity. Workforce can be reskilled, and repurposing could provide an opportunity for harnessing emerging fuels at a reduced cost. A coal TPP could also be used for solar energy development, as the electricity evacuation infrastructure is also present and could be a source for green hydrogen as well. However, the question remains if the country has the necessary preparedness at present to close down coal mines and decommission large-capacity coal TPPs while ensuring a just outcome for the environment, land, labour and all dependent communities. While the transition cannot happen in an ad hoc manner, a comprehensive closure framework is missing. The existing legal and regulatory mechanisms in India dealing with land, labour, environmental, and finance issues are not adequately equipped to address the issues of a coal mine or power plant decommissioning.[25] While the transition may take multiple decades, it is imperative to immediately lay down a Just Transition framework and ensure its implementation (also see Appendix 5B).

Over the years, with faster and larger deployment of RE capacity, concern for grid instability has increased. Wind energy is largely seasonal and the solar plants peak in the afternoon, but both may not coincide with daily and seasonal system peaks. With massive commitments for RE, mainly solar and wind, made by the government over the coming decades, grid instability will increase unless balancing and ramping requirements are present in the system. Measures that will enable better integration of renewables into the grid include overcoming congestion issues in transmission infrastructure to enable better exchange of RE from surplus region to deficit regions, having resource adequacy for balancing grid instability arising from intermittent nature of RE and co-ordinated scheduling and dispatch at country level in a developed power market. Amongst these, the most important requirement is to have resource adequacy for balancing, which can best be provided by battery and energy storage systems (BESS). Battery systems could be charging during system off-peak and supply energy during peak periods, but commercial viability and uncertainty around its large GW scale adoption remain. Other storage and flexible supply systems, like pumped hydro projects (PSP) – on and off-river, hydro storage system, and open cycle gas plants could also provide the required balancing and ramping privilege to the system having large RE variability. However, the falling share of hydro generation, shortage of domestic gas, and expenses associated with PSP, the existing coal TPPs are required to provide the flexibility of smoothening the load curve. The flexibility of a plant can be broadly characterised by the technical minimum at which the plant can operate, permissible ramp-up and ramp-down rates that define the time taken by the plant to respond to demand, the number of times the plant can be shut down and restarted, and start-up time or time taken by a plant to start from a no-load situation. Measures to achieve these features of flexibilisation typically include procedural changes, equipment retrofits, and/or combinations of both. A TPP must be retrofitted with steam extraction and thermal energy storage that allows for power output adjustment without changing firing rate in a boiler to fulfil the role of flexibilisation. Investments towards this should be allowed by the regulator to be recovered through the tariffs and considered a mandatory expense for the development of RE.

Finally, in the long run, clean coal technologies (CCTs) and application of coal combustion byproducts, which are being presently researched for bringing them to the level of commercial acceptability, would be available. CCTs reduce the environmental impact of coal power generation by using coal more efficiently or by removing undesirable pollutants after combustion. Coal washing is the most commonly prevalent CCT in India that can reduce CO_2 emission by 2–3% using washed coal having 34% ash coal as against unwashed coal with 42% ash content. Cost of washing is offset by reduced cost of transportation for low ash coal, lower plant operation and maintenance cost, and higher power generation efficiency. While different approaches to coal washing is well established, other CCTs include a variety of technologies that reduce air emissions and other pollutants in electricity generation. Efficient coal technologies like ultra-supercritical, advanced ultra-supercritical, integrated gasification combined cycle (IGCC), etc would be gradually introduced for the generation of electricity at commercially acceptable rates with extremely limited emissions. Other CCTs that are being explored for a long time are coal gasification and coal liquefaction at the coal mines to produce cleaner and highly efficient fuels. GoI has put in place the National Coal Gasification Mission with the goal of 100MT coal gasification by 2030. Further, coal gasification technologies are also fast evolving for downstream production of hydrogen and chemicals like methanol, ammonia, etc, and for combined cycle power generation. Possibly the most important CCT from the perspective of coal use in power generation is carbon capture, utilisation, and storage (CCUS) technology. CCUS, if commercially viable, provides immense opportunity for India with large coal reserves to continue to use coal and strategically balance energy trilemma. Carbon capture and storage (CCS) is the process of removing CO_2 from industrial processes such as power plants that burn fossil fuels. CO_2 can be transported and stored in underground geological formation or the carbon captured can be used as a by-product. Prototypes of emerging applications of by-product coal combustion in power plants include production of zeolites from fly-ash and carbon nano-tubes from carbon capture are being developed to assess commercial viability and applicability. Zeolites find use in detergent, elimination of toxins and carcinogens, removal of water pollutants, catalytic cracking, production of medical oxygen, etc. Carbon nanotubes have immense potential including applications in energy storage and space programmes.

Conclusion

Energy transition in India, along a decarbonisation trajectory, is fraught with the challenge of ensuring energy security, access, availability, and affordability as the economy has to prioritize its growth and socio-economic development objectives. While India has committed to substantial power generation capacity from non-fossil sources, coal will continue to dominate the energy landscape for multiple decades due to fuel security, reliability, and cost advantage. Besides, the challenges are many for large-scale harnessing of renewable and non-fossil energy sources, even with RE sources that have achieved commercial maturity. In fact, non-fossil sources of energy can be quite dirty if the entire supply chain of these less-polluting energy sources are traced. For many of the RE sources that are extremely material intensive, India has neither the resource control nor processing control over the supply chain. On the contrary, coal supports India's development agenda sans the associated damage that pollution from coal production and combustion causes. Further, in India, the socio-economic dependence of community, industry, and government is very deep, and any ad hoc transition away from coal will be economically, socially, and politically disruptive and unjust. Thus, accepting that India has to tread a sustainable and environmentally benign development trajectory, it would be prudent to find ways to use coal to fuel its growth and development in an environmentally less-polluting manner.

It is important to recognise that coal is not replacing the less-polluting options like RE, hydro, nuclear, emerging non-fossil sources like hydrogen, etc. Instead, coal is moving towards a low energy use circular economy characterized by reduce, recycle, and repurpose of materials. The role of (greener and cleaner) coal is to coexist with alternate fuel forms, provide support to facilitate greater penetration of VRE, and serve as a bridge energy source to pave the way for more efficient technology options. Sooner, our policymakers accept that coal shall continue to be India's primary fuel energising its journey towards becoming a developed country, the better it will be to synchronise technology development, direct investments and government expenses, design policies, and plan implementation frameworks.

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3 Energy Transition and Centre–State Priorities

Alignments and Misalignments of Policies and Decisions

Tirthankar Mandal[1]

Introduction

The power sector in India has experienced enormous growth since independence, growing from 1362 MW in 1947 to around 400 GW in 2022 (Srinivasan 2022). However, this growth has not translated into concomitantly higher per-capita consumption of electricity for the people of India. While existing inefficiencies are a major reason, managing the ambition of the political class with prudent policies in the distribution and pricing of electricity are other crucial causes. It is observed that, in the initial years of nation building, the power sector was expected to fulfil two major objectives, first, to provide basic minimum energy needs of people through provisioning of electricity and secondly, be the input to the modes of production for the country's economy. In doing so, the inherent aim was to ensure that the residential and agricultural sectors get cheaper sources of power, while the industry and commercial segments were charged at higher rates. While theoretically this arrangement seems plausible, challenges arise when political interests are taken into account.

Four elements are key to analysing the interplay of politics and decision making in India's power sector. These are access to quality and reliable power; demand for subsidies; average cost of supply of power; and financial health of the power sector (Dubash, Kale and Bharvirkar 2018). The political and bureaucratic forces used these elements time and again to influence power sector policies across different states of India to ensure beneficial private outcomes. Political interests gain primacy in policymaking under the guise of social welfarism. The popular tool used in this regard was the power tariff for different consumer segments. States competed with each other to offer lower tariffs to residential and agricultural consumers for years together, destabilising the finances of state-owned power entities (Dubash, Kale and Bharvirkar 2018). The issue of agriculture subsidies in the power sector continues to impact financial health even now. In Figure 3.1, we provide a snapshot of the increasing subsidies in the electricity sector as a percentage of GDP since 2016.

Electricity, being a concurrent subject, it was somewhat of a tradition that the state governments focused on determining and designing tariffs and providing electricity benefits to end consumers, and the central government looked after the physical expansion through big projects undertaken through entities like NTPC (in case of thermal power plants) and NHPC (in case of hydel). However, this segregation of responsibilities did not result in greater access or assurance of reliable power to the majority of Indian citizens (Smith 1993). The central government in the 1970s and 1980s created infrastructure for the power sector through transmission lines and higher capacity addition, but they were

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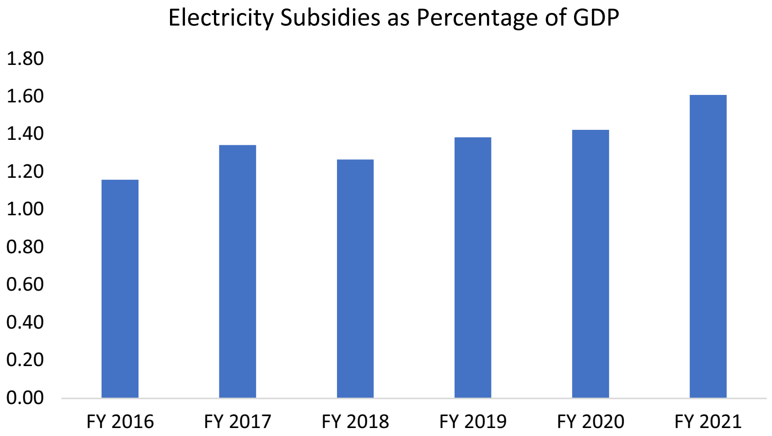

Figure 3.1 A snapshot of the increasing subsidies in the electricity sector as a percentage of GDP since 2016.

Source: RBI Macroeconomic Aggregates, 2022.

mainly to supplement the state government efforts (Tongia 2003) and failed to ensure electricity flow to end users. The then Planning Commission allocated expenditure for subsidies for the power sector, which were decided based on the physical growth of the sector to meet expansion costs (Narayan 2019). But the ever-increasing subsidy bill, despite some being allocated to RE (renewable energy) with low generation cost soon becoming a problem, while attempts to address it were not wholehearted. For example, although the central government during the 1980s and 1990s convened occasional meetings of Chief Ministers' to discuss the power sector, (Dubash and Rajan 2001), concrete actions were not offered. This could be because of pressure groups formed a politically influential and important segment. For example, the demand for increasing agriculture subsidy for power was raised by the states like Maharashtra, Punjab, and parts of Uttar Pradesh, states where farmers were politically and economically influential. As a result, top-level decision makers choose to not disturb existing arrangements but at the cost of financial hara-kiri (Dubash, Kale and Bharvirkar 2018).

It is against this backdrop of pressure groups and specific interests from within individual states themselves that the recent developments regarding RE growth need to be understood. Worldwide, it is believed that RE growth has fundamentally changed the perception of electricity policymaking requiring new thinking around benefit sharing (Khanna, Singh and Ashwini K Swain 2015). The steep decline in costs of RE-based electricity production in recent years coupled with heightened attention to environmental concerns emanating from fossil fuel–based power sources has led to a series of changes in power sector policy to address intermittencies of RE and reap cost efficiencies. However, the older political narratives and priorities still remain valid as issues such as access and agriculture subsidy remain unaddressed (Swain, Dubash and Bhatia 2019). The gradual replacement of the source of power generation is an interplay of technical variables around fossil fuel–based supply and RE resources, political priorities, and state priorities.

In light of RE development, while the targets are set at the national level, the resources exist only among a handful of states,[2] with the remaining states on the fringe. The notion of a common state-driven RE pathway is not even in play, as the priorities for the RE resource-rich states and the RE resource-deficient states are at variance. This explains why the central government took the onus to set the agenda for RE-based growth for the power sector, which has structural implications for the sector. It also coincided with India's position in the global discourse on climate change and emission reduction targets. To the world at large, the central government chose to position itself as an active and interested party, and therefore, the country's ambition was, largely, first decided and announced without sufficient thought being given to implementation design. This approach has had a definitive bearing on the way state governments responded with respect to the power sector in the recent past. The next section delves deeper into this matter.

What Changed and What Remained the Same: Renewable Energy Integration into the Power Sector

The country's journey into RE started in the 1980s, when the central government experimented with these sources as "alternative" sources of energy. During that time, there was not much change in the policy as such, because the capacities were small as compared to the existing mainstream fossil fuel–based power sources. It was only from 2008 to 2009 onwards, when the Jawaharlal Nehru National Solar Mission was announced, that India's ambition for mainstreaming RE was first recognised in the policymaking domain. Then, in 2014, when there was a change in the 10-year-long rule of the UPA government at the national level and the NDA government took over, the Prime Minister announced the big and ambitious number of 175 GW of RE by 2022. This was the first time that India joined the bandwagon of countries that chose formidable targets for decarbonisation. Electricity being the most carbon-intensive sector, the RE target was considered as a game changer. To implement it would necessitate, above all, an alignment of policy at all levels.

As the literature on the power sector suggests, attempts to correct its increasing inefficiencies started well before the advent of REs in the mid-2000s. The dominant set of reforms was implemented during the 1990s along with the overall thrust towards liberalisation across the government (Ramanathan 2001). The implementation coincided with the rapid growth of RE in the country, supported by favourable policies. The reforms were characterised by three waves during the 1990s, in which the attempt to address some of the structural issues of the power sector was thwarted by political interests groups, and fundamental challenges were not addressed adequately (Dubash and Rajan 2001). These are discussed next.

Agriculture Subsidies

One of the issues that could not be tackled even with multiple reforms during the 1990s and in subsequent years is that of agriculture subsidies.

> The power industry bureaucrats and staff, planners, and some classes of consumers became increasingly frustrated with the functioning of the sector. The main complaint of SEB managers was that, as government appointed officials, their elected superiors were providing them directives that interfered with day-to-day operations.
>
> (Dubash and Rajan 2001)

Although technocratic logic suggested a reduction of agriculture subsidies, its quantum continued to increase. Furthermore, on occasion, interference by elected superiors resulted in *ad hoc* decisions such as the extension of the grid network to constituencies, which worsened the operational efficiency of the grid.

Agriculture subsidies also started growing because of the growth of demand for irrigation across the country, which needed pumps. Because electricity for irrigation is not priced in most of states, its profligate use resulted in rising subsidy bills (Regy et al. 2021). While technocratic solutions such as feeder separation (Ramesh 2020) abound, the problem lies elsewhere. Interest groups ensured that the subsidies advanced to the agriculture sector are not even adequately quantified. Currently, at the state level, there is fuzziness around the calculations of the subsidies and no single standardised methodology exists, resulting in debates around capping these subsidies.

The growth of RE led to the mounting agriculture subsidy becoming a subject of discussion at both the central and state government levels during the 2000s. The central government has started addressing the issue in a graded manner. First, through the introduction of provisions in the Draft Electricity Act of 2020, it introduced the separation of feeders for agriculture. In the absence of metering at the end-user level for a large section of consumers, this would provide an estimate of how many units are consumed for agriculture. This in-turn would give states an estimate of the quantum of subsidy required. In the context of falling prices and its distributed nature, plans are put in place to utilise RE for the agriculture sector to minimise T&D losses and get rid of huge transmission requirements (Gambhir and Dixit 2018). If this is achieved, we could untangle an issue without impacting the social contract of the power sector. Secondly, the MNRE has introduced the KUSUM scheme which enabled farmers to feed the surplus power generated from their solar panels to the grid, resulting in extra income. A summary of schemes that could promote an energy transition is provided in the Box on 'Solarising Agriculture' in Chapter 6.

Distribution Companies (DISCOMs) and Their Operations

DISCOMs are at the centre of the electricity eco-system (also see chapter 2). To begin with, in 1947, the DISCOMs oversaw transmission and distribution in a completely integrated power sector. DISCOMS ensured that agriculture and residential customers got cheaper electricity than their industry and commercial counterparts. Electricity pricing in the residential and agricultural segment was much lower than the actual cost of supply, while industrial and commercial customers were charged more, an arrangement popularly known as cross-subsidy. The reforms of the 1990s followed by the Electricity Act of 2003 led to big changes in the role of DISCOMs. They were now restricted to procuring power for consumers from different sources and then distributing them through a state-developed network. They were not supposed to pass on the cost of providing these networks to consumers but were to be compensated with a subsidy, calculated based on the average cost of supply. These changes were implemented to bring efficiency and manage the ever-growing electricity eco-system in the country (see also the discussion in Appendix 8A of Chapter 8).

With the growth in RE in recent years, it has been argued that DISCOMs should be given more liberty to take advantage of the low cost of RE. However, this has not happened, and DISCOMs, across the country, are locked into high-cost power purchase

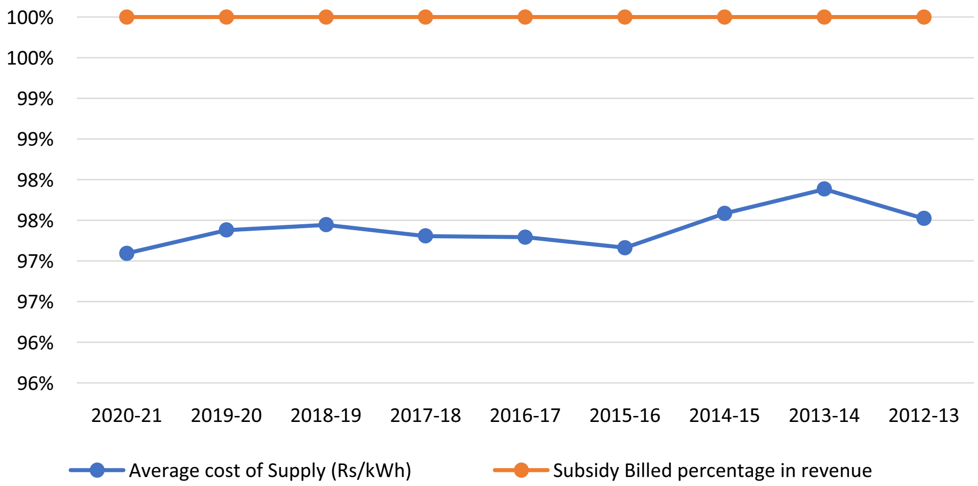

Figure 3.2 Average cost of supply vs revenue tariff for DISCOMS.

Source: PPAC, 2022.

agreements (PPAs) which are either thermal energy or older RE (Agarwal, Rao and Agarwal 2022). In addition, to take part in the new mechanisms of bidding for electricity, the DISCOMs require strong financial backing. Having accumulated a lot of debt over the years their financial position is fragile and therefore, they are unable to take advantage of these new opportunities. So, at the end of the day, DISCOMs are forced to use power from extant PPAs, which are costlier than the current generation prices of RE. With the pooled price of power being higher than the market price of RE generation, it is economically loss making for DISCOMs to supply to consumers. At the same time, having got locked into long-term PPAs, DISCOMs have to continue to provide power at higher-than-market price of RE, completing the vicious circle. Recent notifications, such as the Must-Run Status for RE or Market Based Economic Despatch (MBED), have not helped to address this situation. Figure 3.2 demonstrates that the average cost of supply has remained high for the DISCOMs even though the cost of generation has reduced due to the bundling of high cost of old PPAs and lower revenue recovery.

Misalignments

The growth of RE in the country has been catalysed by both an understanding of our energy economics and global positioning. With an increased reliance on imported coal and international pressure against the use of fossil fuels, coupled with an exponential fall in the generation of electricity using RE, especially solar energy, it was prudent for India to promote rapid solarisation. The political momentum behind solar paved the way for its rapid growth since 2014. However, an examination of specific state policies during that time suggests that some of the priorities between the centre and the state are mismatched.

Disconnect between State and Centre Priorities: Physical Capacity Addition of RE

Between 2010 and 2014, growth in the use of solar energy was 10%, which accelerated to 17% (Shetty 2021) between 2016 and 2020 and then further to 22% by 2022[3]. While these absolute growth rates are impressive, the challenge lies in how they have been achieved. There are seven or eight states in India which have the maximum solar resources. The MNRE has allocated targets for each state to meet India's goal of achieving a capacity of 175 GW of RE by 2022, without consultations with respective state governments. Moreover, many state governments had their own policies with regard to solar energy independent of the MNRE allocations. Table 3.1 provides a comparison of targets allocated by the MNRE with the goals for capacity addition adopted by the respective RE resource-rich states.

One of the reasons for such divergence in targets was competing priorities between the centre and the states. A 2018 news article stated that the requirement from West Bengal to install 5 GW of solar power by 2022 to be aligned with the national target was rejected officially by the CM, citing issues with the availability of land (Majumdar 2018). In other solar resource-poor states, the target set by the MNRE simply did not make economic sense to pursue, and it was easier to purchase RE from available sources using existing mechanisms (NITI Aayog; PWC, Deloitte 2017).

Policies at Cross-Roads

Between the announcement of the target of 175 GW of RE by 2022 by the central government in 2014 and 2020, almost all states in India came up with their own RE or solar policies, demonstrating a political alignment towards RE adoption, driven by falling prices of solar generation. Favourable import policies, 100% FDI in solar industries development in India and other such measures ensured that large volumes of solar capacities were added. However, the distribution side, which was mainly controlled by state agencies, saw inconsistencies. The central government's "open access" rules, such as Feed-in-Tariff, Net-metering, and Must-run for higher RE uptake, were seen by the DISCOMs as hindrances to their own revenue generation.

Therefore, they kept on increasing cross-subsidy surcharges, banking charges, and open-access charges for RE consumers, as the larger issue of the financial health of DISCOMs (interlinked with higher RE procurement) was not addressed by the centre. It was left to the state governments to address the situation. Schemes like UDAY were

Table 3.1 Central allocation vis-à-vis state goals on solar in the context of 175 GW

In MW	*Target set by MNRE*	*State policy-based target*
Maharashtra	22,000	7,000
Gujarat	17,000	6,672
Karnataka	15,000	7,400
Rajasthan	14,000	6,200
Andhra Pradesh	14,000	6,000
Madhya Pradesh	12,000	3,600
Telangana	6,500	1,500

Source: https://www.niti.gov.in/sites/default/files/energy/Executive-Summary.pdf floated time and again, almost as a knee-jerk reaction, rather than a structured and systematic approach to address DISCOMs problems with managing finances. In addition, there is a need to rethink policies such as Feed-in-Tariff, Net-metering, Must-run etc. in light of RE prices having fallen enough to be at par with that of conventional fuels. An active central role in this regard could have created a situation wherein the financial health and RE uptake could be simultaneously addressed for the troubled DISCOMs.

It is to be noted here that even though the state government did not control the DISCOMs directly, they were responsible for appointing the DISCOMs officers. The Regulatory Commissions passing orders for raising tariffs and surcharges were also part of the state government machinery. It is not surprising then to expect that the DISCOMS would follow the lead of the state energy departments and state political interests. Thus, we see that Maharashtra has the highest open-access surcharge, and other RE resource-rich states, such as Karnataka, Andhra Pradesh, and Telangana have also issued open-access surcharges which work as disincentives to consumers opting for RE.

At the central government level, there was a push for rooftop solar through the Rooftop Solar Phase II programme, where DISCOMs are the nodal agencies for implementation. With generation prices of new RE falling and the growth of rooftop solar, the DISCOMs had to make way for consumers who opted for net-metering opportunities. Implementation of such schemes is fraught with challenges such as paying back the customers and balancing the grid. No surprise then that the DISCOMs resorted to delaying tactics for giving permissions and installing metres, although that may not be the only reason that the adoption of rooftop solar has not grown. According to the existing rules, the DISCOMs have to pay penalties for deviation, which could (theoretically) happen due to more and more RE getting injected into the system (CERC INDIA 2022). However, while there is no clarity around how these penalties would be adjusted against incurred costs by the DISCOMs, the regulators do not allow them to pass the costs on to the consumers. There could have been further growth had there been consumer-centric distributed RE policies put in place.

Evolution in Decision Making: Role of States and Central Government

As already discussed, during the decades of development prior to RE, the central government controlled the generation and transmission side of the system, while the state governments managed distribution (Swain, Dubash and Bhatia 2019). In this framework, the growth of the sector was co-terminus with gigantism – big dams, ultra-mega thermal power plants, and multi-crore investments, all driven by the central government. The state governments, on their part, put emphasis on grid expansion, sometimes at the cost of the state exchequer (Kale 2014). These trends changed with the rapid growth of RE in recent years, with state governments now involved in generation also, as evident from the recent declarations on the state solar targets.

The functions of institutions in the power sector are also being "re-imagined." In the recent past, the NTPC started big solar project investments (Mint 2021). New institutions were formed like the Solar Energy Corporation of India (SECI) to deal with the tendering process and bidding of solar energy projects. Older institutions, like the DISCOMs, were made the nodal agencies for the promotion of solar schemes (MNRE 2020), in addition to their roles in procuring and distributing power. These changes impact the balance between the states and the centre in power sector policymaking.

Attempts to Squeeze the Space for States on Electricity-Related Decision Making

One of the most important challenges of the concurrent nature of policymaking in the power sector is maintaining the balance between the central government and the states. However, the rapid growth of RE has affected this to some extent.

The Electricity Amendment Bill 2022 (Bill) introduced in the Parliament recently is a case in point. It has suggested some fundamental changes, which experts believe will alter the balance of power between the centre and the state. First, the Bill suggests the introduction of a DISCOM franchise model across states. This will replace the current models and will allow customers to choose their DISCOMs, in effect introducing competition for distribution. This is despite past experience where the idea of introducing multiple DISCOMs has not succeeded in Uttar Pradesh, Bihar, and Madhya Pradesh. In Odisha, the notion succeeded only in 2020 on the third attempt. Further, it proposes a centrally administered body which will appoint regulators for the State Electricity Regulatory Commissions (SERC) across the country. These would curtail the decision-making power of the state as it would not be able to nominate the SERC members independently. The SERC would then give primacy to issues promoted by the central government rather than their states.

Second, under the Bill, the National Load Despatch Centre (NLDC) is being envisaged as a body to schedule power allocation to the states based on payments. While this was a well-meaning attempt to solve the issue of long-standing dues from the DISCOMs to the generators, this arrangement is likely to cause unequal distribution of power. Financially rich states will get power at their time of need, while financially poor states would be likely to fall into the trap of indebtedness. With this indebtedness, their autonomy to schedule and buy power from the market will be seriously constrained.

Thirdly, while the cross-subsidised consumers will remain under the government-owned DISCOMs and the cross-subsidising consumers (industry and commercial) will be part of the private DISCOMs. This will inevitably pave the way for structural change in the DISCOMs and invite tariff-related alterations. Since the extant Fiscal Responsibility and Budget Management Act will ensure that subsidies for state governments don’t increase, the space for financial autonomy is further restricted for the state governments, who would have to foot the bill for the consumers under government DISCOMs.

Attempts to Reshape Decision-making in Power Sector

Apart from the Electricity Bill 2022, there has been a constant attempt to tinker with the balance of power vis-à-vis state-level electricity entities. The Energy Conservation Act 2022 (amended recently) proposes a reduced number of state government representatives vis-à-vis share of representatives from the central government. In such situations, it becomes easier for the centre to push future directives whereas states might see this as a problem from their perspective.

The Act also proposes that a carbon credit mechanism will be established by the Central Government, to reap the benefits of domestic markets for emission reductions. While there are several ways to establish such mechanisms, the Act remains silent on what these could be and is aimed to create a single mechanism for carbon credit markets in the future. This potentially limits the state governments to take independent decisions on which market mechanism to follow (Munjal 2022) based on their own contexts and priorities.

The attempt is to centralise the decision-making is evident in the Electricity Bill 2022 and the Energy Conservation Act 2022 with a view to enhancing energy efficiency and conservation. It appears that in the electricity sector, the bigger and more formidable long-term impactful decisions taken at the central level in recent times often have sidelined and/or overlooked (some might say encroached) the states' domain of decision-making. Therefore, not only is there a change in the technology of generation of electricity, from fossil fuel to RE-based resources, but simultaneously, the structures of concurrent policymaking are also being tinkered with. Existing concerns such as DISCOM finances, stability of these DISCOMs vis-à-vis fiscal deficit of states, tariffs etc. will be exacerbated with a higher uptake of RE, which is why any reforms must be backed by states' context and that of the region as well (Dubash and Rajan 2001) (Dubash, Kale and Bharvirkar 2018). The current trend to trespass the decision-making domain of the states would lead to further weakening of the management of the sector, rather than addressing the extant systemic issues.

Conclusion

Recent developments around RE have disrupted the power sector in India – physically, structurally, and institutionally. The de facto and de jure alteration of centre–state relationships that existed over the years are built on a narrative of ushering in efficiency and effectiveness in the power sector while maintaining the fundamental objectives of the sector to improve accessibility and affordability.

These changes, which were gradual earlier, are now accelerating at the same pace as the falling prices of RE generation in the country. However, there are inflexion points observed during this period, in the overall policies of the government, which forces us to consider the original balance of decision-making powers between the state and the centre. We demonstrated that from the standpoint of the states, the shifts that have been made in the policies to adopt RE and scale it up were less than optimal.

The huge subsidy burden arising out of the agriculture sector and the DISCOMs' financial loss are the largest sources of inefficiency in the electricity sector. The approach of the Central government to take charge of DISCOMs' operations and decision-making, as if that were the root-cause of inefficiency may be flawed. The issues are deeper and more complex. Neither the centre, nor the state governments, acting alone, can solve them. Even after the reforms and proposed amendments, the concerns related to the agriculture subsidy remain. While the centre could have provided and set basic principles for assessment, it chose the current technical initiative of segregating the feeders, but this mechanism is also prone to political influence.

In addition, policy measures around making India's energy mix more sustainable must be updated to recognise the current generation costs of RE and take into account that they are on a declining trend. More pragmatic policies will create options for DISCOMs to balance the issues like high-cost old RE-based PPAs and newer RE which are low cost to bundle. There is also a need to design policies for retiring inefficient and old thermal power plants which continue to operate due to PPAs obligations.

The social contract of the power sector in India, that is, providing affordable power to the residential and agriculture sector while making power accessible to industry, and commerce is adversely affected as we strive purely for efficiency and bringing more RE into the energy mix. Due to the distributed nature of RE, the narrative has been that cross-subsidy has been a disincentive for industrial and commercial consumers, and they choose to migrate out of the grid, thereby making the grid economically unsustainable. Instead, the distributed and low-cost nature of RE must be harnessed to meet the needs of the residential and agriculture sector, and the central government, together with the states, could design policies to utilise this avenue effectively.

At present the implementation plan for the overarching political and economic goal to decarbonise is too centralised. The importance of using the plurality and diversity of states in this journey cannot be emphasised enough. While the role of the centre is paramount, the state governments should not be left out of the process of planning and strategic thinking. Including them could have a multiplier effect in meeting the overarching goals that the country has set for itself.

Notes

1 The data support in this chapter has been provided by Abhinav Sharma who was recently awarded his Phd from IIT Bombay
2 A maximum of eight to nine states have high solar potential, meeting over 90% of the total solar installed capacity in the country currently, and three to four states in the country meet most of the wind potential. Distribution of RE resources in India is highly skewed.
3 IEA, World Renewables and Waste Energy Supply, April 18, 2023, Paris, retrieved from https://www.iea.org/data-and-statistics/data-product/renewables-information

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4 Macroeconomic Impacts of Coal Transition

Saon Ray, Piyali Majumder, and Vasundhara Thakur

Introduction

The IPCC has recommended phasing out coal-based power plants, hence transitioning away from coal. The implications of the coal transition will be different for different countries. The importance of coal in the Indian economy is undeniable – it supplies 44% of India's primary energy demand (which is up from 33% in 2000) (IEA, 2021). India accounts for 7.1% of total emissions and has 17.7% of the global population. The per capita emissions of the country stand at 2.47 TCO2e compared to the global average of 6.45 TCO2e (Joshi and Mukhopadhyay, 2022). Emissions from coal have risen from 500 MT in 2005 to 1000 MT in 2015.

The share of coal in the energy mix has not changed since 2015, but India has added 58 GW of coal thermal capacity between 2015 and 2019 (compared to 49 GW for solar and wind) (IEA, 2021). Not only is coal an important sector of industrial activity, but it is also used as primary energy in many industries. Many livelihoods are directly and indirectly associated with coal. Coal is also linked to regional development and contributes to the build-up of transport infrastructure (particularly railways) historically. This chapter links with the other chapters in the volume, for example, Chapter 3 by Mandal on centre–state priorities and alignment of policies and several other chapters (also see chapters 5 and 10) that address Just Transition.

The chapter is organised in the following manner: in Section 2, we discuss the macroeconomics of the coal transition in the Indian context with a focus on some key macroeconomic variables like GDP, revenue, resources, and livelihood. Section 3 discusses the importance of coal for the Indian industry. The spatial dimension of the coal transition is discussed in Section 4. In Section 5, we briefly discuss the costs of phasing out coal and bringing in renewables and Section 6 concludes.

Section 2: Macroeconomic Implications of Coal Transition

Table 4.1 provides a snapshot of the importance of coal for India, in terms of production, consumption, reserves, and imports. As is evident from the table, in terms of production and consumption, India ranks second in the world. In terms of coal reserves, it is fifth in the world. Despite this, India needs to import coal (mainly non-coking coal). We discuss this below. Electricity generation from coal power plants stood at 71.3% of total generation in 2019–2020. Coal accounts for 55% of the country's energy needs (Economic Survey 2020–2021). Many of the sectors of the Indian economy, directly or indirectly, are dependent on coal (Deshmane, 2021).

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Table 4.1 Coal statistics

Parameter	*Value*	*Rank in the world*	*Share in world*
Coal production	728.7 MT (in 2018-19)	2nd	9.5% (in 2017)
Coal consumption	968 MT (in 2018-19)	2nd	
Coal reserves	326.5 billion tonnes	5th	
Coal imports	235.2 MT (in 2018-19)		
Coal-fired power plants	208 GW	3rd	10%

Source: Compiled by Authors from various sources.
Note: Coal production data from IEA 2021. Coal share percent and coal reserves from Indian Bureau of Mines (2019) Indian Minerals Yearbook, Coal and Lignite. Coal consumption data from https://www.carbonbrief.org/the-carbon-brief-profile-india. Coal imports data is from Bhushan et al. (2020) *Just Transition in India. Data on coal-fired power plants are from the* Ministry of Power (2021). Data on the share of coal-fired power plants are from https://endcoal.org/global-coal-plant-tracker/

Table 4.2 Emissions from coal for India

Emissions (total)		
Emissions (per capita)	2.47 tonnes of CO_2 equivalent	7.1%

Source: Compiled by Authors from various sources.
Note: Data for emissions and data from emissions per capita from IEA (2021).

GDP

The importance of mining and coal to the Indian economy is undeniable. The contribution of coal and lignite is 0.7%. All India's coal production in the year 2021–2022 registered a growth of 8.6% compared to the level of production in the year 2020–2021. Coal production increased to 778.19 million tonnes (MT) in 2021–2022 from 716.08 MT in the year 2020–2021.

Over the last ten years, coal rents (the difference between the value of both hard and soft coal production at world prices and their total costs of production) contributed on average 0.9% of India's total Gross Domestic Product (GDP) indicating its importance in the economy. This is shown in Figure 4.1.

Revenue

India's coal dependence is also reflected in the fiscal aspect with coal being a source of government revenues (taxes and royalties) (Deshmane, 2021).

Coal India Ltd. (CIL) produces 83% of coal in the country (Ministry of Coal (2020) Annual Report 2019–2020). CIL accounted for 80% (622.63 MT) of the total coal production in India in the year 2021–2022. Singareni Collieries Company Limited (SCCL) is one of the major sources of coal in the southern region of the country accounting for 50.6 MT of coal production in the year 2021–2022. Other companies like TISCO, IISCO, and DVC are contributing very small quantities to the total production of coal in India. For Indian Railways, coal constitutes 44% of its freight revenue. 87% of coal is transported by the Indian Railways (Tongia and Gross, 2019).

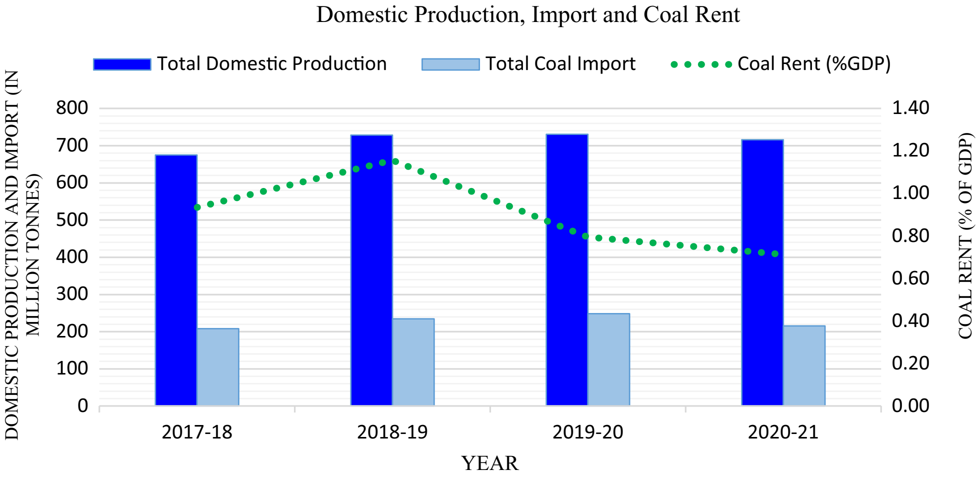


Figure 4.1 Domestic production, import, and coal rent from 2017–2018 to 2020–2021. Domestic Production and Import data from Ministry of Coal. Coal Rent (%GDP) data.

Source: World Development Indicators (WDI).

Bhandari and Dwivedi (2022) document that there are 16 taxes (combining Central and State levels) that are imposed on coal. These include excise duty, clean energy cess, royalty, and contribution to the district mineral fund (DMinF). Coal mining royalties are 14% of the basic price, while the National Mining Exploration Tax (NMET), which is charged for funding exploration by state governments, is 2% of the royalty. The payment to the government from CIL in 2020–2021 included Rs. 96.9 billion as royalty, Rs. 29.9 billion as DMinF, and Rs. 2.1 billion as NMET. The total was Rs. 419.9 billion including Rs. 225.1 as GST compensation cess.

Reserves

Data on total assessed geological coal resources as on 01.04.2021 is 352,125.97 million tonnes (Ministry of Coal, 2022). India has the fifth-largest coal reserves in the world after the United States of America, Russia, Australia, and China.

Imports

India is one of the largest importers of coal in the world. Indonesia, Australia, and South Africa constituted 34%, 31%, and 12% of the total import of coal into India in the year 2021–2022, respectively. Despite increased domestic production, coal power plants and iron and steel manufacturing companies in India are also engaged in the import of coal largely from Indonesia, South Africa, and Australia (Powell et al., 2022).

India's import of coal has declined by 10.8% over the last three years i.e., 234.35 MT in 2018–2019 to 208.93 MT in 2021–2022. Non-coking coal constitutes the bulk, approximately 70% of the total coal imported into India. Imported high-quality coal is majorly used for industrial uses. In 2018–2019, according to the annual survey of industries data, the intensity of use of imported coal is found to be high in chemical products manufacturing and manufacturing of coke oven products.

Primary Energy Needs

Coal is the most easily available and affordable source of energy in India accounting for 55% of the total energy demand. Transitioning away from coal will have implications for the economy. Coal is used as a fuel in industry and other sectors. Despite the growth in renewables, coal dominates India's power generation mix, and will account for a large proportion of power sector emissions even by 2040 (IEA Data Services). According to projections, renewable energy consumption can surge from nearly 20 Mtoe in 2019 to nearly 300 Mtoe by 2040 but will be concentrated mainly in the power sector and driven by growth in solar capacity (BP, 2022).

Livelihoods

There are also implications for livelihoods and jobs as we transition away from coal. Fifteen million people are directly or indirectly employed in this sector. The coal sector directly accounts for the employment of 1.2 million workers in India (Pai and Zerriffi, 2021). Further, the impact falls disproportionately on the most vulnerable members of the workforce as is illustrated in the Appendix 4B on the Kota Super Thermal Power Station.

Given the dependency of the Indian economy on coal, phasing out coal and *transitioning* to alternative/renewable energy sources for affordable power generation and its use in various other processes, thereby sustaining livelihoods *for all* is a herculean task for the policymakers. Especially, the major coal-producing states – Jharkhand, Chhattisgarh, and Odisha – may find it challenging to implement the structural change and generate jobs in the alternative sectors.

Regional Development

Coal is also linked to regional development and contributed to the build-up of transport infrastructure (particularly railways) historically (O Rourke and Williamson, 2001). The regional and spatial dimensions of the importance of coal have been documented (e.g. for Britain by Turnbull (1987) and also regions like Pennsylvania by Latzko (2011)).

Emissions

Coal-based power plants are one of the major contributors to the rising concentration of PM 2.5 in the air and the emission of other harmful gases into the atmosphere. Global coal use continued rising for the second consecutive year in 2018 with China, India, Indonesia, and some other South and Southeast Asian countries, as the main consumers. While India contributes to 7.1% of total emissions globally, in per capita terms India contributes far less than most major developed countries.

According to the International Energy Agency (IEA), currently, India's per capita emissions are 1.6 tonnes of CO_2, much lower than the global average of 4.4 tonnes and India's share of global total CO_2 emissions is only 6.4%. In the mid-1990s, India's carbon intensity of consumption had surpassed that of China and was about one-third higher than China's by 2005 (Birdsall and Subramanian, 2009). India's coal consumption is also expected to grow at a faster rate than Chinese coal consumption between

2020 and 2040. Due to a sharp increase in energy prices due to the Ukraine war, India's use of coal may not decline in the near future.

In low- and middle-income countries, coal is often seen as the cheapest option to build new capacity (Steckel and Jacob, 2021). This is due to a number of reasons including the high capital costs which favour coal (due also to differences in the financing structure of renewables) and the fact that coal is an established technology. This helps to calculate additional costs that may not be apparent upfront in the case of other technologies. In coal-abundant countries, energy security is also stated as one of the reasons for scaling up capacities (Ray and Bandopadhyay, 2020). In the context of the Ukraine war, many countries including India have been forced to rethink the issue of energy security and import dependence in primary energy sources. In many countries, coal royalties and other vested interests may prevent the phasing out of coal (Steckel and Jacob, 2021).

The economies arising from the linkages of the coal sector with the other sectors get partially offset due to the rising environmental impact of the coal-based production process. This in turn can jeopardise India's commitment to reducing the emission intensity of the GDP by 45% by 2030 compared to the level of 2005 and net zero emission by 2070.

Importance of Coal in the Indian Industry

During the period June 2000 to June 2022, coal production has received foreign direct investment amounting to Rs. 119.19 crores (DPIIT, 2022). The allowance of commercial coal mining by the Government of India has provided a further thrust to the domestic production of captive coal mines (PTI, 2022).

The produced coal is despatched not only to the iron and steel and power generation sectors but also to manufacturing industries like cement, fertiliser, chemical, paper, and MSMEs are also relied on coal for their energy requirements.

Ray et al. (2022) analyse the energy mix for organised manufacturing and MSMEs. The energy composition of the five most energy-intensive industries (basic metals, other non-metallic minerals, chemicals, paper, and textiles) indicates that electricity purchased constitutes the bulk of the total energy consumed, followed by coal, petrol, and other fuels. Further, the consumption of coal is higher in the manufacturing of basic metals, followed by the manufacturing of other non-metallic minerals. It can be observed, among the top five energy-intensive manufacturing sectors the other non-metallic minerals (including cement, lime, plaster, ceramics, glass, refractory products, clay products, etc.) are highly dependent on coal for their energy requirements (coal constitutes 47% of the total energy) followed by paper (33%) and basic metal manufacturing industries (21%) (Ray et al., 2022). These are also labour-intensive manufacturing industries. While analysing the energy composition of the Indian manufacturing sector, the Annual Survey of Industries (ASI) unit-level database has been used. The information on the type of energy consumption is reported at the plant level. The amount of energy consumed across five different categories, electricity, natural gas, petroleum, coal, and other fuel, has been aggregated at the industry level (National Industrial Classification 2008; two-digit level) by using a suitable multiplier, as reported in the database. The energy intensity has been calculated as the ratio of each type of energy consumed by the industry to the total output of the respective industry. The transition in the energy composition has been compared between 2010 and 2019 of the top five energy-intensive industries as shown in Figure 4.2. As shown in Figure 4.3, the use of

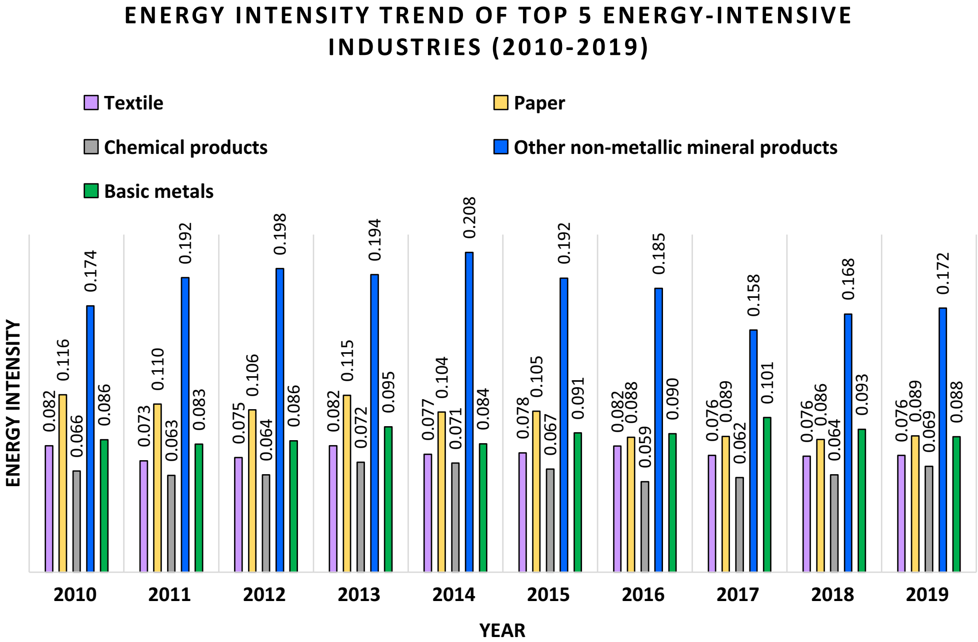


Figure 4.2 Energy intensity trend of five industries from 2010–2019.

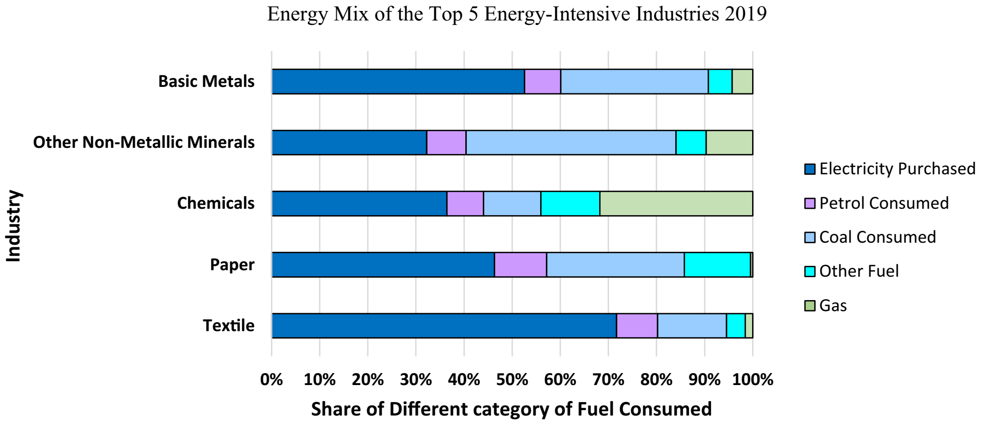
Source: Based on ASI data.

coal has declined for the basic metals and textiles manufacturing industries between the period 2010–2019.

The Spatial Dimension of the Just Transition

The coal reserves are primarily concentrated in the eastern and central states of India with Jharkhand, West Bengal, Odisha, and Chhattisgarh together accounting for 79% of the total reserves of the country. According to the Niti Aayog Energy statistics, Chhattisgarh Jharkhand, and Odisha are also the top three coal-producing states in India, together accounting for 56% of the total coal produced in India. Coal mining and the production of coal are recognised as one of the eight crore industries of the Indian Economy. These eight crore industries are key industries of the economy accounting for 40.27% weight in the Index of Industrial Production (IIP) in India. The coal sector alone accounts for 10.33% weight in the IIP in India. As per the latest statistics of the Index of Industrial Production (IIP), the production of coal increased by 7.6% in August 2022 compared to August 2021 (Office of Economic Advisor, Government of India, 2022). While analysing the policies of the Government of India, it has been observed that several initiatives have been taken to ensure a *transition* towards cleaner energy and a low-carbon path. These initiatives are largely in the form of enhancing energy efficiency through labelling programmes, boosting investment in renewable energy sectors, and making provisions for low-carbon transport equipment and other ancillary infrastructural facilities. However, little attention has been paid to examining the spatial dimension of the transition process across Indian states.

Transition in the Energy Mix between 2010 and 2019



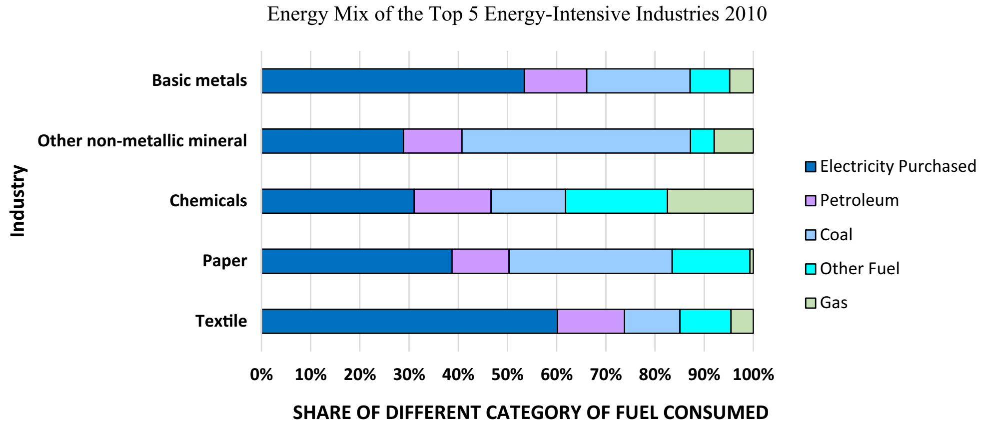


Figure 4.3 Transition in the energy mix of the five energy-intensive industries.

Source: Author's calculation based on ASI unit-level data.

Jharkhand

Jharkhand is a natural resource-rich state with maximum mineral reserves of coal, iron ores, copper ore, uranium, mica, bauxite, granite, limestone, silver, graphite, magnetite, and dolomite. It is the only state engaged in the production of uranium and pyrite. Despite, the rich mineral resources, Jharkhand is one of the low-income states in India. The per capita GSDP of Jharkhand in 2020–2021 (at current prices) was Rs. 75,587, which is lesser than the per capita GDP at the national level (Rs. 1,46,087 at current prices). The share of the GSDP of the state in the GDP of the country decreased from 1.77% in the year 2014–2015 to 1.60% in 2017–2018, and 1.61% in 2018–2019 (P). In 2020–2021, agriculture, manufacturing, and services sectors contributed 23%, 33%, and 44% to the state's economy, respectively. In 2020–2021, the manufacturing and services sectors contracted by 7.1% and 10%, respectively, with respect to 2019–2020.

The geospatial maps have been directly extracted from the Geospatial Energy Map of India, Niti Aayog. This is a unique database to visualise detailed energy sources, installed capacity, and estimated unexplored energy reserves (both renewable and non-renewable) across Indian districts. The software has been launched by Niti Aayog in collaboration with the Indian Space Research Organization (ISRO) on 18 October 2021. This is an open-source software based on Geographic Information System (GIS) technology. The geospatial maps are highly useful to identify the lagging districts in terms of the installed capacity of renewable energy. This in turn facilitates the investment decision towards enhancing the renewable energy–based power generation capacity across these lagging districts.

While analysing the nature of energy used within the state, it can be observed from Figure 4.4a that districts like Bokaro, Dhanbad, Ramgarh, Saraikela Kharsawan, Purbi Singhbhum, and Jamtara are home to coal-based power plants with a total installed capacity of 4900 MW. Figure 4.4c depicts the spatial distribution of coal mines, primarily concentrated in the districts of Bokaro and Dhanbad. Renewable energy sources constitute only 6% of the total installed energy capacity in Jharkhand. Hydropower plants constitute the bulk of the total renewable energy installed capacity followed by solar power plants. Hydropower plants are majorly located on the west side of the State, Figure 4.4b. Apart from coal-based power plants, Dhanbad and Ramgarh also have alternative energy generation sources i.e. biomass-based power plants. Solar power plants are located only in Ranchi and Paschimi Singhbhum. District-wise installed capacity of renewable energy sources has been mentioned in Table 4.A.1 in the Appendix 4A of the chapter. Jharkhand Renewable Energy Development Agency (JREDA) has emphasised the expansion of the solar power generation capacity in the states (Solar Policy 2015, Solar Policy 2022). According to the Solar Policy 2022, JREDA has declared an ambitious goal of expanding solar power generation to 4000 MW by 2027.

Chhattisgarh

Chhattisgarh is also a mineral-rich state, and it is the only state having tin ore reserves. Other mineral reserves like bauxite, limestone, and quartzite are also available in the state. At current prices, the Gross State Domestic Product (GSDP) of Chhattisgarh is estimated at Rs. 4.38 trillion (US$ 57.34 billion) in 2022–2023. GSDP (in Rs.) of the state at current prices grew at a CAGR of 9.98% between 2015 and 2016 and 2022 and 2023. Between 2011 and 2012 and 2019 and 2020, Gross Value Added (GVA) from the agriculture, forestry, and fishing sectors in the state grew at a CAGR of 12.53%. Chhattisgarh's combined exports of aluminium and products, iron and steel, iron ore, and iron and steel products from Chhattisgarh reached US$ 285.56 million in FY22 (until May 2021). Non-basmati rice, aluminium products, and iron ore are the main exports, contributing ~34.3%, ~22.0%, and ~19.5%, respectively, to the state's merchandise exports. Chhattisgarh has also invested in developing industrial infrastructure and has declared the district of Rajnandgaon as a special economic zone.

Chhattisgarh is among the few states having surplus power. The Korba district is known as the power capital of India. These Korba power plants are majorly coal-based power plants. At present, the total coal-based power generation installed capacity is 22,458 MW. It can be observed from Figure 4.4c that coal-based power plants are majorly concentrated in the districts of Korba, Raigarh, Raipur, Bilaspur, and Durg. Moreover, the coal mines are also concentrated in the northern and north-eastern districts of the state

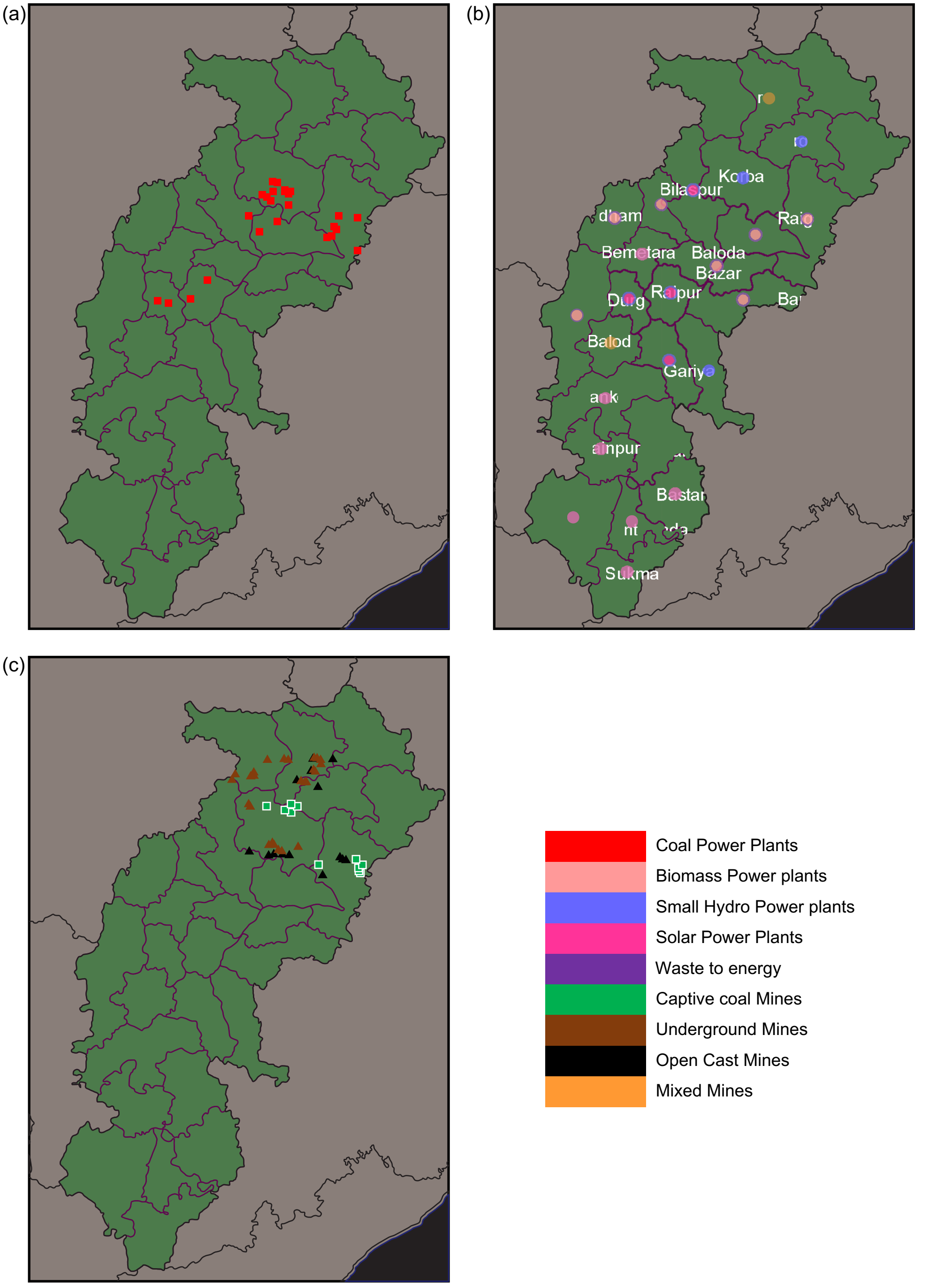
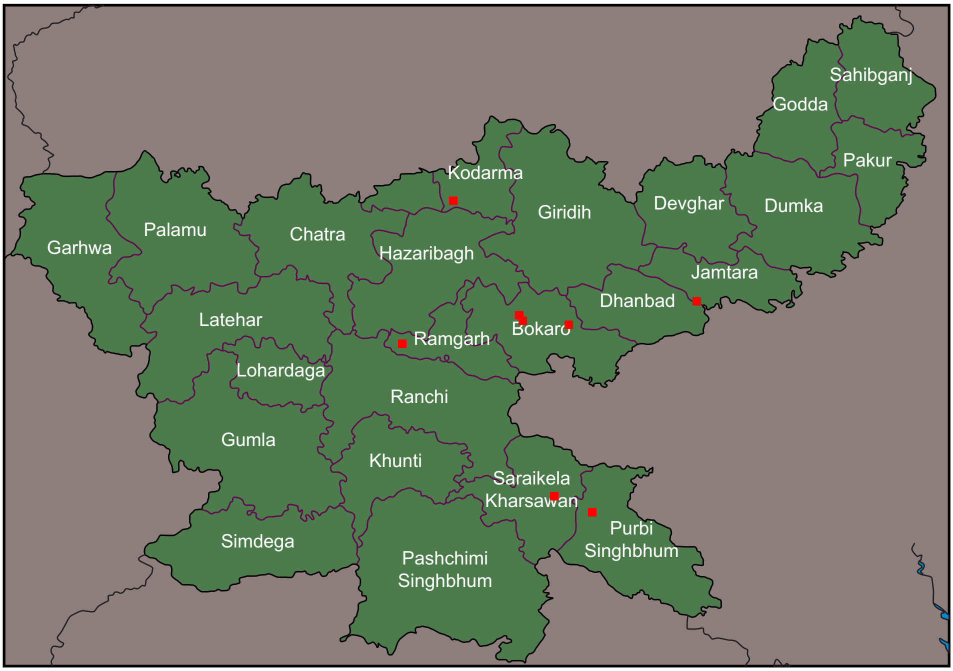


Figure 4.4 a Distribution of coal power plants. b Distribution of renewable energy installed capacity. c Distribution of coal mines.

Source: Energy map, Niti Aayog.

(d)



(e)

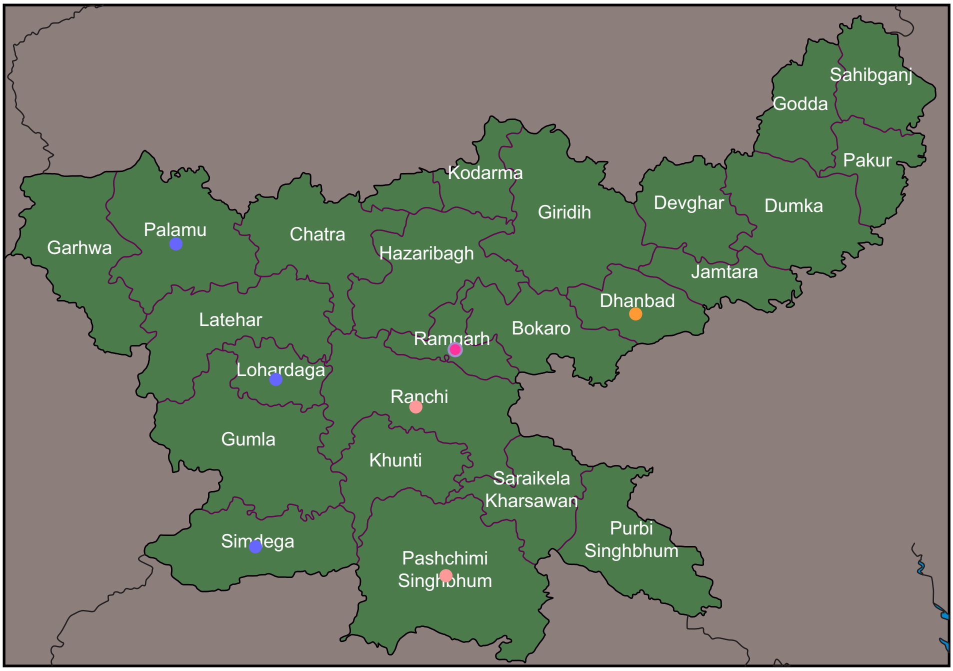


Figure 4.4 d Distribution of coal power plants. e Distribution of renewable energy installed capacity.

Source: Energy map, Niti Aayog.

(f)

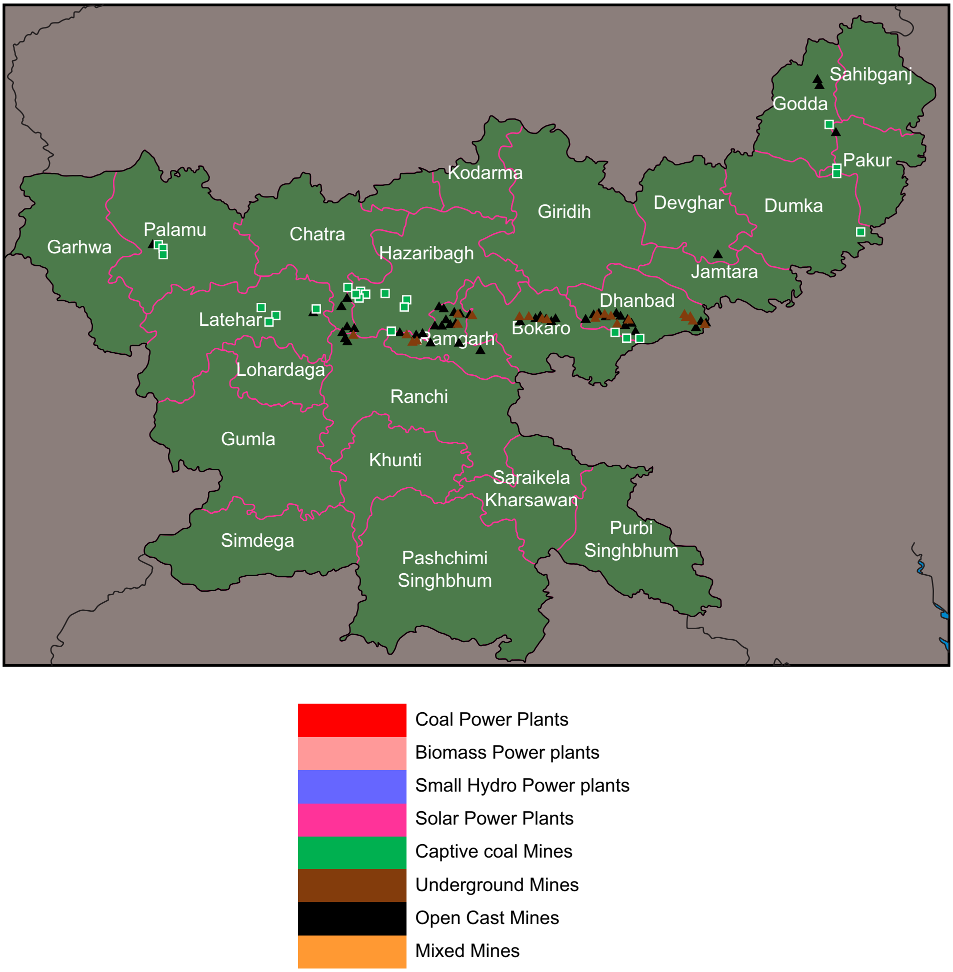


Figure 4.4 f Distribution of coal mines.

Source: Energy map, Niti Aayog.

as depicted in Figure 4.4f. Contrastingly, it is evident from Figure 4.4e) that renewable energy sources are dispersed across the state.

Renewable energy sources (including solar, hydro, biomass, and waste-to-energy) constitute 3% of the total installed energy capacity in Chhattisgarh. Biomass power plants have the potential of reducing CO_2 and presently there are 13 such plants in Chhattisgarh with a total installed capacity of 274 MW. The Chhattisgarh State Renewable Energy Development Agency (CREDA) has allowed for the exemption of electricity duty to the solar power-generating plants for auxiliary consumption or captive consumption within the state till the year 2027. Moreover, as a part of the Solar Policy, it has been emphasised that along with facilitating the installation of solar power projects through single window clearance, improving road connectivity, and creating the land bank, the state government will also be engaged in the development of human resources through institutional training for the alternative energy adaptation. The detailed district-wise installed capacity of renewable energy sources is depicted in Table 4.A.2 of the Appendix of the Chapter.

Financing the Coal Transition

"By 2025, 78 percent of coal plants globally will be more expensive to operate than building new renewable energy with storage" (Grbusic et al., 2019). This observation is further supported by the waning viability of coal plants (Grbusic et al., 2019; Wang et al., 2022).

While there are push factors for the transition such as the declining viability of coal plants, there are also pull factors for transition. These pull factors are the ones making the transition attractive. One of these pull factors is the net gain to be reaped as a result of the transition. Adrian et al. (2022) estimate the costs of implementing this transition and they find a net gain resulting from this transition. Their estimates peg a net gain of around $78 trillion due to phasing out coal.

Calhoun et al. (2021) underscore five principles for designing financing mechanisms for avoiding the risk of using finance for financing the coal transition. These five principles are as follows: "Just and equitable; Additional; Managed; Transformational; Scalable."

Sharan and Saran (2021) note finance as the key factor for facilitating the transition away from coal and moving towards green sectors for India. Singh and Sharma (2021) estimate the cost of decommissioning 130 power plants accounting for 95 GW of installed capacity. They use tariff orders of individual plants to calculate the costs of decommissioning. The costs are estimated to be between Rs. 2.31 lakh crores to Rs. 3.50 lakh crore, while the pay-out to workers is estimated at Rs. 57,490 crores.

Coal subsidies were at Rs. 150 billion in 2020. Coal has been brought under the ambit of 5% GST plus a compensation cess of Rs. 400 (Bhandari and Dwivedi, 2022).

Conclusion

India has announced its intention to decarbonise its economy and become net zero by 2070. Given the importance of coal in India's energy mix, the macroeconomic implications of decarbonisation will be enormous. The objective of this chapter was to examine the implications of this transition for India, in terms of broad macroeconomic indicators. India's possible gains from the transition to a net zero-carbon growth path could be significant. However, there will be direct and indirect impacts of the transition on the economy. Many sectors in India are directly or indirectly connected to coal; these sectors are likely to be affected as well. In this chapter, we examine all such linkages with coal and underline the spillover effect of the transition into other sectors. Also, little attention has been paid to examining the spatial dimension of the transition process across Indian states. The present chapter attempts to study the detailed energy composition of the two major coal-producing states of India viz. Jharkhand and Chhattisgarh. Further, it also tries to identify the potential alternative energy sectors across these two states. As we see from the ensuing discussion, many factors will contribute to the transition of each state – most of these factors are well-known and documented (including the resource base, the topography, or other factors like whether power is surplus or not). Two factors that have to be kept in mind and are not frequently discussed include the linkage of coal in the economy of the state and the political economy of each state. For the former, this chapter has tried to give an overview of the differences between the two states that have been discussed in the paper. More research is needed to extricate the linkages since only then the true impact of the transition can be captured. The political economy factor is beyond the scope of this present chapter, but extant literature can be referred to shed light on this aspect for it will determine the path of the transition in each state.

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Appendix 4A

RE Power Installed Capacity in Jharkhand and Chattisgarh

Table 4A.1 Jharkhand: District-wise installed capacity of renewable energy-based power plants

Installed capacity in MW

District	*Solar*	*Wind*	*Small hydro(<25MW)*	*Biomass*	*Waste to energy*
Dhanbad	0	0	0	3.1 (2)	0
Ramgarh	0	0	4 (1)	1.2 (1)	0
Ranchi	31.9 (9)	0	0	0	0
Paschimi Singhbhum	3 (1)	0	0	0	0

Note: Numbers in the parentheses indicate the number of plants.
Source: https://vedas.sac.gov.in/energymap/view/powergis.jsp

Table 4A.2 Chhattisgarh: District-wise distribution of renewable energy–based power plants

District	*Solar*	*Wind*	*Small hydro (<25 MW)*	*Biomass*	*Waste to Energy*
Korba	0.4 (7)	0	7 (1)	0	0
Surajpur	0	0	0	16 (2)	0
Surguja	0.1 (2)	0	24 (2)	0	0
Bilaspur	3.8 (52)	0	1 (1)	18 (2)	0
Raigarh	5.1 (9)	0	0	37 (3)	0
Baloda Bazar	18.9 (3)	0	0	7.5 (1)	0
Janjgir-Champa	0.3 (3)	0	0	49.8 (4)	0
Mungeli	3.8 (52)	0	1 (1)	18 (2)	0
Kabirdham	0.3 (5)	0	0	20 (2)	0
Bemetara	50.2 (3)	0	0	0	0
Durg	87 (44)	0	0	8 (1)	0
Raj Nandgaon	5.7 (16)	0	0	11.5 (2)	0.3 (1)
Balod	0	0	0	3 (1)	0
Kanker	0.3 (7)	0	0	0	0
Narainpur	0.1 (2)	0	0	0	0
Bastar	0.4 (7)	0	0	0	0
Bijapur	0.1 (2)	0	0	0	0
Dantewara	0.8 (2)	0	0	0	0
Sukma	0.1 (1)	0	0	0	0
Dhamtari	0.3 (5)	0	11 (3)	8 (1)	0
Gariyaband	0	0	7 (1)	0	0
Mahasamund	37.2 (7)	0	0	16.5 (2)	0

Note: Numbers in the parentheses indicate the number of plants
Source: https://vedas.sac.gov.in/energymap/view/powergis.jsp#

Appendix 4B

Transition Impact on Workforce: A case study of Kota Super Thermal Power Station (KSTPS)

Simran Grover and Naini Swami

The Kota Super Thermal Power Station (KSTPS) was established in 1983, with two units of 220 MW capacity each. Owned by Rajasthan Rajya Vidyut Utpadan Nigam Limited (RVUNL), the power station has a current capacity of 1240 MW with seven units in operation. The plant's average age is 27 years as of March 2022. Units 1, 2, 3, and 4 are past their useful life of 25 years, and they are proposed for decommissioning after December 2022.

Over the years, KSTPS has been among the key drivers for the growth of the local economy. The plant creates direct employment and transacts with many associated businesses and service providers. It facilitates a thriving ecosystem of allied livelihoods, such as local transport, real estate, and consumer goods and services, primarily helmed by local small businesses. The power station is deeply integrated with the local economy. This includes full-time employees of RVUNL, contractual employees and labour, service providers, big and small business owners, and various informal workers in the unorganised sector.

The aforementioned livelihood landscape encompasses many marginal workers and groups. Understanding their vulnerabilities in the context of energy transition, particularly repurposing (including decommissioning) the thermal units, requires a nuanced understanding of vulnerabilities at the intersection of caste, class, gender, and employment location.

KSTPS and Livelihoods Landscape

For a qualitative understanding, livelihoods dependent on the plant are classified based on the statutory responsibilities KSTPS bears towards respective individuals or entities. This includes direct livelihoods (permanent and contractual workers), associated livelihoods (entities exchanging goods and services, including the fly-ash brick industry and its wage workers), and allied livelihoods (informal workers and other local businesses that thrive on the economic contribution of KSTPS).

In terms of organisational structure concerning direct livelihoods, KSTPS is divided into 15 administrative departments. Officials (the plant's permanent employees) oversee the work carried out by the permanent and contractual workers in their respective departments. Presently, KSTPS has around 656 permanent employees and 2012 contractual workers (Bask Research 2022). With the increase in their numbers over time, the contractual workers also perform tasks previously reserved solely for permanent technical workers. Despite the similar nature of their work, there is a high wage disparity between permanent and contractual workers. There is also considerable heterogeneity among contractual workers based on their wage categories: skilled, semi-skilled, or unskilled. Broadly, the tasks performed by the plant's labour fall into civil, electrical, and mechanical works. Most skilled workers at the plant are engaged in electrical works, whereas primarily semi-skilled and unskilled workers are involved in civil and mechanical works.

The Factories Act classifies power generation plants as an industry involving hazardous processes because of the perilous nature of the work involved. However, working conditions and exposure to hazards differ as per the location of workers inside the plant. The plant’s boiler and turbine management sites entail working in proximity to high temperatures and heavy machinery. Loss of life and limb due to accidents is common at such sites. Given the presence of high-voltage power operations, electrical work at the plant is critical, albeit not physically taxing. In contrast, work at the coal handling operations that deploy the highest concentration of unskilled contractual workers is highly strenuous. Workers in the department are continually exposed to coal dust and a poor work environment without adequate cooling facilities. As a result, skin diseases and deterioration (and eventual loss) of eyesight are reported as routine consequences.

In the context of the associated livelihoods, the condition of the fly-ash industry workforce is particularly concerning. Prolonged exposure to fly ash is known to increase the risk of asthma, inflammation, respiratory diseases, and cancer. The industry workers report a frequent occurrence of many such health concerns. A majority of the workforce (mostly daily wage labour) in the fly-ash industry is informal, and the sector is unorganised, given the small size of the fly-ash brick-making units. As a result, safety provisions for workers in the units are poorly implemented or absent, and no social security is provided to cope with the health consequences of their work.

Vulnerability of Workforce and Potential Impact of KSTPS Closure

India's labour market, shaped by substantial and procedural aspects of labour laws, accords differential employment status to permanent and contractual workers, significantly limiting rights and entitlements for the latter category of workers. Contract workers account for nearly 75% of the workers employed in the thermal power generation sector (Bask Research 2022). This principal section of the workforce is inherently more vulnerable in the context of repurposing of an associated thermal power plant and the potential loss of employment.

In general, workforce compositions are diverse, comprising individuals with differentiated skills, capabilities, and socio-economic backgrounds. The legal classification of skilled, semi-skilled, and unskilled workers is a commonly used stratification for the contractual workforce.

However, this stratification, which primarily signifies wage difference, doesn’t fully represent the differential capabilities of workers across respective skill groups.

A meaningful understanding of the capabilities of workers to deal with employment loss may be gathered by measuring (or mapping) some of the fundamental factors that shape their opportunities and provide tools for resilience against the impact of employment loss. Their capabilities and hence resilience to deal with the stress of livelihood loss in the context may be explored as a function of their inherent capitals, that is, economic, human, social, and political capital. The resulting capabilities and resilience of a worker (and their household) are likely to define their ability to deal with the loss of livelihood, navigate its perils, and ultimately seek opportunities for income substitution.

Using the above approach, the table below presents a qualitative mapping of the different forms of capital of the skilled, semi-skilled, and unskilled contractual workforce at KSTPS, along with workers of the associated fly-ash brick industry. The parameters used for evaluating economic capital include current income sources, assets, savings, and credit access. Human capital is evaluated based on educational and professional qualifications, skill level, well-being, and occupation co-relations. Social capital is defined as a function of caste position and related networks, neighbourhood, and community relations. Political capital is evaluated based on the degree and nature of participation in local politics and associations, including engagements through labour unions.

A qualitative mapping of capital cross the landscape of particularly vulnerable workers associated with thermal power plants

Category of workers	*Economic capital*	*Human capital*	*Social capital*	*Political capital*
Skilled (mechanic fitter, electrician, light and heavy vehicle drivers, operators, supervisors)	Minimum daily wage of Rs. 283 as specified by GoR. • Better positioned to access opportunities for additional income through other means of livelihood such as small shops, working in other industries. • Indicate a higher degree of asset ownership, including houses and lightweight vehicles. • Insured under the ESI scheme. • EPF deposit serves as the primary saving. • Both formal sources, such as banks and microfinance institutions, and informal sources, such as relatives or colleagues, are utilised to access credit.	Typically hold at least matriculation, with most recent recruits holding ITI diplomas. • Conditions of work are harsh with high occupational hazard risk. • Relatively less prolonged and direct exposure to hazardous materials. • Better positioned to receive alternative employment at current wages as skills and experience are ratified through experience certificates. • Provided with required safety gear such as helmets, gloves, and shoes.	Includes a mix of persons from different caste backgrounds, including Brahmins, Rajputs, Scheduled Castes, and Other Backward Castes. • Most are locals or migrants from nearby areas such as Kota, Tonk, and Newai. Hence likely to have mature social networks.	Members of labour unions, visible and vocal participation in union activities. • As local residents or residents of nearby areas, have some political voice in local decision-making.
Semi-skilled (Helper, junior fitter, welders, gardeners)	• Minimum daily wage of Rs. 271 as specified by GoR. • Access to opportunities for additional income is curtailed due to strenuous work shifts. • Many possess local housing with a high degree of informality in tenure. Some workers possess marginal agricultural land in places of origin. • Insured under the ESI scheme. • EPF deposit serves as the primary saving. • Credit is secured through informal sources such as relatives, neighbours, employers, or colleagues. Express aversion to formal sources of credit.	Typically middle school graduates. • Under-recognition of skill level gained through hands-on work experience. • Degree of direct and prolonged exposure to hazardous materials is high, impacting physical and mental well-being. • Access to alternative employment at existing wages is curtailed due to a lack of formal recognition of skills and experience. • Provision of safety gear such as helmets, gloves, and shoes is not adequate and timely.	Primarily includes workers belonging to Other Backward Castes and Scheduled Castes. • The majority are locals or migrants from nearby areas such as Tonk, Newai, and Jhalawar and hence, likely have mature social networks.	Members of labour unions. However, active and vocal participation is not uniform across the category. • As local residents, may exercise some say in local decision-making. However, capacity for active participation is curtailed due to the informal nature of their settlements.

(***Continued***)

Category of workers	*Economic capital*	*Human capital*	*Social capital*	*Political capital*
Unskilled (labour, cleaning, and sanitation workers)	• Minimum daily wage of Rs. 259 as specified by GoR. • Access to opportunities for additional income is significantly reduced due to the physically strenuous work. • Many possess local housing with a high degree of informality in tenure. Few indicate none to marginal agricultural land holding in places of origin. • Insured under the ESI scheme. • EPF deposit serves as the primary saving. • Credit is secured through informal sources such as relatives, neighbours, employers, or colleagues. Express high aversion to formal sources of credit.	• Generally comprise primary school graduates. • Perform physically arduous manual labour, including civil construction and maintenance work, as well as cleaning and sanitation work. • Opportunities for professional growth are usually stagnant. • Poorly positioned to gain alternative employment due to highly informal nature of work and limited opportunity to gain skills. • Provision of safety gear such as helmets, gloves, and shoes is not adequate and timely.	• The majority belong to Scheduled Castes and Scheduled Tribes, with sanitation and cleaning workers being predominantly Dalits. • Accounts for significant participation of female workforce across the overall livelihood spectrum. • Mainly locals or migrants from nearby areas such as Tonk, Newai, and Jhalawar. Hence likely to have mature social networks.	Members of labour unions. Participation in union activities is minimal. • The participation of women is virtually absent. • As local residents, may exercise some say in local decision-making. However, capacity for active participation is curtailed due to the informal nature of their settlements.
Fly-Ash Brick Industry Workers	• Determination of wages for workers is based on productivity (units of bricks produced or loaded/unloaded). (Rs. 180/190) • The majority of workers are migrants and do not possess any local assets. Some indicated small to marginal agricultural land holding in their places of origin. • Not insured under the ESI scheme, limiting access to healthcare. • Not covered under the EPF Act. Formal savings are absent. • Credit is secured through informal sources such as relatives, neighbours, employers, or colleagues. Express high aversion to formal sources of credit.	• Majority were primary school graduates. • High and prolonged exposure to hazards at the workplace. • Poorly positioned to gain alternative employment due to highly informal nature of work and limited opportunity to gain skills. • Not provided with required safety gear such as helmets, gloves, shoes or masks.	• The majority belong to Scheduled Castes and Dalit communities. • Most are migrant workers from MP, UP, Bihar, and other parts of Rajasthan. As a result, mature local social networks are likely to be absent.	Participation in local politics is virtually absent. • Organised workers' associations are absent.

The capability and resilience of a worker to deal with the impact of the loss of livelihood is a function of their economic, human, social, and political capital. Similarly, a worker is exposed to intersectional vulnerabilities of caste, class, and gender. The observations surfacing during this qualitative research highlight how intersectionality affects workers of thermal power plants. We argue that interventions for "Just Transition" need to take cognizance and be sensitive towards the intersectional vulnerabilities of TPP workers.

The wage and economic differential between the skill-based workforce groups is apparent. The disparity is further aggravated by systemic challenges such as capability reflective skill recognition, ability to pursue additional economic opportunities, and access to finance. Semi-skilled and unskilled workers were observed to be more exposed to hazardous environments and employment-associated risks. This includes exposure to thermal discharge, coal dust, fire, and explosion hazards, etc.

Notably, it is primarily the unskilled workers who occupy hazardous locations such coal and ash handling. Such exposure is observed to have long-term detrimental impact on the health and well-being of the concerned workers. For instance, many workers who have spent their lifetime in coal handling complain of degradation of eyesight and blindness. Similarly, workers involved in fly-ash brick industries (allied jobs) are directly exposed to hazardous waste. Both groups of workers reported high instances of skin and respiratory issues, including silicosis. Such employment locations, while being low-paid, carry high long-term risks for the workers and high financial costs associated with chronic health issues. The associated degradation of health and well-being may severely impact their ability to work and sustain themselves.

Exploration of the social configuration of worker groups associated with the TPP further highlights their intersectional vulnerabilities. Skilled workforce displays a heterogenous social composition, and includes persons from the General Category, Other Backward Castes, and Scheduled Castes. However, social configuration becomes increasingly homogenous as we move to semi-skilled and unskilled workers. Semi-skilled workers primarily belong to Other Backward Castes and Scheduled Castes; unskilled workers are primarily from Scheduled Castes and Scheduled Tribes. The disadvantages which arise from social position reflect in community support systems and collective vulnerability. Large groups of marginal workers from disadvantaged backgrounds serving the TPP have high collective vulnerability. Consequently, this reduces their resilience to deal with the impact of an event such as decommissioning of a thermal plant because of high exposure at the community level. It may be noted that the vulnerability is being discussed in the context of the spatial coordinates and social composition of the workforce.

Furthermore, the ability of workers to voice their challenges and demand safeguards for a Just Transition through policy intervention is a function of their political capital. Observably, political capital drastically diminishes as we move from skilled worker groups to unskilled worker groups. While skilled workers are active and vocal members of labour unions, the participation and engagement among semi-skilled workers are inconsistent. Further, the participation of unskilled workers in union activities is tokenistic and their representation in union leadership is usually absent. Political capital of semi-skilled and unskilled workers is also lower by virtue of their social positions, informal nature of their settlements, and their voting status. The latter is a function of the fact that most unskilled workers are migrants from different backward regions of the state and the country.

It is worth noting that women are estimated to constitute approximately 10% of the contractual workforce engaged by thermal power plants in Rajasthan (Bask Research 2022). They are primarily engaged as unskilled labour for menial jobs such as gardening, cleaning, etc. The associated flys-ash brick industry employs a larger number of women at menial wages. The gendered impact of possible decommissioning is yet to be understood. However, it is clearly observed that women's voices are grossly under-represented, while they are likely to be more vulnerable because of structural gender-based inequalities in India.

While thermal power generation industry employs a large number of people, the majority of the workers are engaged in low-paying jobs with high associated risks. Since the nature of employment is primarily contractual, the legal rights and safeguards for such workers are very limited. Further, the vulnerabilities of these workers are aggravated because of intersectionality of employment position (work environment risks), social positions, economic status, gender, and age. Hence, designing and planning policy interventions for Just Transition demand a deep understanding of intersectional vulnerability.

5 The Social Aspects of India's Energy Transition

Coal, Critical Minerals and Socio-Economic Dependencies

Vigya Sharma and Julia Loginova

India's Energy Landscape

India is currently a far third behind both China and the United States in primary energy consumption (see Figure 5.1). However, with one of the fastest-growing economies in the world and the government's ambitious geopolitical and socio-economic vision, its energy trajectory is set to follow a telling path. By 2050, India will be the world's second-largest energy consumer, behind only China. This makes India critical – and indispensable – to the global climate agenda and the ongoing urgency of clean energy transition.

The surge in energy demand puts India in a perilous position, due largely to two factors: first, a deep reliance on fossil fuels, with an overwhelming share of coal in its primary energy mix (55%; see Table 5.1). As the second-largest coal producer globally, India's electricity mix is heavily reliant on coal (IEA, 2022a). The power sector consumes nearly three-quarters of all coal produced locally, contributing to nearly half of the national CO_2 emissions. Although by 2040, there is a declining trend for coal in the power mix globally, coal will remain the mainstay for India, driving more than 50% of the electricity sector in 2040 – the largest share globally.

Secondly, India's huge development potential and ambition thrive on a reliable, affordable, and secure energy supply. There is a poor historical precedence of absolute decoupling of GDP growth from emissions intensity. A study by Pascale et al. (2020) highlighted the links between advances in HDI and emissions per capita for 163 countries globally. Only one country (two population quintiles of Sri Lanka) demonstrated high HDI with CO_2 emissions per capita consistent with global climate targets. No other country – within the OECD or the vast developing world – has achieved a high Human Development Index (HDI) without a high energy footprint (CO_2 emissions) per capita (see Figure 5.3).

While absolute decoupling is necessary for net zero, it is deeply complex and requires a coherent long-term vision. Over the next few decades, India is likely to advance towards relative decoupling through upgrades in technology and emissions standards.

Recognising these energy challenges, India has committed to ambitious climate mitigation and energy transition targets over the last few years. These include, most recently at COP 26 (in 2021), and revised further before COP 27 (in 2022):

- build non-fossil fuel-based electricity capacity to 500 GW by 2030,
- meet 50% of its cumulative electric power installed capacity from non-fossil sources by 2030,
- reduce the emissions intensity of its GDP by 45% below 2005 levels by 2030,

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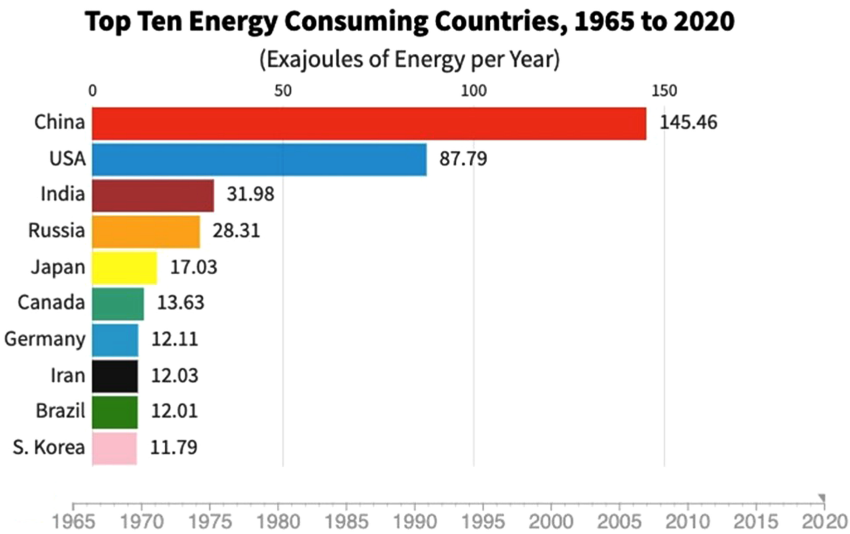

Figure 5.1 India's position amongst the world's top 10 energy consumers.

Source: BP, 2021a.

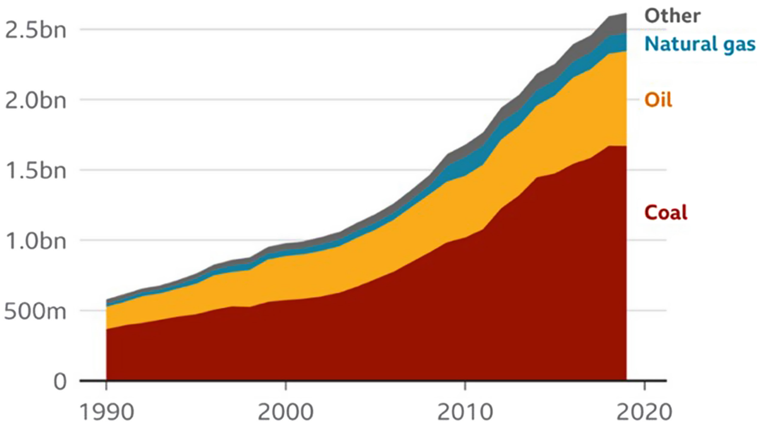

Figure 5.2 India's share of CO_2 emissions by fuel type.

Source: Global Carbon Project, 2022.

- reduce the total projected carbon emissions by one billion tonnes between 2021 and the year 2030, and
- achieve net-zero emissions by 2070.

As such, India has adopted a low-carbon development approach, one that offers a middle path to achieve its ambitious climate agenda without compromising or disrupting its socio-economic development outcomes. The chapter applies a social and institutional lens to unpack this low-carbon development pathway and identify drivers and risks that are likely to influence shifts in India's energy trajectory. Given limited academic research

Table 5.1 Share of primary energy by fuel type

% Share in primary energy mix			
	2009	*2019*	*2020*
Oil	30	29	28
Natural gas	8.2	6.3	6.7
Coal	55	55	55
Nuclear	0.7	1.2	1.2
Hydro	4.7	4.3	4.5
Renewables	1.4	3.9	4.5

Source: BP (2021b).

on the social aspects of India's energy transitions, what impacts are likely to manifest as India phases out its deep reliance on coal and develops renewable energy projects at scale? Both require significant resource commitments to ensure alternative economic ecosystems, a steady supply of raw materials and manufactured products, and sensitivity towards millions of people who face the risk of marginalisation in the rush to achieve climate targets.

Forces that Problematise India's Unique Transitions Challenge

India is not the first – nor will be the last – nation–state to plan long-term shifts in its energy systems. Several nations – mostly in the OECD – have transitioned out of coal over many decades. There are limited signs of an institutional directive on phasing out coal in India just yet. While all efforts are directed at reducing the share of coal in the total energy mix, in absolute terms, coal will remain significant with new investments likely to continue over the next two decades. This is evident in India currently ranked second globally for its coal pipeline (Climate Action Tracker, 2022). The challenge of an absolute coal phase-out in India is shaped by the presence of several internal and external forces. Four factors are critical to understanding these underlying forces:

i) The political economy of India's coal landscape

    India's coal ecosystem is unique, heterogeneous, multi-layered, and complex. It has been dominated by the world's largest coal company, Coal India Limited, and its seven subsidiaries for over six decades. Across the full value chain, including downstream users, nearly 13 million people depend on coal (Dsouza & Singhal, 2021). The coal sector is the single largest contributor to India's industrial activity and fuels India's successful rail model and power generation. Coal assets are mostly located in the country's east which has a history of low HDI, social and environmental legacies, and a politically supported mono-economy culture. Coal-rich states derive revenues from coal mining that, in turn, support basic public services for regional and local development.

    Authors have argued for the presence of multiple economies within a singular coal mono-economy (Lahiri-Dutt, 2016). The significant reliance on tens of millions of informal workers across the coal sector is unique to the Indian context, making it particularly complex. These workers are some of the most vulnerable in the country: low-skilled, often migrants from other regions, and situated at or below the official poverty

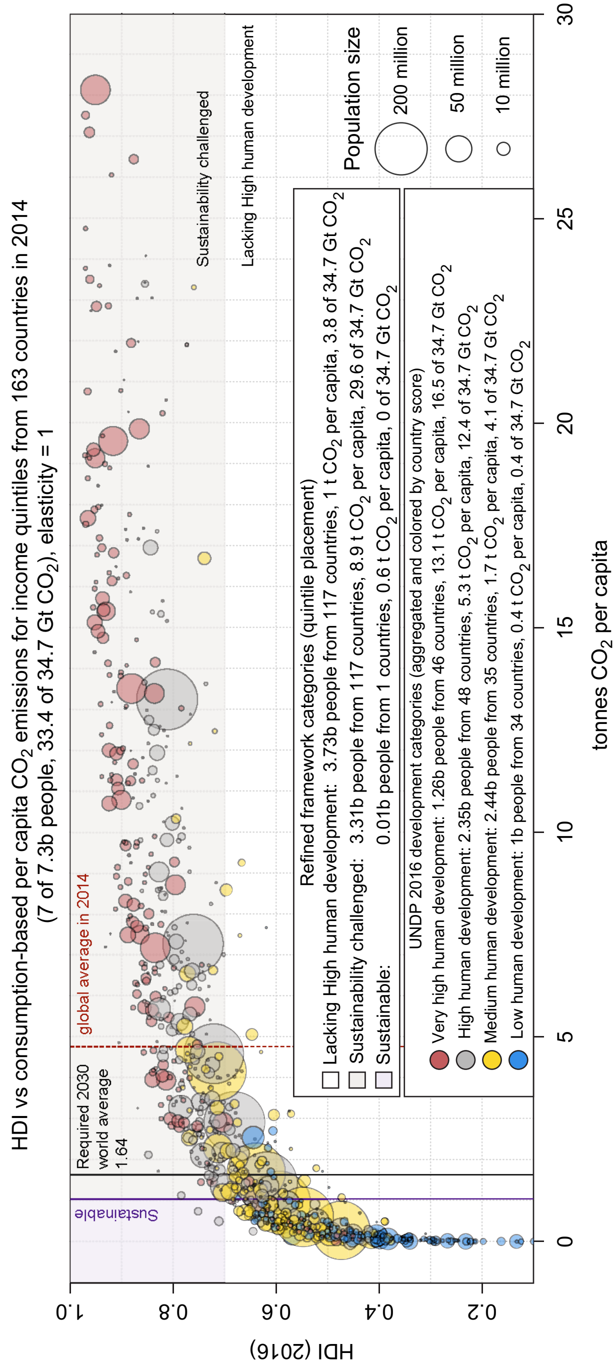

Figure 5.3 Mapping HDI vs. consumption-based CO_2 emissions per capita for income quintiles from 163 countries in 2014.

Source: Pascale et al., 2020.

line. A coal phase-out is likely to result in several direct and indirect impacts not only in the immediate region of focus but across the coal value chain (from formal and informal workers, and service providers through to industrial sectors such as steel-making (see Figure 5.4) and the railways further downstream) (Sharma et al., 2021).

ii) Climate change

India's vulnerability to climate change is undeniable. In the Global Climate Risk Index calculated for 180 countries for 2009–2019, India ranked twentieth overall and was placed second for Average Losses in million US$ and third for average numbers of fatalities (OCHA, 2021). Ongoing challenges with the quality of air and water, high temperatures, flash flooding, and declining rates of precipitation demonstrate the diversity of impacts from a changing climate. As an example, the period of April–May 2022 was India's hottest on record. The shifts in weather patterns are leading to growing uncertainty in food and water security. Over the coming decades, South Asia is likely to be one of the hardest-hit regions in terms of agricultural output. India's groundwater level has also declined by over 60% in

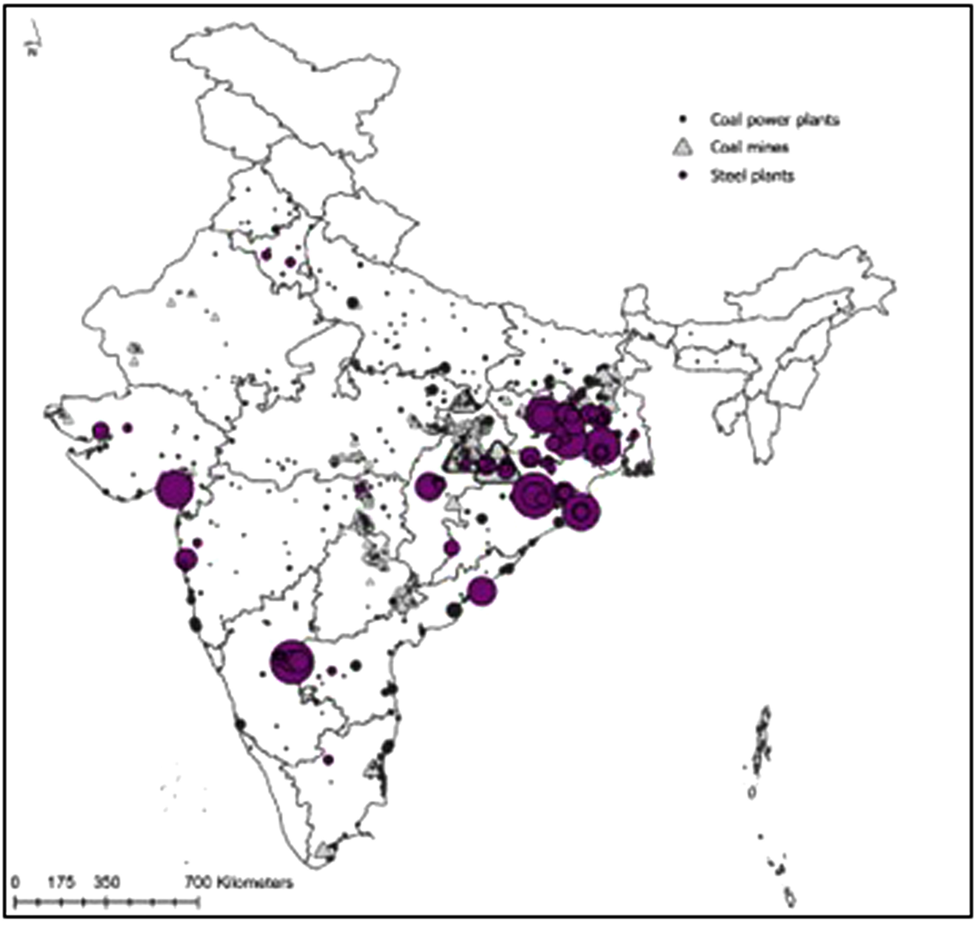

Figure 5.4 Mapping coal value chain in India: mines, power plants, and steel plants.

Source: Global Energy Monitor, 2022.

the last decade. Despite the second-largest farmland area globally, the outlook for India's food and water security remains bleak as much of this farmland remains highly vulnerable to climate-induced changes to weather patterns (Kulanthaivelu et al., 2022). India's perilous climate and poverty/hunger nexus was observed most recently in the Global Food Policy Report (International Food Policy Research Institute, 2022) which highlighted that by 2030, India will have 17 million people facing hunger, the highest globally (Basak, 2022).

Despite just under half of India's working-age population being employed in agriculture, the impact of climate change on the sector is further pushing millions of people out and into urban regions in search of better livelihoods and employment opportunities (Kulanthaivelu et al., 2022). These decisions exacerbate resource pressures on cities, leading to a cyclical process of displacement and disadvantage. Energy remains central to this conversation on urbanisation and rising energy demand. Interruptions to affordable and reliable energy supply threaten to reverse much of the socio-economic progress achieved amongst the urban middle class.

iii) A fast-emerging economic powerhouse

Harvard University's Growth Lab recently declared India (alongside China, Uganda, Vietnam, and Indonesia) as one of the fastest-growing economies by 2030 (Centre for International Development at Harvard University, 2022). It has already overtaken the UK as the fifth largest economy, driven by significant consumer demand – a sign of its expanding middle class and consequent demand for energy (Farrer, 2022). The Indian government has a vision to capitalise on this outlook through its "Make in India" ambition and become a world-leading design and manufacturing hub.

India's rich demographic dividend further supports its potential to become a strong economy. Over the next two decades, India will have its highest working-age ratio ever with a fifth of the world's youth population already in India (MoSPI, 2017). The potential to harness this dividend is contingent upon ongoing investments in health, education, female workforce participation rate, skills and vocational training, and long-term reforms to build its human capital. A secure supply of energy is fundamental to achieving positive outcomes in many of these areas. Equally, there is scope to design smart, forward-looking policies that invest in areas where future growth and jobs are likely to be as India shifts from a fossil-dependent to a green economy.

iv) A history of socio-economic disadvantage and marginalisation

Nearly 50 million people are expected to be living below the poverty line in India by 2040. While advances have been made across all sustainable development goals, tens of millions of people remain socio-economically marginalised under growing inequity. India also suffers from significant socio-economic disparities across states, with coal-rich states consistently performing poorly on HDI. Out of 36 states and Union Territories (UTs), Odisha (rank 29), Chhattisgarh (rank 32), and Jharkhand (rank 33) are India's top three coal-producing regions. This inter-state inequity needs to be considered in how India approaches its transition out of fossil fuels. Most recently at COP 27, India's Environment Minister acknowledged the significance of socio-economic development needs, calling SDGs 'an overriding priority for the developing world' (Yadav, 2022).

Consider the case of the SDG 7. Over the last decade, India has been able to streamline its energy policies to address energy poverty, defined as the lack of access to affordable, reliable, and secure energy supply. Despite several Indian states declaring 100% electrified villages, rural electricity supply lacks reliability, particularly in remote regions. This has, in turn, led to limited opportunities to capitalise on energy access to create productive livelihoods. Similarly, for clean cooking, while LPG access has improved, subsequent uptake and use remain slow and sporadic. SE4ALL suggests although 'only' 14 million people in India currently lack access to electricity, this merely points to an electricity connection (Tracking SDG 7, 2022). A much larger number of people (in 2018, over 300 million (Mukherji, 2018)) face unreliable and poor quality access to electricity, and over 440 million lack access to clean cooking technologies (Tracking SDG 7, 2022).

Social Costs of Coal Phase-out

For most of the last seven decades, coal has been the centrepiece of India's energy story. Coal has strengthened the narrative on nation-building through its contribution to employment and livelihoods, shaping cultural identities, and a strong industrial footprint (Lahiri-Dutt, 2016). Through vested interests between coal, local and regional politics, and the private sector, India's coal economy demonstrates the perils of 'carbon entanglement' (Gurría, 2013).

For these reasons, in the contemporary discourse on energy transitions, coal remains a sensitive topic. This has been evident in the Indian government's back-and-forth position on coal. From Paris Agreement in 2015 to COP 27 in 2022, India has pushed to make incremental changes to its Nationally Determined Contributions and, has sought agreement from other nation-states to underscore its position on a) phasing down, not phasing out, coal and b) calling for a phase-down of all fossil fuels – oil, natural gas, and coal.

Tensions around coal phase-down in India are driven by the traditional positioning of coal as the panacea for pressing development outcomes. This is also reflected in an overdependence on coal producers for public goods and service delivery, otherwise state responsibilities. An institutional will to foster a fossil-free pathway to development over the medium-to-long term is only just emerging. As such, the *distributional* impacts likely to emerge from a low-carbon shift, particularly on India's poor, have not been part of the national discourse until recently. In the absence of adequate policy support and social protection, the local and regional socio-economic costs of moving away from coal will hit those at the bottom of the development ladder the worst.

This leads to a second, important *procedural* aspect. Decision-making about low-carbon transition at the highest policy level excludes communities on the ground that are likely to be at the most risk of disadvantage from a technocratic green policy shift. Considering India's unique multiple coal economies, the rank and file-level dependencies on coal for livelihoods extend beyond those who work informally across India's coal mines. The coal ecosystem supports large-scale industrial activity, along the full value chain comprising scores of small and medium enterprises. The footprint is enormous and wide-ranging both spatially and temporally – from large bauxite mining and smelter plant operators to iron and steel plants to small service providers in industrial regions through to transportation providers, including road and railways (Sharma, 2021).

A full assessment of the social costs of a coal phase-down – or an eventual phase-out – is impossible without comprehensively characterising the strengths, aspirations, and limitations of the human and social capital present in regions and communities along this value chain. Their exclusion in the governance and decision-making processes has already been brought into focus by questioning the state's moral and ethical obligations towards its citizens (Munro et al., 2017; Pierik, 2004). The Just Transitions principle builds on critical questions of rights, consultation, and negotiation to ensure energy transition outcomes lead to co-benefits across economic, environmental, and social aspects of long-term development (OECD, 2017). It highlights the role of institutional responsibility in designing public policies that are fair and equitable across class, caste, gender, race, and ethnic divides (Heffron & McCauley, 2018). In a society such as India facing deepening inequity and a dismal track record in addressing impacts on the marginalised, these questions warrant further deliberation (Aggarwal, 2020).

These social costs are likely to be complicated by the presence of several additional factors: India has had a poor track record of, or focus on, planned closure (Dsouza & Singhal, 2021). Nearly 300 mines are either closed or abandoned in India. This is a pressing challenge with the number expected to grow significantly over this decade as older mines become economically unviable. For the first time nationally, social costs of mine closures have been considered under the purview of the government's closure policy, which in and of itself remains poorly implemented, having only been formally introduced in 2009 (Reuters, 2022). Global literature on mine closure has established that for positive outcomes post-mining, social aspects in closure planning are best initiated at the start of a mine with human, technical, and financial resources committed to ongoing stakeholder engagement and consultation (Bainton & Holcombe, 2018; Owen & Kemp, 2018). Decisions concerning post-mine land use, economic transition pathways, and regional service provision are particularly critical in India which faces deep-seated heterogeneity in stakeholder perspectives and a culture of top-heavy decision-making. To address closure impacts fairly and equitably, time and financial commitments alongside national and regional political will are necessary (Roy & Schaffartzik, 2021).

Social Costs of the Green Energy Transition

India's energy transition extends well beyond a one-dimensional narrative about the social and institutional costs of, and impacts from, transitioning out of coal. Since the early 2010s, India has rapidly accelerated green energy projects, mostly large-scale solar and wind. As shown in Figure 5.5, the spatial distribution of India's energy systems is not uniform. While coal mining is mostly located in the east, renewable energy (RE) projects, mostly solar and wind, are in the country's western and southern regions.

Academic research on the social aspects of clean energy developments has mostly been focused on contestations in the Global North. Studies that explore energy injustices, patterns of consultation and conflict, and risks to natural resource-dependent groups in the Global South are few and far between. The scale and pace of RE development is pushing India as a champion of clean energy within developing regions. But the shift to these new systems is raising several Just Transition challenges, including the nature of community consultation and engagement that need sustained scrutiny (Yenneti et al., 2016; Sovacool, 2021).

The aggressive expansion of the clean energy sector suggests a reproduction of what disadvantaged communities in the eastern resource-rich belt have experienced in the past: land dispossession, agrarian marginalisation, and abuse of rights over decision-making particularly amongst indigenous and ethnic minority groups. According to Stock (2022,

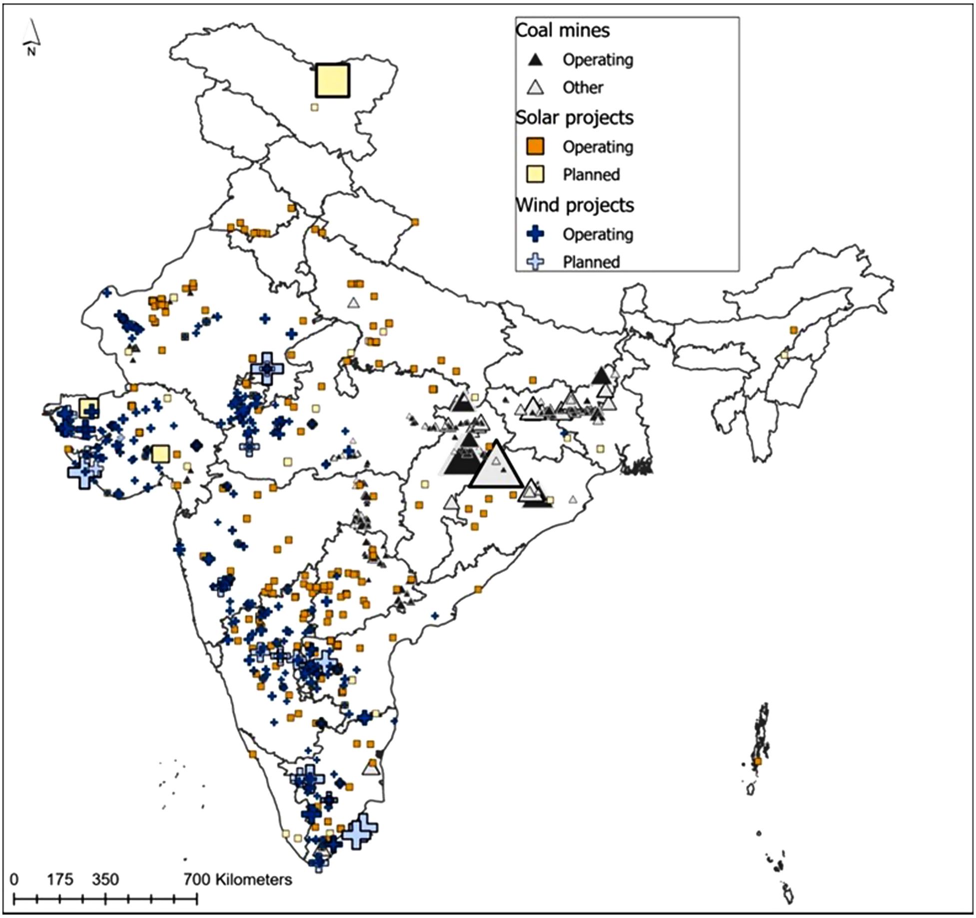

Figure 5.5 Geographical distribution of India's large-scale energy systems (coal, solar, and wind). Global Energy Monitor, 2022

p. 3), "green grabbing for large-scale solar installations are justified through moralistic discourses of 'saving the world' and countenanced by institutions of global climate governance."

Two additional aspects are worth noting in this context. Although structural, their impacts are exacerbated by the "greater good" appeal underpinning green energy development.

India is rapidly pivoting to strong private sector engagement not only in coal mining but also in the roll-out of large-scale renewable energy projects. This is noteworthy considering the private sector has so far operated in a limited capacity in the energy space (mostly in relation to reform and privatisation of electricity in some states, and that too with irregular success) (Ghosh et al., 2021). Since the early 2000s, the private industry has actively sought to harness economic opportunities in "new energy" generation and production, fuelled by comprehensive policy support in the form of incentives and capital subsidies by both central and regional governments (Lakhanpal, 2019; Yenneti et al., 2016). However, there is an underlying note of caution here: unlike the traditional fossil fuel-driven public sector undertakings that have had an implicit responsibility to contribute to India's development agenda (Viswanathan & Aggarwal, 2021), and provide for public goods and services, the new cohort of home-grown corporate players are profit-driven enterprises. There is an inherent lack of sensitivity to the socio-economic development aspirations of hundreds of millions of people whose lives intersect with corporate interests over access to land, water, and other natural resource wealth (EJAtlas, 2015; Lakhanpal, 2019; Rajvanshi, 2022). According to India's ex-environment minister, Jairam Ramesh, "The corporate lobbies are just too powerful and in the name of ease for businesses, environment has become the biggest casualty" (quoted in (Ellis, 2020)).

A second critical – but under-researched – aspect concerns the potential of increased resource extraction to secure the supply of critical minerals necessary for the clean energy transition. There are currently no known reserves of ETMs including, nickel, cobalt, molybdenum, and heavy rare earth elements in India (see Figure 5.6). The Indian

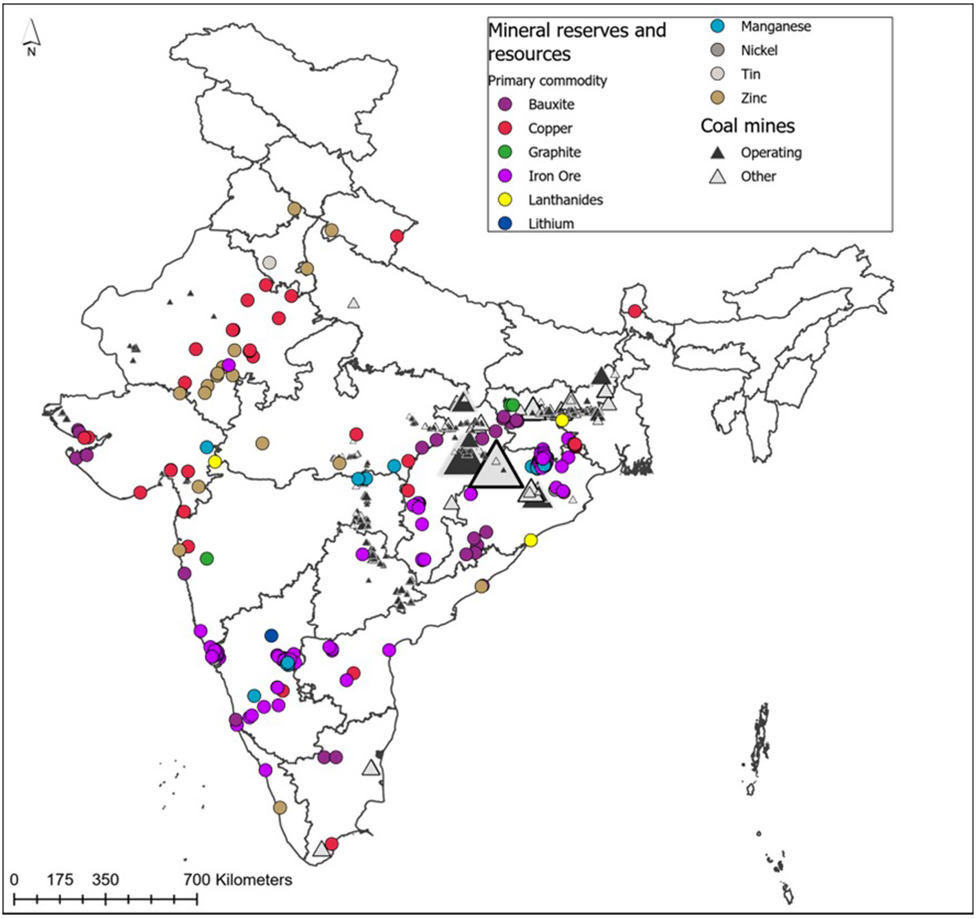

Figure 5.6 An overlay of India's coal mines and ETMs reserves and resources.

Source: Global Energy Monitor, 2022; S&P Capital IQ Pro, 2022.

government recognises its dependence on ETM imports over the short-to-medium term to build its clean technology manufacturing capabilities whilst '**acting quickly** (emphasis added) on the exploration and mining of critical minerals and setting up investments in the downstream value chains [domestically]' (Chadha & Sivamani, 2022).

Recent research has highlighted that caution is warranted as rising ETM demand will inevitably either lead to expansions of current mining leases or the development of new projects (Lèbre et al., 2020). Where institutional capacity is limited, the pace of mining intensification may lead to exacerbating social and environmental externalities. There is also evidence to support that ETMs are spatially located in some of the most sensitive landscapes, including fragile, remote, and climate-vulnerable ecosystems, that host a significant proportion of the world's indigenous and other land-connected peoples (Owen, Kemp, et al., 2022). India's poor record in upholding environmental and social safeguards across past extraction activities does not lend much confidence to future mining projects, particularly when there are likely to be competing economic, strategic, and geopolitical drivers.

A recent study of over 5,000 ETM mining projects globally found that nearly 70% of all ETM projects are on or near land that qualifies as Indigenous Peoples' or peasant land (Owen, Lebre, et al., 2022). The study sample included 20 projects from India covering seven primary commodities.[1] All projects were identified to be in jurisdictions with inadequate permitting, consultation, and consent measures. Fourteen of the 20 projects operated on or near Indigenous Peoples' lands and within 50 km from a violent mining-related conflict over access to land, water, and/or natural resources. All projects existed on or near peasant lands. These are astonishing findings in and of themselves. More importantly, though, they offer a timely indication of the potential social costs of a clean energy transition if mining activities intensify in a context facing concurrent challenges from climate change, poverty, food insecurity, weak governance, and increasing marginalisation.

Three Areas of Interventions for India's Energy Transitions – Drawing on International Experiences

Several world regions have planned and undertaken transitions away from coal since the early 1980s. While the underlying drivers and motivations for these transitions were different from the contemporary conditions propelling India towards low-carbon development, they offer important pointers, nonetheless. Comprehensive research on these past experiences has been widely published elsewhere (Caldecott et al., 2017; Diluiso et al., 2021; Walk et al., 2021). This section briefly reflects on these international experiences to identify relevant lessons for India. As discussed earlier, India's transition challenge is uniquely complex and local. Yet these lessons can guide early planning and resource allocation to build strong institutional structures over the next few decades that ensure transition outcomes are sensitive, fair, and equitable. Table 5.2 draws together key lessons from various international transition experiences to inform India's approach to a Just Transition.

Drawing on these collective experiences, three areas of planned intervention are proposed below. When implemented concurrently, these allow a nuanced understanding of the underlying costs of transition.

Table 5.2 Summary of international experiences with coal phase-out and relevance for India

Regions	*Drivers*	*Governance*	*Successes*	*Failures*	*Relevance for India*
Germany (transition from 1982) (Arora & Schroeder, 2022; Oei et al., 2020)	Continuous planned and controlled coal decline	Coal Commission with a multi-level, multi-sector focus on identifying and managing transition impacts. Complemented by substantive financial commitment	Promotion of new identities and economic opportunities in coal regions to offer sustainable and long-term alternatives	Policy interventions were not able to prevent externalities of structural change, including negative impacts on the labour market, demographic decline, and outmigration	Setting up a non-partisan transition authority that drives polycentricism, devolving decision-making power to regional and local authorities; enabling action on the ground through funding commitment; holistic approach to local/regional development post-coal; inclusive transition planning
Poland (transition from 1987) (Brauers & Oei, 2020; Śniegocki et al., 2022; Szpor & Ziółkowska, 2018)	Shift to market economy and associated sectoral shifts, high costs of coal production, poor economic viability (high production costs, poor labour productivity)	Financial compensation for the coal industry, coal regions and workers; training programmes	Support from municipalities	Negative experiences of insufficient support, causing structural breakdowns. Widespread fear and institutional distrust leading to strong opposition against upcoming coal transitions; lack of focus on environmental remediation in coal regions	Localised place-based planning for orderly mine closures; avoiding social conflicts through miner-specific structural support; building social capital to enable bottom-up initiatives; importance of the trade unions; ties between coal and politics causes vested interests to disrupt planning

The US (transition from 1998) (Bainton & Holcombe, 2018; Greenberg, 2018)	Competition from alternative energy sources (shale gas, renewable energy); anti-coal calls from pro-climate groups	State-driven attention to just and people-centred transition planning	Focus on economic diversification led by local champions and rooted in community ties	Lack of attention to environmental governance and land rehabilitation. High levels of socio-economic decline persist in ex-coal regions	Local champions/ advocates from within the community; focus on quality – not only quantity – of jobs; poor importance to environmental restoration lends to long-term socio-economic decline and legacy challenges
The UK (transition from 1981) (Brauers et al., 2020; Campbell & Coenen, 2017; Gillard, 2016)	Coal decline in primary consumption led to poor economics of coal, ageing infrastructure, and the emergence of climate action	Stringent regulation on coal industry	Local approach to and community-led design of regeneration interventions	Top-down implementation of large funds failed to address vulnerabilities of those most at-risk, leading to further marginalisation and inequity	Programmes likely to be successful when responsive to community needs; alignment between media/ public discourse and decisive policy intervention can expedite transition decisions; entrepreneurship building on existing skills; redeploying social and infrastructure capabilities along the value chain
Australia (transition from 2012) (Edwards et al., 2022; Jotzo et al., 2018)	Increased operating costs, concerns over public and environmental health, ageing infrastructure, government's demand for increased coal royalties	State (province)-based decision-making	Focus on local infrastructure development, and economic diversification	Insufficient time invested in stakeholder consultation	Align transition plans with regional strengths and local priorities; instability in national policymaking is disruptive; design transition plans in consultative dialogue-orientated process; focus on regulating closure

Adapted from Sharma et al. (2023).

i) Knowledge base commensurate with the pace and scale of development

India's energy transition is bound by heterogeneity and complexity that is unprecedented in its economic history. As a first step therefore, governments need to work with locally based civil society groups and researchers to characterise impacted stakeholders across communities and industry groups (along coal and renewable energy value chains) and build a knowledge repository that underlines future change management strategies. The inclusion of researchers will bring a high degree of rigour needed in these characterisations.

At the outset, this would include large data collection and mapping expeditions with a census-like precision about the human, natural, and social capitals present within millions of India's communities at the forefront of the impending energy shift. This knowledge will, in turn, inform the nature, timing, and extent of structural support needed for transition planning over the next few decades. Financially supported by the central government, overseen by a dedicated state government agency, and managed by local NGOs, it will foster bottom-up ownership of the task, and inclusive engagement, thus ensuring sensitivity to local challenges. A baseline repository is critically missing in India; robust data is either dated or difficult to locate or unavailable. Although a daunting exercise (for cost and time reasons), the value of data-driven policy decisions on resource allocation as transition plans are drawn up regionally is indispensable.

ii) Social dialogue, with a focus on consensus building

Considering that energy systems are essentially socio-technical systems, the impacts of large-scale transitions on people and their socio-cultural ecosystems need both acknowledgement and accountability (Miller & Richter, 2014). The value of collaboration and social dialogue in planning for energy transitions has been a significant pillar of the Just Transition narrative (Molina Romo, 2022). It fosters consensus building, trust, greater ownership of the challenge amongst various stakeholder groups – communities, governments, and the industry, as well as a diversity of input in policy formulation (ILO, 2022). Dialogue is critical not only to address grievances but, in the first instance, to identify triggers that could turn into long-term grievances. An inclusive dialogue-orientated approach allows early recognition of pressure points that – if ignored – may lead to disagreements, even ending in violent conflict.

South Africa's NEDLAC and Germany's Coal Commission are examples of national agencies accountable for ensuring stakeholder consultation and engagement on an ongoing basis as a driving force for successful transition outcomes (IEA, 2022b). Another positive example of embedding social dialogue within the broader approach to Just Transitions is evident in the Taranaki region of New Zealand. Homed within the Ministry of Innovation, Business and Employment, the Just Transition unit has meaningfully engaged with partner representatives from across government, worker groups, employers, Māori communities, (non-Māori) local communities, and civil society groups to create a Just Transition blueprint, subsequently leading to the adoption of a series of sectoral roadmaps.

Community marginalisation and lack of inclusion and transparency are widely reported in energy project developments across India (Kaur, 2022; Menon, 2022; Paltasingh & Satapathy, 2021). Improved mechanisms of social dialogue will be critical to ensure impacts of government and industrial policy on local communities at the forefront of the transition are minimised, if not avoided.

iii) Holistic interventions, to extend transitions thinking beyond jobs

India's energy transition planners are already confronted with the challenge of pace. Given the unprecedented nature of the scale of the transition, pace without adequate preparedness may lead to long-term legacy issues. An important aspect of this preparedness is to consider a policy that is all-encompassing in design and outlook.

Most past transitions have focused mainly on job creation. Whilst not unimportant, economic opportunities are seldom equitably accessed in the absence of social stability and ecological integrity of local ecosystems (Wilgosh et al., 2022). There is evidence that poor attention to environmental rehabilitation played a critical role in the lasting socio-economic decline still noted across ex-coal regions in Appalachia (Engle, 2019; Greenberg, 2018). Announcements of the Just Energy Transition Partnerships in South Africa and Indonesia acknowledge these past failures and have thus offered a comprehensive transitions agenda including livelihoods security, infrastructure repurposing, protection of at-risk groups, and engagement with actors across the coal value chains (European Commission, 2022a, 2022b). In relation to environmental restoration for India, interventions will be needed on both circular economy and closure mandates, including revisiting closure-related financial assurance, planning timelines, and regulating penalties for inaction.

Equally, inflection points for social conflicts in India's energy systems need better mapping and planning. The intersection of energy and gender is one notable aspect (Fathallah & Pyakurel, 2020; Tsagkari, 2022). In the coal sector, for example, studies have highlighted the disproportionate impact on women and young girls manifesting in a decline in women's participation in the labour force (Lahiri-Dutt, 2012). Policies that can directly address structural and social barriers to manage the gendered impacts of Just Transition (Braunger & Walk, 2022) in India are urgently needed. A sound knowledge base complemented with a bottom-up consultative process can enable broad-based, but regionally relevant, transition planning.

Conclusion

India has proclaimed its stand on climate change on the global stage. It has committed to an ambitious agenda for climate action but has equally sought to highlight gaps in action from the developed world on technology exchange, climate financing, and responsible consumption of all fossil fuels. India has – perhaps most assertively of all developing regions – also made clear its ongoing reliance on coal over the medium term to meet its urgent development priorities, while it continues to scale up renewable energy production and uptake.

This chapter has highlighted four aspects of the uniquely complex character of India's energy transitions. These factors help make sense of the dichotomy underlying India's current and future choice of energy systems. These are rightful choices but require careful, proactive planning and governance to ensure impacts – and their outcomes – particularly for nearly 600 million Indians (The World Bank, 2022) living in poverty do not cause further marginalisation and inequity.

The chapter identifies three interventions to help design robust long-term energy policy that builds on the principles of justice and fairness over the long-term. These offer a credible pathway towards an inclusive future, one that is not antithetical to India's growth and development ambitions. The first speaks directly to the enormous gap in data availability in India. Recognising that the last National Survey was undertaken in 2011, granularity in demographic, social, mining, and economic data is urgently needed to ensure optimal transition plans are designed and implemented. The second counters India's historically poor record of meaningful engagement and social inclusion, particularly in the context of large-scale industrial activity (e.g., mining and allied industry, energy projects including hydropower, solar and wind). The third draws on international experiences with coal transitions to highlight the importance of a multi-pronged approach to a Just Transition. Extending innovation into transitions thinking can ensure outcomes are socially fair and equitable, and accepting of hard-fought international environmental standards.

Acknowledgement: We would like to thank Dr Andrew Pascale for creating Figure 5.3 included in the chapter.

Notes

1 The commodities included Nickel, Zinc, Bauxite, Copper, Iron ore, Lead, and Lanthanides.
2 Actual investments required are likely to be higher depending on technology mix and transition management costs. Savings and return on investments is not been analysed.

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Appendix 5A

Workforce Transition Management in Rajasthan Rajya Vidyut Utpadan Nigam Ltd

Simran Grover and Manideep Gudela

Context

The clean energy transition is reshaping Rajasthan's energy landscape in more ways than one. More than 90% of the solar capacity is commissioned in western districts of Rajasthan (Jodhpur, Jaisalmer, and Bikaner) because of favourable conditions and the availability of large tracts of land. In contrast, a majority (60%) of the 11.5GW of thermal power capacity is located in the state's eastern districts (Baran, Kota, and Jhalawar). Further, renewable energy sources (solar, wind, and biomass) account for 60% of the total generation capacity (32 GW) installed capacity in Rajasthan of which 98% are private sector investments. This contrasts with 73% of thermal (coal and gas) capacity ownership by Rajasthan Rajya Vidyut Utpadan Nigam Ltd (RVUNL), a public sector generation utility, signifying a fast-paced shift in generation asset ownership within the state.

As of Mar 2023, RVUNL owns and operates 8.6 GW of power generation capacity, of which 7,830 MW (91%) is powered by coal, 603 MW (7%) is gas, and the

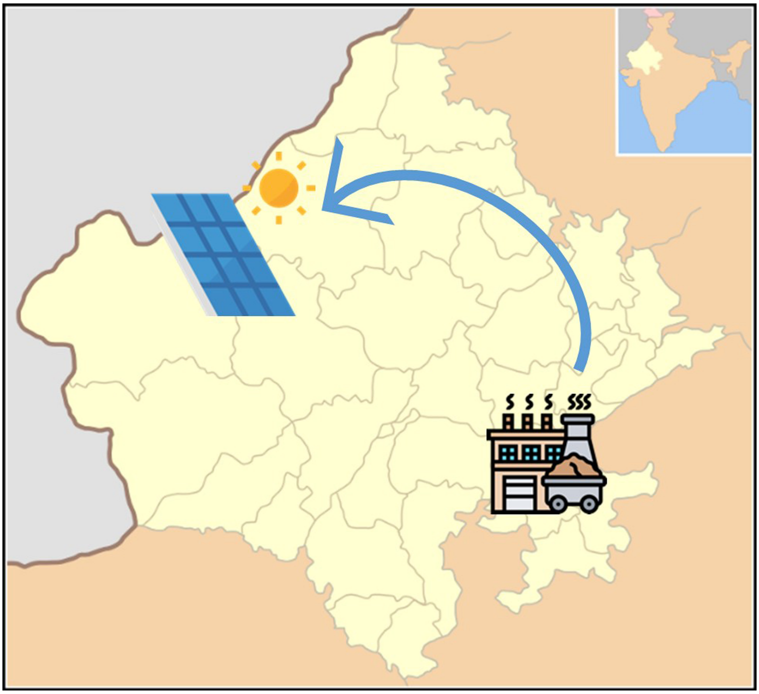

Figure 5.A.1 Geographical shift in electricity generation in Rajasthan.

remaining 164 MW (2%) is hydel. With its current capacity, the utility met 55% of the state's peak demand and 35% of the state's annual energy requirement in FY22.

Given Rajasthan's energy transition trajectory and trends of private sector driven clean energy investments, it is likely that the private sector shall increasingly dominate the power procurement portfolio. RVUNL's clean energy transition shall accelerate the energy transition of Rajasthan, create new opportunities for investments and jobs, facilitate competition through healthy public and private sector participation, and strengthen Rajasthan's energy security.

As per its latest annual report (FY22), RVUNL employs 3,836 permanent employees, all of whom are skilled category workers. Contractual employees include workpersons from skilled, semi-skilled, and unskilled categories. Based on analysis of data obtained through RTI, Centre for Energy, Environment and People (CEEP), reports that the utility employs 2.5 contractual employees for every permanent employee at its coal power plants. Based on this, an estimated 13,295 are employed by RVUNL. Additionally, it also provides hundreds of associated livelihoods (equipment manufacturers, vendors, consultants, contractors, etc.) and thousands of allied livelihoods (livelihoods linked to local economic activities that exist as a consequence of being in the vicinity of a power plant – domestic helpers in employee residences, grocery vendors in the neighbourhood, transport operators for workers, etc.).

RVUNL doesn't have a defined decommission plan for its coal fleet yet, although, as of Mar 2023, 850 MW of its coal power capacity is over 25 years old The utility's current expansion plans include the addition of 2,245 MW of new coal power capacity and 810 MW of solar power capacity (RVUNL, 2022). We explore the transition scenarios for RVUN and evaluate the macro impact on jobs.

Transition Scenarios for RVUNL

We develop three scenarios for RVUNL for the period 2022–2030 based on differentiated rates of decarbonisation. The respective transition pathways aid us in arriving at RVUNL's power generation portfolio mix until 2030 and analyse plausible employment creation (and loss) in the commissioning and operations of different assets. Employment creation for decommissioning thermal assets is not considered.

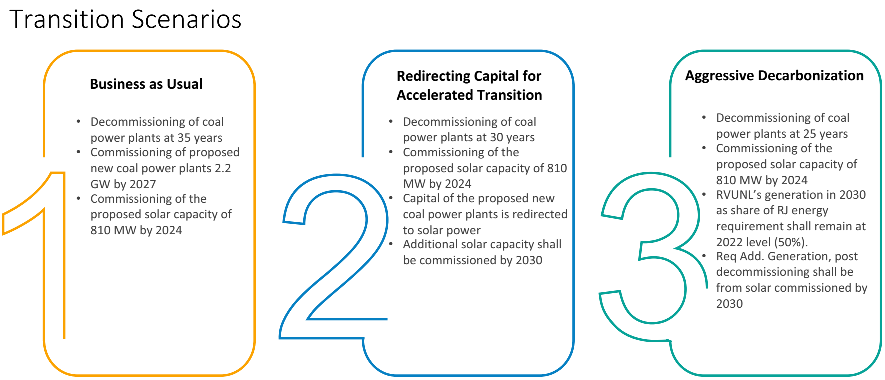

Figure 5.A.2 Methodology for assessing the impact on jobs.

Source: Author's compilation and analysis.

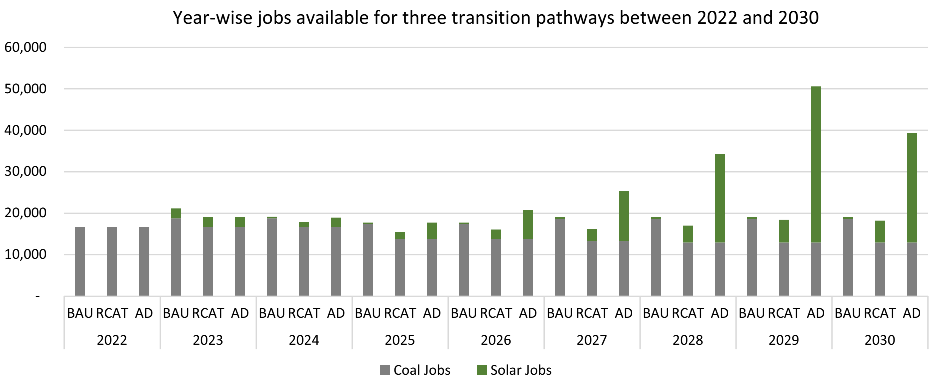

Figure 5.A.3 Year-wise jobs available for three transition pathways between 2022 and 2030.

Source: Author's compilation and analysis.

Scenario 1 – Business As Usual (BAU): Here, the proposed coal power capacity of 2.2GW is considered to be commissioned by 2027, with an addition of 810 MW of Solar capacity in 2024 (announced in the FY22 budget). Considering a realistic decommissioning trajectory based on historical trends, existing coal assets past 35 years are considered for retirement.

Scenario 2 – Redirecting Capital For Accelerated Transition (RCAT): Here, we assume zero thermal capacity addition with the equity capital budgeted by GoR redirected towards solar PV capacity addition. The solar PV capacity addition in this scenario is in addition to the planned 810 MW of Solar capacity simulated in Scenario 1. Further, the retirement of coal assets past the age of 30 years is considered.

Scenario 3 – Aggressive Decarbonisation (AD): This scenario involves aggressive decarbonising by shelving the current plans to add new coal capacity and retiring the existing coal plants at 25 years. The share of Rajasthan's energy requirement met through RVUNL's generation in 2030 shall remain at the current level of 35%, which is achieved through an accelerated addition of solar PV capacity.

Table 5.3 Snapshot of the RVUNL transition under the three scenarios

	2023	*2030*		
		BAU	*RCAT*	*AD*
RVUNL generation capacity (MW)				
Coal	7,830	9,435	6,730	5,535
Gas	604	604	604	604
Hydro	164	164	164	164
Solar	0	810	4,842	10,754
Total	8,597	11,012	12,340	17,056
RJ peak demand (MW)	17,206			
RJ Peak Demand (MW) - 20th EPS		23,534	23,534	23,534
RVUNL generation (MU)				
Coal (R)	42,621	51,358	36,634	30,129
Gas (R)	2,518	2,518	2,518	2,518
Hydro	196	196	196	197
Solar	0	1,419	8,484	18,841
Total	45,335	55,491	47,831	51,685
RJ energy requirement (MU)	95,172			
RVUNL generation vs RJ energy requirement (%)		1,49,063	1,49,063	1,49,063
Additional capital investments (Rs., crores)		19,683	19,683	43,715
Emissions (million tonnes of CO_2)				
Released in the year	49.363	53.533	38.579	31.972
% Change from 2022 to 2030 (+/-)		8%	-22%	-35%
Total emission saving b/w 2023-30		5.67	62.50	87.08
Impact on Jobs				
Number of Job years as on 2022	13,295			
Change in Coal Job years by 2030		2,254	-2,247	-4,145
Pre-Comm. Solar Job years on 2030		0	2,857	6,345
Post-Comm. Solar Job years on 2030		405	2,421	5,377
Total Solar Job years on 2030		405	5,278	11,722
Total Jobs Years Available on 2030		15,955	16,326	20,872
Jobs Created b/w 2023 and 2030		**19,672**	**15,601**	**33,416**

Coal and gas generation(R) is based on rated capacity and normative PLF, and availability adjusted for auxiliary consumption.
Source: Author's analysis.

The impact on jobs is estimated for each transition scenario based on estimated jobs created for the addition of solar and coal power capacity and adjusting for the loss of jobs against the decommissioning of coal power plants. For a comparative analysis, we estimate equivalent job years per megawatt per annum for solar and coal power generation. A job-year is defined as the ratio of time an employee spends on a particular project/task in a given year to the standard total working hours in that particular year. The analysis is carried out for pre-commissioning, post-commissioning, and decommissioning stages, as shown below.

Analysis for Pre-commissioning, Post-commissioning, and Decommissioning Stages

The costs of transition are estimated based on available benchmarks for the commissioning of power plants Rs. 7.3 Cr per MW (GoR, 2022) for coal and Rs. 4.07 Cr per MW (IEEFA, 2022) for solar.

The BAU scenario results in the augmentation of thermal capacity and solar capacity by 2030, resulting in an increase in annual CO_2 emissions of the utility by 8% from its 2022 levels. In the RCAT, the annual CO_2 emissions of the utility level shall reduce by 22% by 2030 from the 2022 levels. The third scenario (AD) is ambitious, wherein the RVUNL, while maintaining its share in the Rajasthan energy landscape, aggressively pursues early decommissioning of thermal assets. This shall demand an investment of Rs. 44,000 Cr[2], save 87 million metric tonnes of CO_2 between 2023 and 2030, and reduce annual emissions by 35%. A summary of the analysis follows.

Impact on Jobs

As can be seen from the table, in the AD (accelerated decarbonisation) scenario, RVUNL is likely to create 33,000 jobs between 2023 and 2030. In comparison, the BAU and RCAT scenarios shall create 19,000 and 15,000 jobs, respectively. Net jobs created are a function of jobs lost due to decommissioning thermal assets and jobs created in the renewable energy industry. It may be noted that additional jobs may be created by repurposing thermal power plants and prioritising adoption of more job-intensive technologies such as distributed solar, but the same are not considered in our analysis.

Energy transition in electricity generation will not simply replace coal jobs with renewable energy jobs as the transition presents a significant spatial shift in the loci of energy generation from the eastern to the western region in Rajasthan. This raises concerns for both direct employment and allied jobs.

The nature and quality of jobs is also a concern. The deployment of renewable energy assets creates a majority of jobs in the construction and pre-commissioning phases, whereas the job intensity for operations and maintenance is very low.

The pre-commissioning jobs for solar PV assets include business development, design and pre-construction, and construction and commissioning, typically lasting less than a year. The majority of the jobs are created during the construction and pre-commissioning phase (2.7 job-year per MW), with 65% being unskilled and semi-skilled (electricals and panel installation) and 35% skilled (site engineering related) in nature. The jobs in the business development phase are 100% skilled, and the design and pre-construction phases require 62% skilled workers. At the same time, in the post-commissioning, the solar plants employ – semi and low-skilled workers, with the majority – 86% of the jobs from unskilled (50%) and semi-skilled (36%) categories (Kuldeep et al., 2017).

The thermal power industry offers long-term jobs, and the majority of personnel employed belong to unskilled and semi-skilled categories. The condition of workers employed for coal handling can be particularly grievous, while their wages do not reflect their risk exposure.

Although the clean energy industry has relatively less hazardous conditions, the wages of the labour force and the short-term nature of the clean energy jobs may impact the long-term sustenance and growth of the associated labour.

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Appendix 5B

How a Village in Maharashtra Sparked a New Discussion on the Transition Away from Coal

Vinuta Gopal, Badri Chatterjee, and Tanmay Takle

The small village of *Nandgaon*, which has 800 residents and is 90 kilometres from Nagpur city, in the Indian state of Maharashtra, served as the catalyst for a discourse about what could be done to lessen the detrimental effects of coal on an agrarian community. When locals' demonstration against the illegal disposal of fly ash in their farmlands made national headlines, the-then State Minister of Environment, Aaditya Thackeray took notice. He halted the fly ash from being dumped in the area and started a process to build alternative livelihoods and a solar power plant there. This incident also sparked a more in-depth discussion on coal plant phase-down and community involvement in the state. The actions taken in Nandgaon, the difficulties encountered by various local administrations there, and the function of community involvement are all discussed in this case study.

Assessing the Magnitude of the Issue

To meet its goal of supplying enough electricity to Maharashtra, MAHAGENCO relies on the thermal power plants at Koradi (2400 MW) and Khaparkheda (1340 MW), both of which are close to Nagpur. They haven't, however, succeeded in raising the standard of living for people who live and work close to power plants. Coal mines, manganese mines, and brick manufacturing industries are among the other businesses in the area.

Farmers in Nandgaon had been cultivating their land for decades when, without their consent, in November 2021. Maharashtra State Power Generation Company (MAHAGENCO) started dumping truckloads of fly ash from the nearby Khaperkheda Thermal Power Station (KTPS), located 40 km away.

Late at night, residents of the area and Zilla Parishad members from Nandgaon started filming the fly ash disposal. Using this as evidence, they started demonstrating (Manchanda, 2021) against the illegal ash slurry dumping in their farmlands, highlighting that it was a flagrant breach of environmental laws. Most importantly, fly ash was being discharged without receiving a no-objection certificate (NOC) (Behl, 2021) from nearby inhabitants.

The ash pond, which is situated in the hamlet next to the Pench river, according to Sonali Manoj Varkhade, Sarpanch of Nandgaon, was having a negative impact on the entire village (Bose, 2022). Its spread was causing air pollution, ruining crops, poisoning water sources, drinking water, and having serious health effects on the local community.

Using Research, Communicating the Effects of Fly Ash Contamination

A group of researchers and civil society members (CSOs), through an in-depth study, brought this village's situation to public attention. A research paper released by the Centre for Sustainable Development, Manthan, and Asar evaluated pollution and its impacts on local communities living in 21 villages, including Nandgaon, located adjacent to KTPS and Koradi thermal power plant ("POLLUTED POWER," n.d.).

The research showed significant pollution across water bodies with dangerous metals such as mercury, arsenic, aluminium, lithium, and others contaminating the surface, groundwater, and drinking water, as well as widespread contamination of air, water, and soil owing to fly ash (www.ETEnergyworld.com, 2022). Water samples failed to meet the Bureau of Indian Standards' drinking water standards and exceeded safe limits by 10–15 times.

Reporting to the State, Centre, and Outlining the Situation on the Ground

Given that they were aware of the health implications and how their future was being affected, local residents began to start registering their concerns publicly, not only with local government authorities but also directly with the-then State Environment Minister, Aaditya Thackeray as well as Union Minister, Nitin Gadkari, and the Ministry of Environment Forests and Climate Change (MoEFCC). Nandgaon residents sent a slew of letters to officials at various levels of government, under the direction of their village head (block, district, and state levels) (Jog, 2022).

The-then State Environment Minister called a number of meetings in the months that followed (December 2021 to February 2022). The Minister rejected the excuses being made by MAHAGENCO, saying that "the environment cannot be sacrificed at the expense of development, especially where consent from locals is not in place." He gave the State pollution control authority instructions to visit the location and suggest solutions before deciding on the next steps. Government and CSOs worked together to achieve an overarching understanding of the problem and devised thorough solutions.

Union Minister Takes Cognisance, MoEFCC Calls for Spot Inspection

Nitin Gadkari, a Nagpur-native and then Union Minister for Road Transport and Highways, was prompted by people's complaints to also call for MAHAGENCO to reduce pollution from both the Koradi and Khaperkheda thermal power plants. The Minister argued for the earliest possible action taken immediately.

On February 4, 2022, in a related development, representatives from the Union Environment Ministry visited Nandgaon and neighbouring districts. The team sent a report to MAHANGENCO for compliance and asked them to form a committee with representatives from the Maharashtra Pollution Control Board (MPCB), involved NGOs, Sarpanches from impacted villages, and MAHAGENCO officials to regularly monitor the site.

Series of Actions Commence: Closure of Fly Ash Dump at Nandgaon

An order was issued for KTPS to stop dumping ash slurry at Nandgaon on February 1, 2022, by the MPCB. According to the notice, MAHAGENCO violated environmental standards since it did not get consent from locals. The Chief Engineer, KTPS, complied with the order and halted dumping on February 4, 2022.

Residents of Nandgaon experienced great relief when the ash dumping stopped, but after learning about the detrimental effects that the fly ash already dumped at the site was having on locals' quality of life, the local community, led by mothers and other women, banded together to write a letter to the Minister. They asked that the ash pond be permanently closed, the bund repaired, and residents' quality of life be improved through better employment opportunities.

This spurred Aaditya Thackeray to visit Nandgaon and assess the site himself while the MPCB established a comprehensive prohibition on the disposal of fly ash within three months and directions for site rehabilitation were put in place.

Minister's Visit and Community Interaction

On 14 February 2022, Thackeray and his team inspected the whole fly ash dumpsite. Thackeray visited the location to make sure everything was proceeding according to plan and spoke with the locals, particularly the women. A group of mothers, led by the Sarpanch, met with Thackeray and expressed their concerns, which the

Minister took cognisance of. The Nandgaon ash pond will soon be permanently closed, announced Thackeray (Bhalerao, 2022). In addition, he gave the mothers and the local community the assurance that a plan will be put together for the improvement of the community and the provision of employment opportunities.

Maharashtra Marks the Start of an Energy Transition Movement

The Environment Department was proactive and forward-looking in response to requests from the civil society and started a series of interventions for Maharashtra's Energy Transition, making it the first state in India to do so. On 14 February 2022, the following announcements were made public:

- Putting a solar plant in operation at Nandgaon – After the fly ash was removed, the State ordered MAHAGENCO to make plans for a 20 megawatt (MW) solar power project.
- Opportunities for locals in Nandgaon to reskill and find jobs were created as part of a strategy for the area's upliftment and to maintain a balance between the needs of the community and the energy industry as it transitions from coal to clean energy (Deshpande, 2022).
- Residents who lost their land or suffered health problems as a result of the fly ash were awarded a total compensation of Rs. 5 crores by the Energy Department of Maharashtra (Behl, 2022).
- Study on Power Plant Phase Down – A thorough investigation into how outdated and polluting coal-fired power plants might be gradually shut down in accordance with updated nationally calculated contributions was initiated.
- An audit of Maharashtra's power plants' pollution prevention practices would be conducted. Regulating thermal power plants that don't adhere to the rules would be necessary.
- 100% Fly Ash would be utilised for environmentally friendly and infrastructure projects and brick manufacture. Plans of a similar nature will be made for other plants in Maharashtra.

Furthermore, the Environment Department's submission to the state legislative assembly in June 2022 said that the actions to remove the Nandgaon fly ash dumpsite were the first to be taken in India since the Dadri NTPC fly ash site was ordered to close as a result of procedural issues in 2008.

Current Scenario

MAHAGENCO has currently (as on November 2022) removed 85% of the fly ash, and preparations for the solar facility are on with tenders filed in September 2022. Out of 150 farmers, 92 received financial aid from the Energy Department, and 83 others were given jobs by the district administration. Fly ash disposal is still not permitted in Nandgaon. But this is only one of many villages in this area that are at risk from fly ash pollution.

Lessons

We need ground research to provide evidence on the current state of environmental and social compliance of power plants. This needs to be shared with the local community, local administration, the management of the power plants and regulatory authorities to enable a constructive engagement between community, local leadership, and regulatory authorities.

We need informed local communities to be able to engage with all the decision makers.

Panchayat leaders and relevant ministers need to understand the alternatives available to them. Local CSOs could play a role in engaging with the community on a regular basis on the issues related to the transition.

Most importantly, leadership must be enabled at all levels of governance and political will to provide the necessary momentum for implementing the regulatory processes and to build the dialogues required for an alternative future.

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6 Deep Electrification in India

A Review of Strategies, Policies, and Sectoral Developments

Sarthak Shukla, Shubham Thakare, and Raghav Pachouri

Introduction

Energy transition has emerged as a key enabler of climate action requiring decarbonisation across the sectors of the economies. The potential of extensively electrifying the major energy-intensive sectors of any economy in realising the goals of energy transition and climate action is significant. This strategy, commonly referred to as deep electrification, is premised on tapping the potential of low-carbon and carbon-free electricity systems to decarbonise energy-related sectors including power, transport, buildings, domestic cooking, and other such energy-intensive economic activities.

Deep electrification of economic sectors can provide the much-needed strategic levers to eventually assist in the decarbonisation of the economy and enable nations to approach the global and domestic climate action goals, particularly pertaining to achieving net-zero carbon emissions. According to a report by the International Renewable Energy Agency (IRENA), renewable energy–powered deeper electrification of global energy systems can help in achieving about 75% of energy-related emission reductions required by 2050 (IRENA, 2018). Globally, the potential of renewable energy–powered deeper electrification has been estimated by several reports which have pegged deep electrification and fuel switching to electricity as environmentally benign strategies for achieving climate goals and carbon reduction. For instance, a study by researchers from Stanford and UC Berkeley suggests an electrification plan for all 50 states of the USA in which the incremental electricity demand is to be met by renewable energy sources (Stanford University, 2015). Similarly, the United Nations Sustainable Development Solution's Deep Decarbonisation Pathways project contemplates the national deep decarbonisation potential and strategies through its work in 36 countries (Institute for Sustainable Development and International Relations, n.d.).

The needle on electrification of key energy-related sectors is moving fast in the Indian context as well. This is evident from the concerted efforts of the Government of India and several State Governments towards electrifying sectors such as road transportation, railways, buildings and domestic cooking, amongst others. Targeted policies as well as private sector–led action in these areas are a testimony of the recognition of deep electrification as a key enabler of India's climate commitments and energy transition strategy.

At the same time, it is also widely recognised that beneficial outcomes of deep electrification will only materialise if efforts on greening the electricity grid are accelerated. For every device, appliance, product, or sector which gets electrified and connected to the power grid, every incremental achievement towards greening the grid transcends into the entire fleet of grid-connected products and sectors. Thus, deep electrification is inherently

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associated with structural challenges pertaining to greening the electricity supply, along with techno-economic, social, political, and environmental issues that persist. Addressing these issues will go a long way in rolling out deep electrification plans with effectiveness and efficacy of efforts towards realising the intended objectives of energy transition and decarbonisation.

Policies Supporting Deep Electrification in India

The policy landscape in India is increasingly embracing and promoting the electrification drive of key sectors through a host of schemes, policies, and other such initiatives. The prominent sectors where critical policies supporting deep electrification are active include transport, buildings, industry, domestic cooking, and agriculture.

Transport

In the transport sector, the Union Government is implementing its flagship scheme called Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles in India – the FAME Scheme (Ministry of Heavy Industries, n.d.-b). This scheme was started in 2015 as part of the National Electric Mobility Mission Plan 2020, launched in 2013, which aimed at achieving national fuel security by promoting electric and hybrid vehicles in the country (Ministry of heavy industries, 2013). The FAME scheme aims at incentivising electric vehicles across all the segments namely two-wheelers, three-wheelers auto, passenger four-wheelers, light commercial vehicles, and buses through supply-side and demand-side incentives on manufacturing of these vehicles by the Original Equipment Manufacturers (OEMs) in the auto sector. Phase-II of the FAME India Scheme is being implemented for a period of three years from April 2019 with a total budgetary support of Rs. 1,00,000 million, more recently the scheme has been extended till 31 March 2024 (Livemint, 2021). In the first phase of the Scheme about 0.28 million hybrid and electric vehicles are supported by way of demand incentive amounting to about Rs. 3,590 million. Phase-II mainly focuses on supporting electrification of public and shared transportation and aims to support, through subsidies, 7,000 e-Buses, 0.5 million e-3-wheelers, 55,000 e-4-wheeler passenger cars, and 1 million e-2-wheelers for which a budget provision of Rs. 10,000 million for a period of 3 years (2019–2020 to 2021–2022) has been earmarked for the establishment of charging infrastructure across the country(Ministry of Environment, Forest and Climate Change, 2021).

Apart from these initiatives, the Government of India recently approved the National Mission on Transformative Mobility and Energy Storage which aims to strategically recommend ways and means to transform the mobility sector into a low-carbon and electrified system by means of policies supporting electric vehicles manufacturing and adoption (NITI, 2019). Under this mission, a Phased Manufacturing Programme (PMP) is to be launched to prioritise local production across the E-mobility value chain.

In addition to this, the Ministry of Power, Government of India, has rolled out guidelines for setting up charging infrastructure and building an enabling and supportive ecosystem for the smooth roll-out of electric vehicles (EVs) in the country (Ministry of Power, 2022a). The objective of these guidelines is to enable faster adoption of EVs, ensuring reliable, accessible, and affordable charging infrastructure and ecosystem, affordable tariffs, generation of employment and income avenues, encouraging Electrical Distribution Systems to adopt EV charging infrastructure and promotion of energy security. Furthermore, in the aftermath of the COVID-19 pandemic, the Union Government launched a Production-linked Incentive Scheme aimed at promoting indigenisation of manufacturing ecosystems in various sectors – one of them being Advanced Cell Chemistry (ACC) and Automobile and Auto Component Industry (Ministry of heavy industries, n.d.-a). These directly add to the efforts of promoting e-mobility as a modal shift in the transportation sector in the country.

In the railways sector, the Indian Railways has spearheaded a drive to achieve 100% electrification of the railway system in the country. Apart from this, the Indian Railways has pledged to become a net-zero utility by the year 2030 along with increasing the modal share of freight in railways to 45%. All these targets and initiatives are premised on the electrification of Indian Railways and fostering renewable energy sources to cut down on emissions from the sector (Ministry of Railways, 2021).

Industry

Apart from the transport sector, the Government of India is also addressing the decarbonisation needs of the industry sector by promoting policies which aim at greening the industrial sector. The policies that seek to enhance energy efficiency in various sectors, including industries, are one set of such policies which propel electrification and greening of the concerned sectors. The Perform-Achieve-Trade (PAT) Scheme is a flagship scheme of the Ministry of Power, in which selected sectors and designated consumers are notified under the scheme and are allowed a tradable certificate mechanism in lieu of energy efficiency gains/losses they achieve (Bureau of Energy Efficiency, 2022). The National Green Hydrogen/Green Ammonia Policy is a pioneering effort by the GoI to spearhead decarbonisation across heavy Industries. It allows for green hydrogen/ammonia manufacturers to purchase renewable power from the power exchange or set up renewable energy capacity themselves or through any other developer (Ministry of Power, 2022b). This is in line with the government's vision to make India a green hydrogen hub and set up hydrogen valleys in the country, as envisioned by the Indian Prime Minister in 2021. The national policy also provides the distribution licensees to procure and supply renewable energy to the manufacturers of green hydrogen/green ammonia in their states at concessional prices, providing priority access to the electricity grid and supporting manufacturers through extending the Renewable Purchase Obligation benefits.

Residential

In the residential sector, the National Building Code of 2016 is envisioned as an instrument for providing national-level guidelines for regulating construction activities across the country (Bureau of Indian Standards, n.d.). This code serves as a model code to be adopted by all agencies involved in building construction works. ECBC (Electricity Conservation Building Code), which is being renamed to Electricity Conservation and Sustainability Building Code through the Energy Conservation (Amendment) Bill 2022, is incorporated as an addendum to the NBC to provide it a wider coverage (Ministry of Power, 2022c). This code provides for current as well as futuristic advancements in building technology to reduce building sector emissions and promote low-carbon buildings. The implementation of ECBC rests with states which can accommodate local conditions. The code defines standards for building design and construction and aims to reduce energy use by 50% in the commercial building sector by 2030, translating to energy savings of 300 billion units and peak demand reduction of around 15 GW, avoiding emissions to the tune of 250 million tonnes of CO_2 (Ministry of Environment, Forest and Climate Change, 2021).

In the domestic cooking segment, the flagship scheme by the Ministry of Petroleum and Natural Gas (MoPNG) called the Pradhan Mantri Ujjwala Yojana (PMUY) aims at transitioning the cooking sector away from conventional fuels such as cow dung, firewood, coal, and others to the cleaner modes like liquified petroleum gas (LPG), as an interim step, by distributing connections to rural, deprived, and willing households (Ministry of Petroleum & Natural Gas, n.d.). A potential alternative is using electricity as a fuel and induction stoves in the domestic cooking segment in households which can provide substantial climate, socio-economic, and health-related benefits.

Agriculture

Similarly, the agriculture sector is geared towards electrification and decarbonisation by virtue of schemes aimed at electrification of agricultural value chain, grid integration of irrigation pumps, and penetration of distributed renewable energy solutions at the farm level. Pradhan Mantri Kisan Urja Suraksha Evam Utthan Mahabhiyan Scheme (PM-KUSUM) was launched for de-dieselisation of the farm sector and enhancing farmers' income by providing energy and water security and also to decarbonise the farm sector. The scheme aims at achieving 30.8 GW solar capacity through the installation of small solar power plants of capacity up to 2 MW on barren/fallow/pasture/marshy land of farmers, replacement of 2 million diesel pumps by standalone solar pumps and solarisation of 1.5 million grid-connected agriculture pumps by 2022. In order to strengthen domestic solar manufacturing, use of domestically manufactured solar cells and modules for standalone solar pumps and solarisation of grid-connected pumps is mandatory under the scheme. This scheme will result in savings of 27 MtCO2 emissions per annum across the country. Further, it will also result in the reduction in the consumption of coal by 9.34 million tonnes per annum. As a result of the replacement of diesel pumps with solar pumps, there will be an estimated savings of 1.2 billion tonnes of diesel (Ministry of Environment, Forest and Climate Change, 2021).

Solarizing Agriculture: An Ecosystemic Approach towards the Transition to Low-Carbon Power Generation

Susmita Chatterjee and Vinay Jaju

Because decarbonising the agriculture sector has major ramifications for the food security of a nation, delimiting carbon emission should come with a package of practices and technology throughout the value chain. This is the focus of some of the flagship programmes such as *Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM)*, launched by the Ministry of New and Renewable Energy (MNRE) in 2019 to solarise 10 lakh grid-connected agricultural pumps. It has three components, namely commissioning of 1000 MW renewable energy source–based power projects, installation of 17.50 lakh standalone Solar Powered Agriculture Pumps, and solarisation of 1,00,000 grid-connected agriculture pumps. In addition to decarbonising, solar pumps also address the concerns related to poor irrigation because of erratic power supply which in turn will help result in better production of crops and increase farm incomes.

The successful implementation of PM-KUSUM on the ground requires a holistic ecosystem that will support the sustainable usage of solar irrigation pumps in future too. This can be achieved through a multi-stakeholder engagement model where financial institutions, government bodies, civil society organisations, renewable technology companies, service providers, and corporates come together. Periodic engagement will eliminate the procedural delays in implementation and encourage a vibrant convergence model that would ensure increased access to renewable technologies for farming communities. The lynchpin of such ecosystem models will be farmers' income that should increase through subsidising these technologies or through business models such as buy-back of surplus power. The ecosystem model entails engaging local youth and training them as solar technicians to create a local cadre of technicians to ensure sustained usage of renewable technologies. A holistic model with an ecosystem around it will focus on targeted energy shifts throughout the agricultural value chain involving distributed renewable energy (DRE) technologies from production to post-harvest stages. These include solar rice mills, solar rice hullers, solar threshers, solar dryers, and solar food processors.

Small and fragmented landholdings present an impediment to adopting renewable energy technologies such as solar pumps at scale. This calls for innovative community ownership models, pump technology, water use technologies, and creation of an enabling ecosystem for adoption and uptake. Such community-based models have been experimented with in some states.

A major limitation for large-scale adoption of these DRE technologies is the high upfront cost which can be addressed through financial innovations such as First Loss Default Guarantee (FLDG) which can be set up by tapping into climate finance. FLDGs function as Revolving Guarantee Funds that act as collateral for the small and marginal farmers who can access credit from financial institutions to invest in such technologies. The available climate finance from national and international donors may be parked in the FLDGs which will then help in mobilising more finance from other financial institutions like Banks and Cooperatives on other Non-Banking Financial Institutions (NBFCs).

Collaborations for Deep Electrification in India

Policy action spurred with collaboration across the organisations from institutions, researchers, manufacturers, legal authorities, and regulators would fasten the adoption of deep electrification technologies across different sectors. Some examples of such initiatives are provided below.

The EV30@30 campaign was one of the earliest collaborations launched to spur deep decarbonisation in the transport sector. The ambition of the campaign, spearheaded by the Clean Energy Ministerial, is to reach the goal of a 30% sales share of EVs by the year 2030. This target, along with initiatives to decarbonise the power sector, is poised to keep the globe on track to meet the climate goal of being a net-zero world by 2050.

Currently, 13 member countries and 23 supporting countries and organisations are part of the campaign, including India (Clean Energy Ministerial, 2021).

Industrial Deep Decarbonisation Initiative (IDDI) is yet another Clean Energy Ministerial initiative which seeks to form a coalition of public and private organisations that are working to stimulate demand for low-carbon industrial markets. Coordinated by UNIDO, the IDDI is co-led by the UK and India. Additional members include Germany and Canada. The initiative brings together a strong coalition of related initiatives and organisations including the Mission Possible Platform, the Leadership Group for the Industry Transition, the IRENA, and the World Bank to tackle carbon-intensive construction materials such as steel and cement (UNIDO, n.d.).

IH2A (India Hydrogen Alliance) is an industry-led coalition that aims to support public policy and private sector actions to develop the hydrogen economy and a domestic hydrogen supply chain in India. IH2A is an open platform and a member-driven coalition, without legal entity, led by a Steering Group and Work Group leads. Chart Industries, Reliance Industries Limited (RIL), and JSW Steel are the IH2A Steering Group members (India Hydrogen Alliance, 2021).

International Experiences

There are many global collaborative actions to increase the pace of adoption of such emerging technologies(Global Efficiency Intelligence, 2021). Although the beneficiaries of collaboration might be different in the Indian context, it is interesting to take lessons from such global experiences to take forward in India. The deep electrification initiatives in France are touched upon below, which could have useful takeaways for India.

Energy pathways developed for France profess that the strongest climate impact can be achieved by replacing fossil energy with electricity (or hydrogen produced from electricity) in passenger and freight road transport. The replacement of fuel oil and fossil gas heating systems during building renovation and greater use of electricity or low-carbon hydrogen for certain industrial processes, or electric boilers, are other ways to reduce emissions. Among the end uses, the transformation will be significantly observed in sectors where electricity is not a mainstream source of energy today. By 2050, it is estimated that electricity demand in the transport sector could reach 100TWh as opposed to 15 TWh today, and a similar spike is estimated for the industry sector. Hydrogen production is also estimated to require 50 TWh in 2050 as opposed to nil today (Réseau de Transport d'Électricité, 2021).

In the path to offsetting direct emissions, Figure 6.1 represents the contribution of electrification strategies in reducing direct emissions by 2050. Sector-wise percentage decrease in emissions resulting directly from electrification is observed and the importance of electrification in the transport and industry sector is reiterated.

Sectors for Deep Electrification in India: Low-Hanging fruits

This section explores some of the techno-economic aspects and the impact of electrification of the prominent sectors on the electricity grid. The sectors are selected primarily from the point of view of recent policy-related developments and mandates of the Government of India. Additionally, declining trends in technology costs, emission intensity, multiplier effect on economy, and employment intensity of selected sectors also

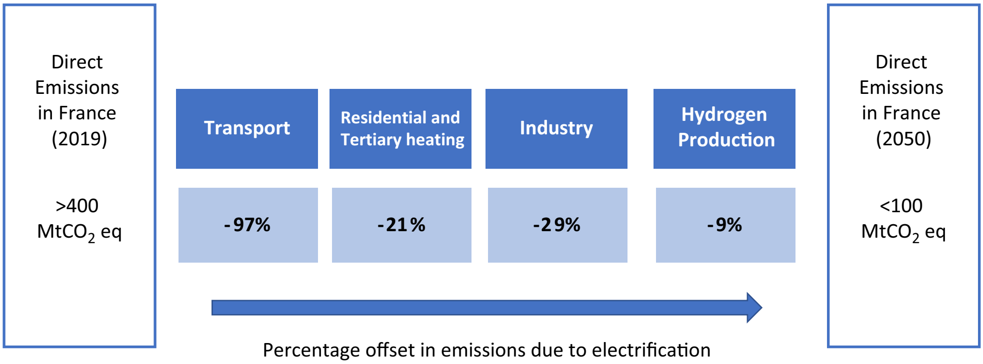

Figure 6.1 Contribution of electrification strategies in France.

Source: Compiled by authors from https://assets.rte-france.com/prod/public/2022-01/Energy%20pathways%202050_Key%20results.pdf

have been considered while making the selection. The four prominent sectors include transport, industry, agriculture, and residential.

Transport Sector

Consisting of road, rail, aviation, and shipping sectors, the transport sector in India is a ripe one from an electrification point of view, particularly in the road and rail transport segments. Be it the modal shift from Internal Combustion Engine (ICE)–based vehicles to Electric Vehicles (EVs) in the road transport sector or electrification of railway lines and operating electric locomotives instead of diesel-based ones, there is a huge potential for availing climate benefits by electrification and decarbonisation of these modes of transportation.

According to the IEA, the road transport sector is the fastest-growing energy end-use sector in India with energy use increasing by over five folds in the past three decades. Transport sector in India is heavily dependent on oil and petroleum products which account for meeting over 95% of all the energy demand in the transportation sector (International Energy Agency, 2021). As of 21 November 2022, the total number of registered vehicles in the country stood at 30.79 crores with a meagre 0.6% being electric vehicles and petrol and diesel vehicles comprising 81.6% and 14.5% of total vehicle stock, respectively (MORTH, n.d.). This, read with the fact that vehicle ownership and demand are also growing year-on-year, points to the huge scale of potential to electrify the existing fleet of vehicles and target new sales of vehicles to be battery-operated ones.

However, there are crucial bottlenecks and hurdles in the path to electrification of the road transportation sector. Primarily, the upfront cost of ownership of an electric vehicle is higher than its ICE counterpart which induces a disincentive in the minds of potential customers from a purchasing perspective. Additionally, operations of EVs require a reliable charging infrastructure to be in place for smooth operation and satisfactory customer experience. Upon a full charge, the vehicle operates for a limited number of kilometres which induces a range anxiety amongst prospective buyers. This, in the current context of the lack of an established charging infrastructure ecosystem, is another critical hurdle which is negatively affecting the uptake of electric vehicles in the country. Furthermore, competitive and resource-based disadvantages of manufacturing EVs locally remain a key issue. Availability of critical minerals, design elements of electric vehicles, semiconductors, and other important raw materials is challenging in the country and India depends on imports of such elements for the manufacturing of EVs. Several policy initiatives are operational in the country which address some of the key challenges hindering the uptake of EVs in the country, across all the vehicle segments.

Several studies have estimated the impact of EVs on the electricity grid on the basis of different scenarios of EV adoption. National Electric Mobility Mission Plan 2020 estimates that an additional requirement of generation capacity to the tune of 775 MW to 865 MW is required to meet the EV penetration targets laid out in the plan, requiring an investment to the tune of Rs. 5000 crores in power sector infrastructure and another Rs 1300 crores in the charging infrastructure (Ministry of heavy industries, 2013). Another report suggests that India will need more than 20 lakh charging stations by 2030 to meet the needs of the growing EV market in the country(JMK Research & Analytics, 2022). NITI Aayog's estimates based on the Government of India's targets of EV uptake by 2030 pegs the number of EVs on road at 812710 with a daily charging power requirement of 2394.8 MWh by 2030 (NITI Aayog and RMI India, 2019).

Additionally, for the rail sector, an assessment by the Indian Railways estimates the power demand to rise from 2000 MW presently to 4000 MW, for achieving the targets of broad-gauge electrification and Dedicated Freight Corridor project by the end of the year 2022 (Livemint, 2018).

These estimates point towards the substantial impact of electrification endeavours in the transport sector on the power demand and the need for investing in the power sector's infrastructure development as well as decarbonisation initiatives.

Industry Sector

Energy efficiency has ensured a fair share of emissions reduction through the last decade by PAT compliance. Nevertheless, fuel switching and use of electricity for the process can improve efficiency substantially. Promoting the use of electricity as a fuel is a key enabler of emission reduction for prominent energy-intensive industries including iron and steel, textiles, fertilisers, refineries, and industrial heat and transport. Several of these industries are operating on the burning of fossil fuels, primarily coal, for meeting their energy demands. In many cases, coal is used as the fuel to generate electricity which runs the manufacturing units in these energy-intensive units. Thus, there exists a need for both electrification and decarbonisation of electricity being used in several industries in the Indian economy. A key instrument that can spearhead this process in the industrial sector is green hydrogen, which is premised on the usage of renewable energy sources for producing hydrogen which can be used to power several of the industries mentioned earlier.

Green hydrogen is fast emerging as a low-carbon alternative to existing methods and fuels of energy generation in these sectors. However, there are also critical barriers that affect the prospects of the adoption of green hydrogen as an alternative to fossil fuels in these industries. The prime concern being the cost competitiveness of renewable-powered hydrogen generation which is expected to become a commercially viable option by 2040(NITI Aayog and RMI India, 2022). This, in addition to the availability of low-cost coal, implies that uptake of hydrogen will be subject to financial constraints in the absence of high amounts of subsidies or other financial incentives. Green hydrogen is expected to be a game changer for the steel industry with the deployment of technologies predominantly hydrogen direct reduced iron production with the use of zero-carbon electricity in Electric Arc Furnace.

GoI is focusing on replacing existing fossil fuel with green hydrogen and its associated feedstock. Another industry is the fertiliser industry which uses ~26% (PPAC, 2020) of the total country's natural gas demand (with reliance on imported LNG increasing YoY). It is estimated that ~7.5 MT of green hydrogen demand (IEEFA, 2022) would be consumed by mid-century in the sector. With the provision for waiver on electricity wheeling, it would be much interesting to see its scope as well as in the decentralised production of green ammonia. As per the estimates by The Energy Research Institute, penetration of hydrogen in the key energy–intensive industries of India will spur the hydrogen demand to reach 16 Mt in the baseline scenario and over 21 Mt in low-carbon scenario with higher penetration of low-carbon technologies in the respective industrial sectors. The impact of 16 Mt of green hydrogen production translates to over 700 TWh of additional electricity being generated, which poses a significant infrastructural challenge as well as an opportunity for the renewable energy sector in India (TERI, 2021).

Agriculture Sector

The agriculture sector's energy usage comes primarily from irrigation. Conventionally, diesel generator sets have been deployed on a large scale to extract water for irrigation purposes in agricultural fields. Electrification of agricultural irrigation has been the focus of several policy programmes of the Government of India, as highlighted in the previous section of this chapter.

Apart from electrification of irrigation, the policy focus of the government has also encompassed upcoming technologies such as electric tractors and the deployment of renewable energy–based solutions on agricultural farms, including standalone solar plants for additional power and income generation opportunities for the farmers. Additionally, adoption of electric tractors is also another low-hanging fruit on which the government is keen on capitalising in the near future with the perspective of reducing the emission intensity of the agricultural sector in the country.

At the same time, there exists crucial challenges, specifically the techno-economics of electrification alternatives vis-a-vis the conventional modes of farming. In the case of electric pumps or solar-based pumps for irrigation, the cost economics are tilted in favour of continuing diesel pumps. This is also aggravated by the lack of access to reliable power, an issue which has largely been addressed by means of electrification drives across the country and achieving 100% electrification. However, reliable supply of quality power still remains a challenge in many pockets. In the case of solar-based pumps, though there exists a targeted subsidy and incentive-based programme for enhancing the adoption of solar pumps by farmers, there are upfront costs that hinder the same. Other than this, one of the key structural and legacy challenges that hinder the adoption of clean energy electric installations in the Indian agricultural sector is the fact that landholdings are typically small and most of the farming is subsistence farming. Thus, the majority of farmers do not have the financial capital to invest in such technologies which promise to return benefits gradually after an initial upfront investment. Then there are regulatory and administrative bottlenecks in availing scheme benefits, agricultural connections, power supply, and providing documental verification for the host of approvals required.

Electricity consumption in the year 2020–2021 for the agricultural sector stood at 20.24% of total electricity consumption and highlights the energy-intensive nature of the sector. With 11 major DISCOMS of the country consuming 95% of electricity consumption in agriculture and annually providing over Rs. 1 lakh crores as electricity subsidy for agriculture, there exists a significant footprint of agricultural consumption in the power sector. Additionally, nearly 80 lakh pumps out of approximately 3 crore agricultural pumps installed in India are diesel pumps. The total diesel consumption of these pumps in a year works out to 5.52 billion litres per annum along with equivalent CO_2 emission of 15.4 million tonnes. India's efforts towards solarisation of the agricultural sector are expected to result in reducing carbon emissions by as much as 32 million tonnes of CO_2 per annum. This is also envisioned to result in the reduction of import bills on account of petroleum products through the reduction of diesel usage by 1.38 billion litres per annum (MNRE, 2019).

Residential

This sector is another enabler for adopting and implementing low-carbon electrification measures that may include cooking, heating/cooling, and energy-efficient buildings. As previously stated, cooking is predominately based on firewood and coal leaving a huge potential for green electric sources untapped. While the Indian Government is working on a mission mode to enhance the coverage of LPG connections in households, an increased usage of LPG could lead to energy security issues along with challenges including the high cost of refill and poor access to refill depots. However, the transition to LPG will likely result in a lock-in of assets as a greener transition towards induction cooking is also on the charts.

Deepening the initiatives on energy efficiency in the residential and building sector can result in significant avoided emission savings. These include transitioning from air-conditioning to low-carbon cooling alternatives, green buildings and energy efficiency standards being adhered to in the construction and operations phase.

Some of the key challenges faced by the electrification and decarbonisation efforts in the residential sector pertain to the information gap, difficulties relating to the accessibility of existing schemes, and issues related to the administrative capacity to roll out such innovative initiatives at such a scale, especially amongst deprived and underserved communities, amongst others.

If ECBC is implemented rigorously throughout India, it has the approximate potential of saving 300 billion units of energy and over 15 GW of peak demand reduction which would result in a saving of around Rs. 350 billion. Subsequently, GHG emission reduction of over 250 MtCO2 is estimated (Ministry of Environment, Forest and Climate Change, 2021). While the impact and savings through the deployment of electric induction stoves are not yet quantified in the Indian context, they are likely to spur the electricity requirement from the power sector and entail emission savings.

Thus, through solarisation of agricultural pumps through PM-KUSUM and achievement of PM-UJJWALA yojana targets in the residential sector, emission savings are estimated to the tune of 32 MtCO2e per annum and 250 MtCO2e, respectively.

Challenges for Deep Electrification

Although electrification of energy-intensive economic sectors holds vast potential towards realising India's climate goals of being a net-zero economy by 2070, there exist several intrinsic and extrinsic challenges that need to be addressed.

The first such challenge is conceptual in nature. Deep electrification, as a standalone concept, is incomplete without the decarbonisation of the power sector. In the Indian context, it appears in many cases that electrification is the end goal of a particular initiative and decarbonisation of the power sector is a parallel side-track activity. This creates silos of separate interventions and their convergence and alignment towards the broader climate goals appears to be missing from the narrative, planning, and implementation.

Second, the economic viability of available technology alternatives of electrification in many of the sectors is a deterrent to the large-scale uptake of such technologies. Most of the alternatives have a high upfront cost and they break-even after a considerable amount of time, which makes their adoption currently susceptible to incentives and subsidies. A primary cause of this, in many instances, maybe the nascency of the stage of development of these technologies which adds to the cost of operations, while the economic dividends are reaped over a longer time frame.

Third, supply chains for the manufacturing and distribution of such technologies are dispersed and often fragile. A country like India with significant resource constraints, especially in critical minerals, rare earth, and semiconductors, amongst others, is heavily reliant on imports from other countries to develop and distribute these technologies. This has a ripple effect on the cost of production, and thus, the retail cost of such technologies, as well as affects the resilience of the supply chain which gets exposed to external shocks that may disrupt the supply chain. Covid-19 was one such shock which shed light on the fragility of global supply chains.

The top-down approach towards deep electrification leads to an information gap around newer electric technologies. Be it EVs, or green hydrogen, or farm-level solar plants, the broad approach has been to incentivise the end users to pick up these technologies by providing fiscal and other incentives. This runs simultaneously with a target that the government has set for itself to be achieved. On many occasions, such an approach runs the risk of being perceived as an external unknown product being forced down upon the public. There appears to be a lack of participatory processes being followed at the grassroots level before the introduction of newer electric-based technologies to garner support and ensure buy-in.

A related issue is that switching fuels from conventional to electric based is not just about technological shifts, but also entails behavioural shifts at the consumer end to adopt the new technologies. There are very strong social, cultural, and economic factors that inform the behavioural decision-making by any individual, household, or enterprise which needs to be captured and addressed in a careful manner before introducing newer technologies which may act as a negative disruption otherwise.

Way Forward

Given the potential of a deep electrification strategy to mitigate carbon emissions from the economy along with the challenges it carries, a four-pronged approach is suggested for deep electrification for India.

First, instead of focussing heavily on addressing the supply-side issues for low-carbon electric-based technologies, due importance and policy emphasis must be given towards resolving demand-side bottlenecks. This implies that the hesitation amongst the end users towards the adoption of electrified technologies, including behavioural factors, needs to be adequately addressed. Conducting frequent workshops, campaigns, and events about such technologies and their benefits and information sharing through interactive and effective means of pilot studies are some of the ways through which confidence and demand can be generated from the ground-up. Additionally, the involvement of potential end users as stakeholders, instead of only having those groups that are informed already about the technologies, can prove to be extremely beneficial when it comes to scaling-up the adoption.

Second, making the adoption of electrification technologies conditional upon financial incentives and subsidies can create more problems than it solves. The sustainability of efforts of deep electrification should be ensured while planning and implementing. This may be done by clarifying a subsidy phase-out plan when a policy is announced or using innovative financial mechanisms in which the upfront subsidy given is eventually recovered once the technology becomes viable. However, such ways are subject to their acceptance by the stakeholders, especially end users, and efforts should be continuously made to have them on board while such decisions are being made.

Third, before a regulatory framework towards the governance of any electrification initiative is announced, it may be put to a sandboxing text which can help the policymakers identify key challenges that may come up in the implementation stage. This also provides policymakers the much-needed flexibility to go back and make necessary amends in the framework in order to make the initiative more effective on the ground.

Finally, deep electrification strategies and initiatives need to be converged and aligned with decarbonisation initiatives, in letter and spirit. This implies that the initiative towards electrification of economic activity or a sector should not be limited to achieving the objective of electrification only but have concrete elements that pertain to ensuring deep decarbonisation to go along with it. Such convergence will ensure a smooth transition and better realisation of the climate goals and also provide clarity to financial and market-level stakeholders towards investing in deep electrification strategies.

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Part 2

Governance and Policy Perspectives: an Introduction

Mritiunjoy Mohanty and Runa Sarkar

Chapters in this section deal with two distinct but oftentimes inter-related themes: one set of chapters analyses policies or policy frameworks that shape some aspects of energy transition; a second set analyses issues related to institutional governance of energy transition, i.e., both the positive and the normative. Therefore, chapters in the section give readers an overview of extant policies and their effectiveness, as well as how they might be.

Chapter 7, by *Simran Grover*, *Naini Swami*, *and V. Suresh*, foregrounds the lives and livelihoods of people in the context of policy commitments made to achieve low carbon pathways. It uses the Indian Constitution as a reference framework to define governance and development principles to help achieve Just Energy Transition. It argues that, given the country's economic, social, and cultural diversity, a one-size-fits-all transition strategy would neither be feasible nor desirable. What would be most appropriate is a decentralized and participatory governance regime. It argues that in India, given the structural inequalities based on caste and gender, "procedural justice" attains great significance which cannot be delivered by decentralization alone. Therefore, it argues that a bottom-up decentralized process, which includes disadvantaged and marginalised groups, would be necessary for a just energy transition.

Chapter 8, by *Sarthak Shukla and Raghav Pachouri*, assesses the policy landscape with regard to energy transition in terms of its objectives, governance mechanisms, and tools of regulation and impact thus far. It then makes key recommendations emerging from the analysis. It argues that an important enabler of policy effectiveness will be intra- and inter-sectoral coordination. In addition, measuring progress will be the key enabler of policy. Therefore, a real-time policy monitoring mechanism is of critical importance. The chapter has two associated Appendices. The first, Appendix 8A *(Equitable Distribution of Market Risks – A Critique of the Electricity Act 2003)*, by Simran Grover, argues that a conceptual analysis of risk distribution may be critical to understanding the challenges facing the electricity sector. The second, Appendix 8B, *(Untapped Scheme Convergences for Promoting Renewable Energy in India),* by Sayantan Dey and Vinay Jaju, argues that a convergence between schemes will not only ensure the growth of renewable energy but also bring co-action between programmes with respect to implementation and creating sustainable assets for the community.

Chapter 9, by *Mritiunjoy Mohanty*, *Saon Ray*, *and Naini Swami*, analyses the recent reassessment of industrial policy both in theory and practice and its applicability particularly given that decarbonisation will involve technological change. It begins by observing that industrial policy is now being widely used by both developed and developing countries, particularly in the context of green technology and clean energy. The reassessment of

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industrial policy establishes that past episodes of industrial policy have been significantly more successful than earlier understood. It notes that moving beyond market failures, the state has an entrepreneurial role to play in reducing Knightian uncertainty, particularly in the context of technological change. The chapter has an associated Appendix. Appendix 9A *(In-situ Power Generation in Urban Space for End Users),* by Arunava Ghoshal discusses the role of policy and policy convergence in stimulating the scaling up of rooftop solar power generation and use.

Chapter 10, by *Madhura Joshi and Swati Dsouza*, analyses challenges, processes, and pathways that have led to dialogue and legislations on coal phaseouts and Just Transitions in South Africa, Germany, Poland, and the USA. It also draws lessons from these experiences for India's planned coal phasedown. It argues that whatever may be the short-term pressures, the phasing out of coal is inevitable. That being so, it is much better to plan for it rather than be faced with the social and economic dislocation of a steep decline in coal use and production. This is all the more so given that the experience of countries that have undergone phaseouts tells us that transition paths tend to be both long and uncertain. In Germany's Ruhr Valley, it took more than 40 years to regain its earlier levels of economic activity. Unemployment in coal-producing regions in the UK remained higher than the other regions until 2008. In South Africa, it took more than 10 years just to arrive at a consensus on the way forward. Planning therefore is absolutely central to the effectiveness of a Just Transition.

Chapter 11, by *Jahnavi G. Pai*, *Munna Jha*, *and Vinuta Gopal*, is a bottom-up view of energy transition, especially from that of marginalised communities whose lives and livelihoods depend on coal. It makes a case for including the voices of the local communities in the discourse around energy transition and the pathways ahead. It argues that the experience of Jharkhand and Kerala (detailed in the associated Appendix 11A) establishes that both in a poor mining state (Jharkhand) and a relatively prosperous non-mining state (Kerala), the key to effectively coping with climate change was relatively autonomous Gram Panchayats with empowered local political leaderships willing to consider alternatives better suited to their areas. Appendix 11A *(Decentralised Electricity Generation Using Rooftop Solar: A Case Study of Perinjanam Village),* by Hari Subbish Kumar Subramanian, discusses the village of Perinjanam, a classic example of empowered local self-governance, leading to a successful model of decentralised rooftop solar power generation at the Panchayat level.

7 Governance Principles for a Just Energy Transition

Simran Grover, Naini Swami, and V. Suresh

Energy Transition and Justice

Energy transition is not just about technological change in energy production but crucially includes and entrenches a transition in consumer behaviour, institutions, and their power, infrastructure, and cultural discourses (Williams & Doyon, 2019). The global fuel (oil and gas) crisis triggered by the Ukraine–Russia conflict has highlighted, once again, the complications of international geopolitics and its entanglements with global and regional energy security. In the present context, energy production from extractive sources and entrenchment of investments in energy assets are pressing concerns for citizens and institutions of sovereign nations.

Coal mining's deleterious environmental impact is well documented. Recent research presents compelling evidence against open-cast mining activities from multiple districts across India (Ranjan, 2019). Land clearing and mining operations remove natural vegetation and fertile topsoil, leave permanent scars on the landscape, impoverish soil quality, and drastically change ecosystems' biotic and abiotic components (Mishra & Das, 2017). A 2016 report highlights that coal mining activities in India have caused the displacement of 87,000 people since 1973, including 14,000 Adivasis (Amnesty International, 2016).

Does a clean energy transition offer an alternative development paradigm which is environmentally non-extractive and socially inclusive?

The emerging evidence suggests otherwise. Renewable energy projects are reported as sites of conflict between local communities and project developers (Aggarwal, 2021). In Rajasthan, the Supreme Court's order, to install bird diverters on the high-voltage lines and to move them underground in identified critical regions (M.K. Ranjitsinh v Union of India , 2019) when the avian population was endangered because of contact with high-voltage lines of the upcoming renewable energy power plants, is yet to be implemented.

Further, a central issue at the heart of energy transition is its impact on livelihoods. The coal economy employs only 4.7 million people directly across the globe but supports a much larger number of indirect jobs and livelihoods, cutting deeply across sectoral value chains of many industries (World Bank, 2021). Clean energy transition navigates complexities at the intersection of corporate interests, state priorities, and lives and livelihoods of people; enshrining social and environmental justice in the energy transition is a matter of human decency and dignity. Chapter 20 delves deeper into the concept of Just Transition and what it means for all stakeholders.

For India, clean energy transition provides an opportunity to shape new paradigms of development and growth, where the need for a "Just Transition" takes centre stage. Given the unique social, cultural, historical, and economic context of India, the consensus

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on the vision of "Just Transition" and principles that may be adopted to achieve the same require a broader political recognition and acceptance.

In the following sections, we deliberate on some such governance principles for a just energy transition by exploring the critical domains of labour and environmental governance.

Labour Governance and Just Transition

The Just Transition of the workforce is inextricably linked to the creation of decent work and quality jobs in accordance with nationally defined priorities (United Nations, 2015). The decent work agenda is a long-standing goal of the International Labour Organization (ILO) as well. Broadly, it refers to "access to full and productive employment with rights at work, social protection, and the promotion of social dialogue" (ILO).

The ILO Declaration on Social Justice for a Fair Globalization recommends member states to lay down mechanisms for measuring decent work indicators (ILO, 2008). In pursuance of the same, an expert body of the ILO adopted a framework for Decent Work Indicators covering ten substantive elements relating to the four strategic pillars of ILO's Decent Work Agenda: (i) employment creation, (ii) social protection, (iii) rights at work, and (iv) social dialogue. The ten substantive elements of decent work agenda are employment opportunities; adequate earnings and productive work; decent working time; combining work, family, and personal life; work that should be abolished; stability and security of work; equal opportunity and treatment in employment; safe work environment; social security; and social dialogue and employers' and workers' representation (ILO). The legal indicators for decent work cover maternity protection (including weeks of leave, replacement rate, and coverage), paternity and parental leaves, maximum hours of work and paid annual leave, and minimum wage setting procedure and level (ILO, 2013).

The salience of the decent work agenda is reiterated in the guidelines for a Just Transition towards environmentally sustainable economies and societies (ILO, 2015), whose key recommendations are:

- Integration of social dialogue, including adequate, informed, and ongoing consultation into the institutional framework at all levels.
- Recognition, promotion, and realization of fundamental principles and rights at work.
- Recognition of the strong gender dimensions of environmental challenges and opportunities and the creation of specific policies to address the same.
- Coherence in economic, environmental, social, education/training, and labour policies.
- Creation of a Just Transition framework for creating decent jobs, anticipating employment impacts, adequate and sustainable social protection for job losses and displacement, skill development, and social dialogue, including the effective realization of the right to organize and bargain collectively (ILO, 2015).

Understanding the Indian Workforce

The workforce in India is broadly classified into three categories: self-employed, regular wage/salaried, and casual workers. An analysis of the PLFS Annual Report 2019–2020 shows that amongst the three categories, the majority of India's workforce comprises self-employed people (53.5%), followed by casual workers forming 26.3%, and only 18.2% who are regular wage or salaried workers (NITI Aayog, 2022). The labour laws segment the workforce into informal and formal workers and the labour market into organized and unorganized sectors.

Together, the informal workers and unorganized sectors form the country's informal economy, where workers are excluded from the benefits of formal contracts, paid leave, and social security benefits. There is persistent conceptual ambiguity in classifying informal and formal workers and organized and unorganized sectors. The disparities arising from the absence of legal protection for informal workers are considered a fundamental governance flaw (Shyam Sundar, 2019).

Evidence suggests that the coverage of social security schemes amongst economically and socially vulnerable sections has remained poor. While regular workers are largely covered by the provident fund regime, the growing segment of casual and contract workers, even in the organised sector, appear to be discriminated against. The entire self-employed workforce is inherently excluded. Although the statutory provisions of the provident fund are supposed to be applicable universally amongst industries specified in Schedule I, the evidence clearly points to a dismal state of affairs (Sakthivel & Joddar, 2006).

Seasonal and circular labour migrants form a growing segment of the informally employed. Poor and low-caste workers form a disproportionate proportion of such workers comprising the lowest rung of labour at organised sector work sites. They are segmented and fragmented by the recruitment process and along the lines of caste, sex, ethnicity, language, and region. This segmentation and fragmentation create the basis for capital to acquire low-cost, highly flexible labour, who work long hours and take up the most dangerous work. Gender-based labour segmentation builds on the culturally determined social reproduction responsibilities of female workers and other socio-cultural factors (Srivastava, 2019).

As far as the coverage of social security schemes is concerned, 85% of workers from non-farm sector belonging to the category of SCs and OBCs do not have social security benefits. For the other categories, it stands at 75%. Amongst the unorganised segment of workforce, there is hardly any coverage of social security schemes. For instance, coverage of the Workmen's Compensation Act which provides for security and medical treatment in the context of occupational and workplace accidents and mishaps is not available for the bulk of workers in the informal and causal labour segment. Estimates for the organised segment suggest that 85–90% of the workforce belonging to the category of STs and others are covered under social security schemes, but coverage for SCs and OBCs is lower, being less than 80% for OBCs (Sakthivel & Joddar, 2006).

India and the ILO Conventions

India is a founding member of ILO and has contributed significantly to setting ILO standards, which have substantively influenced its labour governance. India has ratified 47 conventions covering 15 subjects. Fundamental ILO Conventions ratified or ignored by India are listed in Table 7A.1. However, of the 47 Conventions and 1 Protocol ratified by India, 38 are in force, 5 Conventions have been denounced,[1] and 5 instruments have been abrogated[2]. From the ILO conventions relevant for Just Transition, India has ratified 10 of the 25 instruments. Social security, social policy, occupational safety and health, and labour relations remain neglected subjects in the existing architecture of binding ILO standards accepted by India (ILO, 2015). Table 7A.2 provides a detail of the Just Transition conventions accepted by India.

An important fundamental convention not ratified by India relates to collective bargaining despite the Constitution of India guaranteeing, under Art. 19(1)(c), the right to freedom of association as a fundamental right subject to reasonable restrictions (The Constitution of India, 1950). Further, labour laws in India provide statutory recognition to trade unions to raise issues and negotiate with employers. However, India's domestic standards on collective bargaining are weaker than those specified by ILO. The amendments to labour legislation have adversely impacted collective bargaining rights. This includes steps such as increasing the minimum requirements for recognition of unions from seven to at least a hundred workers or 10% of the workforce, whichever is lower (Hussain & Wani, 2011). The increased minimum requirements of workers for union registration are very high compared to the international standards that specify a minimum of 20 workers for the recognition of trade unions.

Further, while labour laws provide enabling provisions for negotiation between employers and workers, the same is not mandatory. After independence, collective bargaining developed in a centralized way in India, with the state playing mediator between employers' and workers' associations. However, with the advent of economic reforms, and the influence of globalization, the system of collective bargaining was decentralized. As a result, highly segregated mechanisms of collective bargaining emerged along the fault lines of regions and industrial sectors (Bhattacharjee, 2001). Workers' participation in trade unions has significantly declined, and collective bargaining practices continue to emaciate (ILO, 2018).

Exploring Governance Principles at the Intersection of Labour Governance and Just Transition

3.6 million people are estimated to be directly or indirectly employed in the coal mining and power sector across 159 districts in India. While informal workers produce a fraction of coal in India, the informal sector creates many more jobs than total employment in the formal coal mining industry (Pai, 2021). On the other hand, the thermal power generation sector employs mostly formal workers. However, the majority of the labour is employed through sub-contracting, diminishing their power for collective bargaining as they are unionized. Further, there are many associated industries and services (ash handling, brick, and cement) which employ a large number of informal workers. From the 1990s, post liberalisation and economic reforms, the formal sector has substantively shifted towards engaging contractual workers. The contractual workforce largely consists of unskilled and semi-skilled workers, working in extremely hazardous conditions for minimum wages.

The clean energy transition imposes a major challenge for jobs, livelihoods, and local economy. The sites of coal mining and thermal power generation are not necessarily suited to be replaced by renewable energy assets, and they often demand significant investments to remedy decades of environmental degradation.

The renewable energy generation sector also offers a strikingly different job landscape. Renewable energy assets built on commercial technology such as wind and solar employ very few people for operations and maintenance. Further, the majority of the jobs created (guards and labour for cleaning solar modules and clearing vegetation) are menial in natural and employ unskilled workers. The industry creates temporary jobs during the construction and pre-commissioning phase, which does not provide the long-term reliability of coal and power sector jobs.

While it may be argued that the renewable energy sector offers a far better and safer work environment, it does not guarantee better jobs. Given the temporary and contractual nature of the work, the workforce is at the mercy of the industry to decide their wages without any mechanisms for collective bargaining and legal safeguards.

As carbon-intensive industries are gradually dismantled, possibly over the period of the next 30–40 years, the clean energy transition provides a rare opportunity to envisage the fundamental economic and development paradigms. As we strive to transform our extractive and exploitative relation with natural ecosystems and the environment, do we also strive to stop the exploitation of human beings for cheap labour and financial gains of the few at the cost of many?

The rule of law does not allow public policy to limit rights and justice to workers of a particular industry. Delivering equitable growth and inclusive development shall require a transformative approach towards labour governance. Just Transition shall posit the rights of workers and equitable development against corporate interests and economic growth at the cost of the masses. These are non-binary and complex trade-offs which require much deliberation. The decision-making and action for transforming labour governance in the back-drop of energy transition shall be shaped by the broad governance principles we practice while framing our legislation (and legal framework), designing our institutions, and deciding on paths of action.

Environment Governance and Just Transition

Environment legislation in the country gained momentum with the landmark United Nations Conference on the Environment (1972) in Stockholm. The Stockholm conference led to the setting up of the National Committee on Environmental Planning and Coordination. This committee played a key role in the framing of the Wildlife Protection Act, 1972; the Water (Prevention and Control of Pollution) Act, 1974; and the Air (Prevention and Control of Pollution) Act, 1981.[3]

However, the most important development in the Indian landscape of environment law was a result of the unfortunate Bhopal Gas Tragedy in December 1984. After the incident, the Indian government came up with the Environment Protection Act, 1986 which was presented as an instrument to combat environmental pollution in all aspects. The Act gave wide regulatory and punitive powers to the central and state authorities.[4]

The institutional development to regulate and implement environmental law gathered pace with the introduction of the aforementioned legislations. In 1980, the Tiwari Committee was constituted for suggesting ways of improving the legal framework for protecting the environment, recommended the constitution at the central government level, of the Department of Environment, later renamed the Ministry of Environment and Forest (MoEF) in 1984. The Water Act, 1974 established the Central and State Pollution Control Boards, and their scope was expanded by the Air Act, 1981. Further, in 1995 the National Environment Tribunal Act was enacted to establish an environment tribunal to adjudicate environmental disputes and decide the liability of the polluter. The National Green Tribunal Act of 2010 repealed this law and established the National Green Tribunal (NGT) with broader and overarching powers of adjudication.

The Panchayat Extension to Scheduled Areas (PESA) Act, 1996, gave greater autonomy to tribal communities living in Scheduled Areas (Schedule V, Constitution of India) by extending the powers of local self-government (Panchayats) to include control over natural resources and traditional institutions. The Act recognised the Panchayats in the Scheduled Areas as an institution of self-governance and accorded the Gram Sabha (village assembly) powers to promote community ownership, control of minor forest produce, protection of community resources and rights, and recognition of traditional leadership and institutions.

In a major development, the Forest Rights Act 2006 recognized the rights of forest-dwelling communities and intended to reverse the historical injustice they have faced. The Act provides for the recognition and vesting of individual and community forest rights. It also requires that forest-dwelling communities be consulted before any decision is taken that affects their rights or forests. The Act establishes a process for granting rights to forest land, including the right to reside in, protect, and conserve the forests and their biodiversity; the right to use and access forest produce; and the right to protect the traditional and cultural heritage of the forest-dwelling communities.

India has a rich history of environmental movements, dating back to "Bishnoi Movement" in the 1700s that sought to protect the faith of the community and the sacred trees of their village. In the post-independent era, various movements like the Chipko (Uttarakhand, 1973), Save Silent Valley (Kerala, 1978), Jungle Bachao Andolan (Bihar, 1982), Narmada Bachao Andolan (1985), and others have sought to assert the rights of people and preserve natural ecosystems. Hence, it is important to explore the environmental governance in India at the intersection of policy, jurisprudence, and public (and environment) interests.

Environment Rule of Law and Environment Protection Act

The rule of law refers to the idea that all individuals and institutions, including governments, are accountable to laws that are publicly promulgated, equally enforced, and independently adjudicated and which are consistent with international human rights norms and standards.

In 2013, the United Nations Environment Programme ("UNEP") adopted Decision 27/9, on Advancing Justice, Governance and Law for Environmental Sustainability, which introduced the term "Environmental Rule of Law" to integrate critical environmental needs with the essential elements of the rule of Law (Jain, Ahlawat, Sinha, & Jain, 2022).

Environmental rule of law has been recognized as a crucial element in achieving sustainable development, as it provides the legal framework and mechanisms for the protection of the environment and the promotion of sustainable practices. It also helps to ensure that the rights of individuals and communities are respected and protected in relation to the environment. This includes the right to a healthy environment, the right to access information and justice in environmental matters, and the rights of indigenous peoples and local communities to participate in decision-making processes related to the environment.

The Environment (Protection) Act (1986) provides (EP Act) for the protection and improvement of the environment and the prevention of hazards to human beings, plants, and animals. Section 3 of the EP Act empowers the central government to take all necessary measures as it deems necessary or expedient for the purpose of protecting and improving the quality of the environment and preventing controlling and abating environmental pollution. In unequivocal terms, this section lays out that this power is to be used for protecting and improving the quality of the environment. The power under this section is of protectionist nature, but it is to be used for protecting the environment and not for relaxing environmental safeguards for any other reason (Jain, Ahlawat, Sinha, & Jain, 2022).

We explore the environmental governance in India in the context of the mandate of the EP Act 1986 and the Environment Rule of Law, including the principle of non-regression,[5] through some amendments introduced under the EP Act.

- **Environmental Impact Assessment Rules**

  In the draft EIA Rules 2022, MoEF&CC displayed policy intent to introduce business-friendly amendments at the cost of public interests and environmental safeguards. While the draft notification was not adopted (possibly because of public resistance), the ministry later introduced specific amendments which are contrary to the "principle of non-regression."

  MoEF&CC vide notification dated 14 July 2022 exempted thermal Power Plants up to 15 MW based on biomass or non-hazardous municipal Solid Waste using auxiliary fuel such as coal, lignite, or petroleum products up to 15% from the requirement of environmental clearance. It further exempted highway projects of strategic and defence importance up to 100 km from the line of control or border subject to compliance with the Standard Operating Procedure notified in this regard from time to time. Ports and harbours exclusively engaged in fish-handling capacity were also exempted from environmental clearance. Vide notification dated 12 April 2022, the MoEF&CC extended the validity of environmental clearance for mining from thirty (30) years to fifty (50) years, aligning it with Mines and Minerals (Development and Regulation) Amendment Act, 2015.
- **Diluting the Role of Gram Sabha and Forest Dwellers**

  Gram Sabha is accorded special authority under the Forest Rights Act (FRA) 2006 to execute its mandate. This includes acknowledgement of individual forest rights and the conservation of the forest environment (Forest Conservation Rules, 2022 – An overview of changes that snatch rights of Gram Sabhas, 2022). The Forest Conservation Rules, 2016 had embedded the need for Gram Sabha consent as a procedural requirement for prior approval for forest diversion by the environment ministry. The 2022 Rules have expunged this mandate. The central government can approve the project without any prior approval from *Gram Sabha*. The process of ensuring recognition of rights and final forest diversion is the responsibility of the state government (Nandi, 2022). Over the past few years, attempts have been made to dilute the legal provisions concerning the diversion of forestland, wherein executive orders and circulars of the MoEFCC have directly sought exemption from obtaining *Gram Sabha's* consent (Trivedi, 2022).

The various amendments (proposed/notified) by the MoEF&CC outlines the intent of the Government. The development paradigm increasingly undermines the critical need for environmental protection and acknowledging the rights of communities for sustainable growth. They pave the way for further exploitation and extraction of biological resources through direct intent and dilution of environmental safeguards.

In its December 2022 report, Vidhi Center for Legal Policy presented an analysis of 123 regulatory instruments issued by MoEFCC, consisting of orders, office memorandums, circulars, letters, and notifications. It highlighted the number of changes introduced which circumvented the process of law, often against the spirit of the EP Act, and weakened the "environment rule of law" in the country by removing or relaxing norms in the interest of economic growth (Jain, Ahlawat, Sinha, & Jain, 2022).

Exploring Governance Principles at the Intersection of Environment and Just Transition

Energy transition, similar to climate change, is "a double inequality" (Barrett, 2013), as the shift in the livelihoods landscape imposes risks on local communities and associated workforce, while the rewards of transition are cornered by investors and major corporates in the energy sector. The energy transition shall reshape the energy infrastructure, requiring the decommissioning or repurposing of existing assets, and building new infrastructure. In both scenarios, the presence of vulnerable communities in the proximity of the infrastructure is, typically, disproportionately high. Transition away from coal and treatment of carbon-intensive assets present environmental (and other) risks because of poor remediation practices and the absence of a comprehensive governance framework to mandate the same.

The social and environmental impact of large-scale deployment of renewable energy assets is now well documented. For instance, large-scale utility solar PV generation assets are rapidly changing the land use patterns across the states leading energy transition. In Western Rajasthan, conflicts are being increasingly reported as the rights of communities to *Orans* (sacred groves) and their preservation are being undermined. The region is home to highly vulnerable pastoral communities. Increasing exploitation of the region for renewable energy deployment is impacting their traditional routes and limiting their access to fodder as common lands are encroached.

The massive transmission infrastructure for evacuation of solar power in the Thar Region of Rajasthan threatens the endangered Great Indian Bustard (GIB) and other avian species. In the case of M.K. Ranjitsinh v Union of India (2021), the Supreme Court ordered the installation of bird diverters on the high-voltage lines and to move them underground, mandatorily in regions identified by the Wildlife Institute of India and subject to feasibility in others (supreme court, 2019). In response, the Ministry of New and Renewable Energy (MNRE) has filed an application seeking modification of the order on technical grounds (Thomas, 2022). Yet, the ministry identifies 75 GW of renewable energy potential in Rajasthan, of which 45 GW potential lies in the GIB zone (Central Electricity Authority, 2022).

An analysis of the emerging trends in energy transition suggests that the development paradigm and environmental governance principles share the same tenets that shaped the carbon-intensive economy and exploitation of natural resources. In the quest of development and climate action, public policy has to address many pertinent questions. Trade-offs are perhaps inherent to the clean energy transition, the process of decision-making and setting up of priorities shall be shaped by the broader governance principles and development goals.

Deliberating Governance Principles for Energy Transition

> The resilience of nations is manifest in their ability to anticipate and prepare for shocks, which, in turn, depends on the technical capacities of organizations and institutions at the front lines of crisis response, the overall functioning of country systems, and the governance structures that "set the rules of the game."
>
> (UNDP, 2011).

Conversations on the increasing threat of climate change highlight the rising complexity of governance issues at global and national levels. In this context, enhancing state resilience has become a key policy priority. Good governance is recognized as a foundational determinant of resilience among the various facets influencing state resilience (Brown, 2022).

There is a lack of consensus on the definition of good governance as a conceptual framework, despite its many proponents with varied interpretations. International institutions such as the World Bank and multilateral development banks focus on economic institutions, public sector management, transparency and accountability, regulatory reform, and public sector skills and leadership as relevant aspects of good governance. In contrast, organisations like the United Nations, European Commission, and the Organisation for Economic Co-operation and Development adopt a more expansive approach by including aspects like democratic governance, human rights, and political governance that are amiss in the approach of the international finance institutions (Gisselquist R. M., 2012).

Governance may be defined as a system of (1) policies, (2) values, and (3) institutions which (a) mediates decision-making, (b) creates a mechanism for articulating demands and differences, and (c) operates on core ethical/values-based system. The fundamental governing principles for the energy transition can be derived from various sources, including individuals, institutions, and conventions. For India, the Constitution provides perhaps the most comprehensive and nuanced framework for Just Energy Transition as it intricately enshrines the elements of social, economic, environmental, and political justice in a timeless manner. The UN members states recognise eight core values and principles of democratic governance: (a) participation; (b) equity, non-discrimination and inclusiveness; (c) gender equality; (d) consensus oriented (e) rules-based; (f) transparency; and (g) accountability and (h) responsiveness. These principles are congruent with key human rights principles set out in various UN declarations and conventions. They can be summarized in three core principles: (a) participation and inclusion, (b) accountability and the rule of law, and (c) equality and non-discrimination. The application of these three core principles for governing energy transition to deliver social and environmental justice is discussed next.

Participation and Inclusion

Participation and inclusion include empowerment through representation in government and other (e.g., administrative and local) mechanisms facilitating free, active, and meaningful participation in decision-making processes. Participatory political regimes deliver more equitable distributional outcomes and produce "superior institutions" better suited to local conditions (UNDP, 2011).

The energy transition discourse in India has been shaped by top-down policy, driven by national commitments for climate action. It has focussed heavily on addressing technical and financial barriers, mobilising public resources for subsidies (such as Production Linked Incentive schemes, exemption of wheeling charges, net metering, etc.) across the renewable energy value chain. However, the substantive impact on livelihoods (especially, the informal economy) as a result of the transition away from coal, has rarely attracted the attention of policy makers.

Accountability and the Rule of Law

The rule of law is a fundamental principle of governance that holds that all individuals and institutions are subject to the law and that the law should be applied equally and fairly to all. In a democratic country, it is essential for protecting the rights and freedoms of the citizens. Accountability ensures that individuals and institutions are transparent and accountable to the people they serve. It is a critical component of good governance and is essential for building trust and confidence in institutions and organizations. Together, these are essential for effective participation and managing conflicts (UNDP, 2011).

The concept of the Rule of Law finds full expression in the Indian Constitution. The Preamble re-emphasises the high ideals of equality, justice, liberty, and fraternity (Baxi, 2007). Article 14 establishes "Equality before Law" as a fundamental right. Right to (dignified) work, a fundamental human right (UDHR, 1948), is inalienable from "Right to Life" under Article 21 (Olga Tellis & Ors. vs Bombay Municipal Corporation & Ors., 1985). Further, various articles under Part IV of the Indian Constitution, Directive Principles of State Policy, enshrine the guiding principle for the State to deliver social, economic, and environmental justice. Directive Principles lay out guiding principles for labour governance that include the Right to Work (Article 41. The Constitution of India, 1950) and the dignity of workers (Articles 42, 43. The Constitution of India, 1950). Article 43A further directs the state to empower workers by securing means of participation of workers in the management of establishments and institutions in all sectors. The principle of conservation and preservation of the environment was also enshrined in Article 48A through the Constitution (Forty-second) Amendment Act 1976.

The Indian constitution establishes "accountability" as a fundamental principle through several mechanisms. This includes separation of powers (of the government) amongst the legislative, executive, and judicial branches; checks and balances between the three branches of the government; establishment of independent institutions;[6] and a guaranteed Right to Information.

Thus, the fundamental principles for establishing and safeguarding the rights of workers, communities, and the environment are well enshrined in the Constitution of India. It succinctly established the Rule of Law and the Environment Rule of Law to guide India's policy discourse towards Just Energy Transition.

Non-discrimination and Equality

The principles of equality and non-discrimination are part of the foundations of the rule of law (United Nations). In the context of Governance, the principle of equality seeks to address structural inequalities (be they social, political, or historical) by extending the development gains to the most excluded individuals and groups (UNHCHR, 2008). Institutions that ensure non-discrimination and equality can mitigate any detrimental impact on the most vulnerable through different means including ring-fencing of social expenditure and the prevention of the erosion of normative standards in times of crisis (UNDP, 2011).

The Constitution of India guarantees equality before the law and prohibits discrimination on the grounds of religion, race, caste, sex, or place of birth. Article 14 of the Constitution states that "the State shall not deny to any person equality before the law or the equal protection of the laws within the territory of India." Article 15 prohibits discrimination on the grounds of religion, race, caste, sex, or place of birth. The Constitution also provides for affirmative action for the benefit of disadvantaged groups such as Scheduled Castes and Scheduled Tribes. In addition, the Constitution also establishes various commissions and committees to address issues related to equality and social justice, such as the National Commission for Scheduled Castes, the National Commission for Scheduled Tribes, and the National Commission for Women.

In the context of the clean energy transition, the principle of affirmative action may be extended for disadvantaged groups resulting from employment and livelihood vulnerabilities. Delivering justice in the course of the clean energy transition required a transformative change in our economic and development paradigm in a manner that seeks the restoration of human rights for all, sanctifies dignity of all workers, and promotes the preservation of the environment.

Emergence of a New Governance Paradigm: A Critique

In May 2022, the Union Minister of Power and New & Renewable Energy, Mr R.K. Singh, asked the Chief Ministers of all States and Lieutenant Governors of Union Territories (UT) to set up State Level Steering Committees for Energy Transition. The Steering Committees will work under the chairmanship of the Chief Secretaries of the respective States/Union Territories along with relevant departments. The Minister reiterated that States/UTs have a vital role in meeting state-specific goals on sustainable development in the most energy-efficient way.

A report of the Inter-ministerial Committee on Just Transition from Coal, published by NITI Aayog, highlights the need for a Just Transition policy addressing five key issues of livelihoods, community health, physical and social infrastructure, repurposing of resources, and public finance. The Committee advocated for a three-tier task force to enable a Just Transition. Tier I, with representation from Central Govt. ministries and Civil society, shall ensure a Just Transition in the process of coal mine closure and set guidelines and good practices in the process by guaranteeing convergence and alignment with existing national policies and programmes. Tier II is constituted for each coal-bearing state, to safeguard the state's concerns, oversee plans for each asset closure in that state, and develop the regional development framework to enable the closure of coal mines with Just Transition principles. Tier III is constituted by Tier II for each asset being closed, at least four years prior to closure, with representatives from the affected local communities, project staff, and corresponding district administration and agencies. It shall develop and implement the redevelopment and repurposing plan for each asset that is being closed, based on public consultations.

In a very progressive move, the Government of Jharkhand recently set-up the "Sustainable Just Transition Task Force" with members including the Department of Planning, Mines and Geology, Environment Forests and Climate Change, Rural Development, Urban Development, Tribal and Minority Welfare, Labour and Employment, Training and Skill Development, Energy, Tourism, and State Coordinator State Level Bankers Committee. The Task Force has identified multiple objectives in the domain of impact assessment, sensitization of district officials, the role of communities in climate change mitigation, promotion of entrepreneurship, formulation of district action plans, and others.

The aforementioned emerging trends of policy action for Just Transition seem to acknowledge the intersectionality of energy transition across different sectors and line ministries. Further, the three-tier framework acknowledges the need for decentralised planning and representation.

While it is a good start, steering committees and task force don't have the administrative authority or permanence needed to navigate the complexities of energy transition. Navigating the challenges and complexities of energy transition shall require a comprehensive legal and institutional framework that encompasses various sectors and development initiatives. While there may be merit in exploring new institutions to be stewards of the energy transition, the role of existing institutions that execute development agenda across different tiers and sectors can't be ignored.

Values and Principles for a Just Energy Transition

Rule-based and Science-based Governance: Managing energy transition requires complex decision-making for long-term outcomes; primarily energy security, affordability, and sustainability. Uncertainties are integral to this process, often resulting in high social and economic costs when the margin of errors is high. Infrastructure demand, market economics, consumer behaviour, supply chains, and capital adequacy are some of the many uncertainties.

Given the complex and nuanced science behind energy transition, it is pertinent that transition governance embraces a science-based outlook. A rule-based system of policy and regulations can evolve to enable transition management for multiple outcomes. For instance, logical development goals shall evolve and informed trade-offs can be made based on broader transition values and principles. This shall also promote systemic transparency and accountability.

Intersectional and Decentralised Governance: At the fundamental level, energy transition shall redefine how energy is produced and how it is consumed. From an economic perspective, it shall encompass all major sectors such as power, mobility, industry, agriculture, consumer products and services, etc. Some of the development challenges shall include energy reliability and affordability (hence, energy justice), livelihoods, and rights of directly impacted workers and communities. Hence, transition management shall demand conscious policy interventions across key sectors and development initiatives.

As India commits to an energy transition pathway, its challenges shall intersect with its social, economic, and cultural diversity. Addressing such spatial complexities require contextual understanding, and hence, the need for a decentralised governance regime for effective and efficient transition management. Decentralisation also improves transparency and accountability through participatory decision-making and accessible institutions.

Inclusion and Participation: Indian society is entrenched with structural inequalities based on caste, class, and gender. Structural inequality can limit the benefits of distributive justice. For instance, despite affirmative action of reservation, the most disadvantaged groups are unable to access its benefits in India as reservation quotas are rarely realised across many key institutions. Hence, the aspect of "procedural justice" becomes pertinent in evolving Just Transition governance. Decentralisation, on its own, doesn't guarantee the same.

Inclusion of impacted disadvantaged workers and groups in decision-making and transition management may be an effective mechanism for achieving procedural justice in transition governance. This shall also imply, as far as feasible, power is devolved to the bottom tier of governance to facilitate meaningful participation by disadvantaged groups.

Conclusion

Governing energy transition to make it just and equitable is complex and challenging. The discourse needs to begin by acknowledging the structural inequality and disparity entrenched in our social and economic systems. This shall require building conscious sensitivity towards historical oppression and engaging in dialogue to transform the current reality towards a more just and equitable social and economic system. A hard-coded governance regime cannot be prescribed here, but the core principles discussed here can facilitate an evolutionary governance paradigm which shall continuously seek to transform the current reality.

Notes

1 No. 2 Unemployment Convention, 1919, No. 5 Minimum Age (Industry) Convention, 1919, No. 22 Seamen's Articles of Agreement Convention, 1926, No. 108, Seafarers Identity Documents Convention, 1958, and No. 147 Merchant Shipping (Minimum Standards) Convention, 1976.
2 No. 4 Night Work (Women) Convention, 1919, No. 14 Minimum Age (Trimmers and Stokers) Convention, 1921, No. 16 Medical Examination of Young Persons (Sea) Convention, 1921, No. 21 Inspection of Emigrants Convention, and No. 22 Seamen's Articles of Agreement Convention, 1926.
3 https://www.cambridge.org/core/journals/environmental-conservation/article/abs/indian-national-committee-on-environmental-planning-and-coordination/B0C955DDFFDB40104553B6FE15D73205
4 https://ijsw.tiss.edu/greenstone/collect/ijsw/index/assoc/HASH01ff/74b6e1e2.dir/doc.pdf
5 The principle of non-regression prohibits any recession of environmental law or existing levels of environmental protection and comprises its protective norms in the category of non-revocable and intangible legal rules, in the common interest of humanity (UNEP, n.d.).
6 The Election Commission, the Comptroller and Auditor General, and the Central Vigilance Commission.

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Appendix 7A

Fundamental ILO and Just Transition Conventions and India's Policy Stance

Table 7A.1 Fundamental ILO conventions ratified and ignored by India

Fundamental conventions ratified by India	*Fundamental conventions not ratified by India*
No. 29 Forced Labour Convention, 1930	No. 87 Freedom of Association and Protection of the Right to Organize Convention, 1948
No. 100 Equal Remuneration Convention, 1951	No. 98 Right to Organise and Collective Bargaining Convention, 1949
No. 105 Abolition of Forced Labour Convention, 1957	No. 155 Occupational Safety and Health Convention, 1981
No. 111 Discrimination (Employment and Occupation) Convention, 1958	Protocol of 2014 to the Forced Labour Convention, 1930
No. 138 Minimum Age Convention, 1973	
No. 182 Worst Forms of Child Labour Convention, 1999	

Table 7A.2 Just Transition conventions ratified and ignored by India

Just Transition conventions ratified by India	*Just Transition conventions not ratified by India*
No. 29 Forced Labour Convention, 1930	No. 87 Freedom of Association and Protection of the Right to Organize Convention, 1948
No. 81 Labour Inspection Convention, 1947	No. 98 Freedom of Association and Protection of the Right to Organize Convention, 1949
No. 87 Freedom of Association and Protection of the Right to Organize Convention	No. 102 Social Security (Minimum Standards) Convention, 1952
No. 87 Freedom of Association and Protection of the Right to Organize Convention	No. 117 Social Policy (Basic Aims and Standards) Convention, 1962
No. 100 Equal Remuneration Convention, 1951	No. 129 Labour Inspection (Agriculture) Convention, 1969
No. 105 Abolition of Forced Labour Convention, 1957	No. 140 Paid Educational Leave Convention, 1974
No. 111 Discrimination (Employment and Occupation) Convention, 1958	No. 144 Tripartite Consultation (International Labour Standards) Convention, 1976
No. 122 Employment Policy Convention, 1964	No. 148 Working Environment (Air Pollution, Noise and Vibration) Convention, 1977
No. 142 Human Resources Development, 1975	No. 150 Labour Administration Convention, 1978
No. 174 Prevention of Major Industrial Accidents Convention, 1993	No. 151 Labour Relations (Public Service) Convention, 1978
	No. 154 Collective Bargaining Convention, 1981
	No. 155 Occupational Safety and Health Convention, 1981
	No. 161 Occupational Health Services Convention, 1985
	No. 170 Chemicals Convention, 1990
	No. 187 Promotional Framework for Occupational Safety and Health Convention, 2006
	No. 189 Job Creation in Small and Medium-Sized Enterprises Recommendation
	No. 193 Promotion of Cooperatives Recommendation, 2002
	No. 195 Human Resources Development Recommendation, 2004
	No. 202 Social Protection Floors Recommendation, 2012

8 Policy Framework for Energy Transition in India

Sarthak Shukla and Raghav Pachouri

Context

At the 21st Conference of Parties (COP-21) to the UNFCCC held in December 2015 in Paris, 196 countries (including India) adopted the Paris Climate Agreement which aims to limit global warming to well below 2°C, preferably to 1.5°C, compared to pre-industrial levels (MoEFCC, 2018). As a part of this legally binding treaty, India announced its Nationally Determined Contributions (NDCs) in October 2015, which were updated in August 2022 after its approval by the Union Cabinet of Ministers (GoI, 2022c).

In order to give effect to these NDCs, various policies and schemes were promulgated by the Government of India and several state governments. One of the focal elements of such policies has been the concept of "energy transition", i.e., transforming the energy systems from being carbon intensive to low carbon and subsequently carbon free.

Though India's recent climate commitments on international forums are one of the major drivers of energy transition domestically, the idea of energy transition exists in laws and policies which were passed much before the announcement of India's NDCs. Be it the Energy Conservation Act 2001, or the Biodiversity Act of 2002, or the Electricity Act of 2003, all of them have provisions that indicate the need for enhanced and rapid decarbonisation of the energy sector as one of the policy priorities.

In particular, the proposed amendments to the Electricity Act 2003 have explicit provisions that pertain directly to transforming the power and energy sectors. Furthermore, "Energy Transition" and "Climate Action" were two of the four priority areas announced by India's finance Minister while tabling the Union Budget for the fiscal year 2022–2023 (*Budget 2022: Emphasis on Energy Transition and Clean Energy, Energy News, ET EnergyWorld*, 2022). Apart from the Government's ambitions, several other entities and institutions have come forward and announced their vision towards implementing the principles of energy transition. A common type of such announcement involves the entity pledging to become a net-zero emitter of carbon emissions by a particular year. Many corporates, Public Sector Undertakings (PSUs) like the Indian Railways, urban local bodies, and other institutions have announced vision statements to this effect.

The significance of energy transition is not only evident from the policy-related developments of the past but is also showcased by the government's plans for growth and development going forward. The push towards renewable energy power generation, electrification of the transportation sector through electric vehicles, green buildings, sustainable agriculture, afforestation, and other such developments indicate a clear shift towards transitioning the energy system from being carbon intensive to eventually low carbon and carbon free in the near future.

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This chapter explores the current legislative, policy, and regulatory landscape of energy transition in India and assesses the performance of key policies towards mitigation of GHG emissions as well as enhancing the capacity of adaptation and resilience of sectors towards climate change. It also evaluates the linkages between the existing landscape of policies pertaining to energy transition and India's long-standing climate commitments and goals.

Policy Framework for Energy Transition in India – An Overview

In the Indian context, "Energy Transition" derives its policy mandate from a host of legislations, regulations, schemes, and other such policy-related instruments. The laws currently in force domestically provide the legislative bedrock to the government and its agencies to undertake executive decisions to give effect to the provisions laid out in the respective acts.

Owing to the growing importance of renewable energy, the erstwhile Ministry of Non-Conventional Energy which was created in 1992 was renamed to the Ministry of New and Renewable Energy in 2006. This ministry forms the bedrock of energy transition initiatives, particularly in the power sector, with a focus on enhancing the installed capacity of renewable energy sources in the country and enabling grid integration.

There are primarily five existing laws in India which provide legislative backing to the key elements of "energy transition", either directly or indirectly; *the Forest (Conservation) Act, the Energy Conservation Act, the Biodiversity Act 2002, the Electricity Act 2003, and the Compensatory Afforestation Fund Management and Authority Act*. The next section will elaborate on these laws.

Apart from the legislative framework noted above, one of the key elements of India's Energy Transition policy landscape is the *National Action Plan on Climate Change* along with *State-level Action Plans on Climate Change* devised and implemented by various states. These plans provide the basis for a plethora of missions and schemes which relate to the energy transition.

Additionally, there are various schemes and policies which are promulgated by the relevant authorities at the Union and State levels that are a result of either implementation of the vision of the respective government or the legislative mandate provided by relevant acts or statutes.

Lastly, the policies, initiatives, and schemes, either standalone or as part of any existing statute, have concrete policy and regulatory instruments which give effect to the mandate of the said initiatives. These instruments may be in the form of incentives or subsidies or structural tools of regulation like placing processes in place or institutional practices that set up institutional structures for implementing any policy/scheme/initiative. These instruments are the quantitative or qualitative indicators by which the performance of any such policy or scheme can be effectively measured.

This landscape is summarised in Figure 8.1.

This chapter attempts to assess the performance of select legislations, policies, schemes, initiatives, and regulations which pertain to energy transition through the lens of their efficacy, efficiency, reliability, and progress in terms of realising the policy-specific vision as well as the national climate-related ambitions. Furthermore, it draws from the analysis certain actionable recommendations to bridge the gap between policy intent and its progress of implementation, when it comes to energy transition.

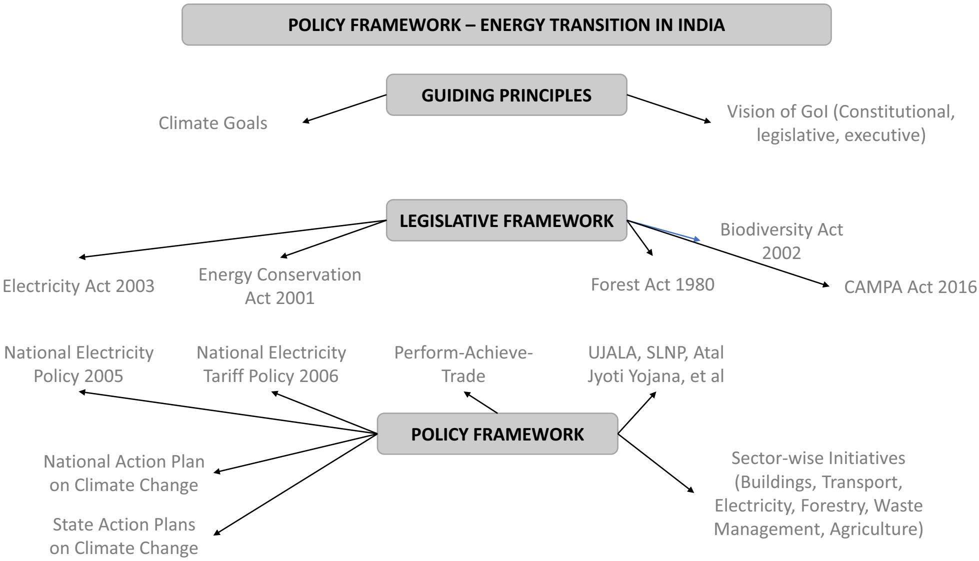

Figure 8.1 Policy landscape of energy transition in India.

Source: Author compilation.

Assessment of Legislations Related to Energy Transition

A scrutiny of the existing legislations that pertain to energy transition throws light on certain critical insights with respect to the landscape of legislations and their role in furthering the energy transition in India. In this regard, there are general findings and act-specific findings, which are elucidated in Table 8.1.

Let us take the Biodiversity Act 2002, as a case, and understand its trajectory so far.

- The Act was promulgated after several other acts related to environmental protection came into force in India including the Indian Forest Act, 1927, Wildlife Protection Act, 1972, and Environment Protection Act, 1986. During the period preceding 2002, India also became a signatory to multiple international treaties including Ramsar Conservation on Wetlands, 1971, Convention for the Protection of World Cultural and Natural Heritage, 1972, Convention on International Trade of Endangered Species of Wildlife Fauna and Flora, 1973, Convention on the Conservation of European Wildlife and Natural Habitat, 1979, World Conservation Strategy, 1980, and the UN Convention on Biological Diversity (CBD), 1992.
- The CBD of 1992 became the basis for a comprehensive plan for the protection of biodiversity. With the opening of the economy, the need to address issues of bio-piracy and intellectual property rights of indigenous resources and communities was increasingly being felt.
- During the period 2000–2002, a civil society group was commissioned for preparing India's National Biodiversity Strategy and Action Plan. However, this plan was not accepted by the government. Therefore, the government decided to release its own draft on National Biodiversity Plan which was made by the technocrats. The Act of

Table 8.1 Landscape of legislations and their role in furthering energy transition in India

	Energy Conservation Act 2001	*Biodiversity Act 2002*	*Electricity Act 2003*	*Forest (Conservation) Act 1980*	*Compensatory Afforestation Fund Act 2016*
Overview	The EC Act, passed in 2001, is an act that provides structural and functional frameworks for enhancing energy efficiency and energy conservation in India	This act derives itself from the Convention on Biological Diversity adopted by the UNFCCC at the Rio Earth Summit	This was passed which aimed at consolidating the existing legislations in place and promoting holistic development of the power sector	The Act give powers to the Central Government to restrict the usage of "forest land" for "non-forest purposes"	This act was promulgated for setting up of a fund to deposit and utilise the monies received from user agencies
Objectives	Energy efficiency and energy conservation	Provide for conservation of biological diversity, sustainable use of its components and fair and equitable sharing of the benefits arising out of the use of biological resources, knowledge'	To consolidate the laws relating to generation, transmission, distribution, trading and use of electricity and generally for taking measures conducive to development of promotion of efficient and environmentally benign policies, and for other issues and matters connected therewith or incidental thereto	Conservation of forests and related matters	Establishment of a fund under public accounts of India and public accounts of each state and Union Territory and utilisation of the monies deposited by user agencies towards artificial regeneration, assisted natural regeneration, protection of forests, forest-related infrastructure development, wildlife protection and other such matters
Governance	Provides for institutional mandates along with processes, plans and strategies as partofthegovernance framework for the legislation	As per the act, the National Biodiversity Authority (NBA) was established in 2003 which performs facilitative, regulatory and advisory functions as laid out under the BD Act 2002. State Biodiversity Boards (SBBs) at state-level and Biodiversity Management Committees (BMCs) at the local level to aid in implementation of the BD Act 2002	Comprehensive governance framework comprising of Appropriate Governments (Union Government or State Government), Appropriate Commission (CERC, or SERCs, or JERCs), Central Electricity Authority (CEA), Load Dispatch Centers, Appellate Tribunal for Electricity (APTEL), Advisory Boards, Ombudsman, amongst others	Advisory Committee is provisioned to be constituted in order to advise the Central Government for approving the application for diversion of any forest-land for non-forest purposes by any State Government or any other authority	Provides for a two-tier governance mechanism with creation of a National Compensatory Afforestation Fund Management and Planning Authority at the national level, along with State Authorities at the state-level

Regulation	Key instrument of regulation is of standards, norms and obligations	Granting approvals for access, benefit-sharing and enforcing intellectual property rights under the act. The SBBs and BMCs, also use information dissemination as an instrument of regulation in which they ensure that critical data regarding the biological resources are maintained properly	Primary tool which is to be exercised by the Appropriate Commissions is the economic tool of regulation (tariffs). The Act also confers quasi-judicial powers to the Appropriate Commission and the APTEL for grievance redressal and passing orders to give effect to the provisions enshrined in the EA 2003	Granting approval by the Central Government, advisory role by the Advisory Committee, rule-making by the Central Government and penalties and offences	Economic tool of regulation (Fund establishment and utilisation)
Outcome	The impact of various programmes of the bureau during FY 2019-20 amounted to electrical energy savings of 143.03 billion units worth Rs. 87019 crores and avoided generation capacity of close to 45.22 GW.(BEE, 2022)	Since its inception, the NBA has cleared the approval for 3094 applications while rejecting 39 applications. Additionally, in the FY 2020-21, the NBA received a sum of Rs. 8,40,98,477 as a benefit-sharing component under the BD Act 2002. (NBA, 2022)	The installed capacity of renewable energy reached to 164.93 GW (including hydro) as on 30.09.2022 from 12.39 GW in the year 2007-08.(GoI, n.d.-b) The electricity generation from renewables increased from a meagre 20 TWh in 2007-08 to 145 TWh in FY20.(GoI, n.d.-b)		As of 2020, the CAMPA Fund had a corpus of Rs. 54,394 crores collected by various user agencies over the course of 5 years.(GoI, 2020a)

2002, based on this plan was passed by the Lok Sabha on 2December 2002 and Rajya Sabha on 11 December 2002. The objectives of the Act were:

- Conservation of biological diversity,
- Sustainable use of its components,
- Fair and equitable sharing of the benefits arising out of utilization of genetic resources.

- However, there have been major hurdles pertaining to the implementation of the act, which have come to light recently. The prominent challenge is the delayed establishment of State Biodiversity Boards and Biodiversity Management Councils at local levels owing to which several thousand crores of potential revenue is reported to have been lost by the National Biodiversity Authority.
- Furthermore, in a more recent development, the proposed amendments to the Biodiversity Act have faced stiff opposition from environmental groups claiming that provisions are pro-capitalism and dilute the centricity of local communities envisaged in the original act. The amendment also refers to the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilisation to the Convention on Biological Diversity which was adopted on 29 October 2010 in Nagoya, Japan, of which India is a signatory.

Key Takeaways

A brief review of the key legislations related to energy transition in India offers critical insights and takeaways with regard to the overall legislative framework, governance, and regulatory systems established under the legislations and the performance of the legislations so far. Some of the critical takeaways from this framework are listed below:

- Most of the legislations, being older than almost two decades, have not seen any recent revisions getting implemented to incorporate the necessary contextual amendments required to give effect to India's global climate action commitments. While there have been attempts at amending these legislations, these have been largely infructuous so far and the act remains operational in its original form. Thus, as they stand, necessary modifications relating to India's NDCs and climate commitments have largely remained absent in these legislations.
- The existing legislations have set up a comprehensive system of governance structures and institutions in place for furthering energy transition. Primarily, these institutions provide for the promotion of renewable energy, stabilisation of carbon stock, and placing systems of checks and balances to ensure the adequacy and effectiveness of sustainability measures in developmental projects. These systems provide the much-needed governance and operational and financial support for spurring energy transition–related developments.
- The existing tools of regulation deployed by the operational legislations towards spearheading India's energy transition are mostly top down and conventional in nature. For instance, approvals, standards, penalties, and economic tools dominate the regulatory landscape so far. Thus, there is significant scope to make use of innovative and fit-for-purpose, bottom-up tools of regulation including structural, transactional (contract

enforcement), information-based, behavioural, and self-regulatory tools of regulation (see Chapter 11).

- The existing legislations have used delegatory powers in many instances whereby these have provided for delegated authorities to come up with plans, policy frameworks, advisory reports, and other such delegated functions. However, there exists a need to ensure timely performance, effectiveness, and compliance of the original as well as delegated legislation by the competent authorities. This also needs to be done in a transparent and participatory manner and, if needed, be placed before Parliament or a state legislature, as the case may be.

Sector-wise Policies

This section lists some of the prominent and recent policies and schemes in the crucial sectors of the economy from the energy transition's point of view. The sector-specific policies and schemes are assessed for their regulatory structure, performance, and key challenges therein, in order to come out with takeaways and recommendations for furthering the transition of energy systems away from fossil fuels and towards low-carbon and green sources of energy.

Power Sector

The policies related to energy transition in the power sector are highlighted in Table 8.2.

Energy Efficiency Sector

The policies for energy efficiency sector are enlisted in Table 8.3.

Industry

The policies for industry sector are enlisted in Table 8.4.

Electric Mobility and Transport Sector

The policies related to electric mobility and the transport sector are highlighted in Table 8.5.

Agriculture Sector

The policies of the agriculture sector that pertain to energy transition are highlighted in Table 8.6.

Waste Management Sector

The policies in the waste management sector are highlighted in Table 8.7.

Table 8.2 Power sector-specific policies furthering the transition of energy systems away from fossil fuels and towards low-carbon and green sources of energy

S.N.	*Policy*	*Year*	*About*
1	National Electricity Policy (MoP, 2005)	2005	Amongst other issues, the National Electricity Policy 2005 seeks to address energy conservation, environmental issues, co-generation and non-conventional energy sources and technology development and research and development.
2	National Electricity Tariff Policy (MoP, 2006)	2006	The first National Electricity Tariff Policy makes provisions pertaining to pricing of non-conventional electricity generated, including co-generation. It stipulates that distribution utilities procure a minimum share of their electricity from non-conventional sources, as determined by the Appropriate Commission, at preferential tariffs.
3	Jawaharlal Nehru National Solar Mission(SECI, 2010)	2010	Launched as a sub-mission under the National Action Plan on Climate Change (2008). A phase-wise initiative to promote, monitor, and expand the solar energy installed capacity in the country.
4	Deen Dayal Upadhyay Gram Jyoti Yojana (MoP, n.d.-b)	2014	Being one of the flagship schemes of the Ministry of Power, DDUGJYs main objectives included To provide separation of agriculture and non-agriculture feeders facilitating judicious rostering of supply to agriculture and non-agriculture consumers in the rural area, and Strengthening and augmentation of sub-transmission & distribution (ST&D) infrastructures in rural areas
5	Ujjwal Discom Assurance Yojana (UDAY) (MoP, n.d.-a)	2015	This was a scheme for financial turnaround of power distribution companies (DISCOMS) with the objectives of operational and financial efficiency improvements in state-owned distribution utilities through a host of fiscal and non-fiscal measures.
6	Sahaj Bijli Har Ghar Yojana – SAUBHAGYA(GoI, n.d.-c)	2017	The scheme focused on last mile connectivity and providing electricity connections to all the unelectrified households in the country. Being one of the world's biggest Universal electrification initiatives with collaborative and concerted efforts of Centre and States, it was a concurrent program to Deen Dayal Upadhyaya Gram Jyoti Yojana' (DDUGJY).

(*Continued*)

Table 8.2 (Continued)

S.N.	*Policy*	*Year*	*About*
7	Renewable Purchase Obligations	Continuing	RPOs have emerged as a prominent mechanism to enhance the share of RES in India's electricity mix. As per this mechanism, RPOs are the targets specifying a certain percentage of RE out of the total consumption of the obligated entities. The obligated entities include DISCOMS, open access consumers and captive power generation companies. However, the RPO regime is often faced with the critique of non-compliance by obligated entities to a substantial degree. For instance, the RPO target for the financial year 2019-20 was set at 17.5% but the achievement on pan-India basis was merely 12.73% and compliance is less than 55% of the target for about 20 states.(CEEW-CEF, 2021)
8	Renewable Energy Certificates	Continuing	RECs are tradable instruments issued by POSOCO to registered projects after an energy injection report by relevant State Load Dispatch Center is provided to ascertain that 1 MWh of RE is injected into the grid by the project developer. These certificates can either be purchased at power exchanges or retained by the developers for self-consumption and cannot be resold. RECs are purchased by obligated entities for RPO and also voluntarily by companies and individuals to reduce their carbon footprint. As of October 2022, the total REC inventory stood at:(GoI, n.d.-g) Solar REC – 61,02,993 Non-solar REC – 78,52,726 Total – 1,39,55,719
9	Round the Clock Power Procurement (RTC)	2020	Owing to prevailing market conditions, falling prices of RES and intermittency of renewable energy based power, the Ministry of New and Renewable Energy issued guidelines to enable the procurement of RTC power by DISCOMS from grid-connected RE power sources, complemented/balanced with power from coal-based thermal power projects, through a tariff based competitive bidding.(GoI, 2020b)
10	Resource Adequacy – Electricity (Amendment) Bill(GoI, 2022a)	2022	The Electricity (Amendment) Bill 2022 provides for inclusion of resource adequacy as a strategy to be framed by distribution companies at both generation planning and operational stages. As per the Bill, the SERCs shall frame the regulations for Resource Adequacy and the DISCOMS are required to submit the Resource Adequacy Plan in accordance with the act and regulations framed by SERCs.

Table 8.3 Energy efficiency sector-specific policies furthering the transition of energy systems away from fossil fuels and towards low-carbon and green sources of energy

S.N.	*Policy*	*Year*	*About*
1	National Mission on Enhanced Energy Efficiency (BEE, n.d.)	2008	NMEEE is one of the eight national missions under the National Action Plan on Climate Change (NAPCC) launched by the Government of India in the year 2008. The mission aims to strengthen the market for energy efficiency through implementation of innovative business models in the energy efficiency sector. It consists of four initiatives: 1) Perform-Achieve-Trade Scheme – For improving energy efficiency in energy intensive sectors 2) Energy Efficiency Financing Platform – For providing a platform for capacity enhancement of stakeholders related to energy efficiency financing 3) Market Transformation for Energy Efficiency – For accelerating shift towards energy efficient appliances 4) Framework for Energy Efficient Economic Development – For development of fiscal instruments to promote energy efficiency
2	Market Transformation for Energy Efficiency (MTEE)		Initiative aims at accelerating the shift to energy efficient appliances in designated sectors through innovative measures and making products affordable. Appliances identified for priority development include refrigerators, ceiling fans, air-conditioners, water heaters, and motors. This program also supports Make in India initiative through accelerated market transformation and supporting the MSMEs. UJALA Scheme and Street Lighting National Programme are the initiatives launched under this program. Under the Unnat Jyoti by Affordable LED for All (UJALA) scheme, LED bulbs, LED Tube lights, and Energy efficient fans continue to be provided to domestic consumers for the replacement of conventional and inefficient variants. Till November 2020, over 366.85 million LED bulbs, 7.207 million LED tube lights, and 2.340 million energy efficient fans had been distributed by EESL across India. This has resulted in cumulative emission reduction of 180.08 MtCO2 from 2014-15 to November 2020. Under Street Lighting National Programme (SLNP), conventional street lights are being replaced with smart and energy efficient LED street lights across India. The programme is being implemented by Energy Efficiency Services Limited (EESL), a Joint Venture (JV) of PSUs under the Ministry of Power, Government of India. Under SLNP, up to September 2020, EESL has installed over 11.25 million LED street lights in Urban Local Bodies and Gram Panchayats across India. This has resulted in cumulative energy savings of 18.071 billion units and emission reduction of 14.82 MtCO2 from 2015-16 to 2019-20.(GoI, 2022c)

Table 8.4 Industry sector-specific policies furthering the transition of energy systems away from fossil fuels and towards low-carbon and green sources of energy

S.N.	*Policy*	*Year*	*About*
1	National Green Hydrogen Policy	2022	The National Green Hydrogen Mission is aimed at aiding India's climate ambitions and making it a green hydrogen hub. In line with the same, the Ministry of Power notified the Green Hydrogen/ Green Ammonia policy in 2022. (*Green Hydrogen Policy – Regarding*, 2022)
2	Steel Sector	NA	Application of Hydrogen Direct Reduction as a feasible technological option for greening India's steel sector
3	Production-linked Incentive Scheme		With an outlay of Rs. 1.97 Lakh Crores for the Production-Linked Incentive (PLI) Schemes across 14 key sectors, to create national manufacturing champions and to create 60 lakh new jobs, and an additional production of 30 lakh crore during next 5 years, was announced in 2020.(*PLI Scheme May Generate 6 Million Jobs in next 5 Years: FM Sitharaman | Business Standard News*, 2022) The key relevant sectors covered in this scheme include High-Efficiency Solar PV Modules (Ministry of New and Renewable Energy); Advance Chemistry Cell (ACC) Battery (Department of Heavy Industry)

Key Takeaways

A review of the functional and institutional structures of the existing sector-specific initiatives on energy transition yields the following takeaways:

- *Aligning Central and State-Level Initiatives* – There exists multiple initiatives that are operating at national level along with simultaneous initiatives on related themes by several state governments in many instances. For instance, the promotion of renewable energy is done through both Union Government's initiatives and state-level policies of various states. In such instances, there is a need both for alignment of efforts and a working collaboration between the different agencies at all the levels of governance.
- *Climate Justice* – A critical element in the existing policy landscape is India's key vision in its NDCs relating to climate justice. There exists a need to put in place a comprehensive action plan that highlights how the concerns of socio-economic footprint, ecological justice, and political justice can be achieved. The existing policies in the renewable energy sector need to address such concerns relating to climate justice.
- *Intra and Inter-sector Convergence* – There are a plethora of initiatives and schemes across sectors as well as within each of the sectors as highlighted in the previous section. On one hand, there are sectoral agencies and departments overseeing the initiatives while on the other hand, there exists a multitude of institutions within the sectors also, some with overlapping jurisdictions. Thus, there exists a critical need for institutional and functional convergence across and within each of the sectors to give effect to the vision of energy transition.

- *Governance and Performance of Initiatives* – The governing agencies for various policies and schemes vary across the levels of governance, both vertically and horizontally. This results in a need for placing checks and balances which ensures that governance agencies performing various functions are functioning effectively and are sensitive to ground realities. This needs to be approached as a policy study and causal factors for such performances must be identified and addressed in a transparent manner. Such an intervention needs to be a part of the existing policy landscape on energy transition.
- *Instruments of Regulation* – In most of the initiatives and schemes, the tools of regulation being used conform to conventional instruments of regulation. Innovative regulatory instruments such as sandbox regulation (pilot-based scaling) and self-regulatory models are yet to be adopted and tested in the sphere of energy transition which becomes all the more crucial given the importance of behavioural change highlighted by one of India's NDC on LIFE.

Table 8.5 Electric Mobility and Transport Sector-specific policies furthering the transition of energy systems away from fossil fuels and towards low-carbon and green sources of energy

S.N.	*Policy*	*Year*	*About*
1	National Electric Mobility Mission Plan 2020 (GoI, 2012)	2013	NEMMP aims to deploy 4,00,000 passenger battery electric cars (BEVs) by 2020. If these BEV adoption rates continue beyond 2020, India could save 4.8 billion barrels of oil and 270 million tonnes of CO_2 emissions by 2030.
2	Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles in India (GoI, n.d.-d)	2015	Launched as part of NEMMP, the scheme aims at incentivising electric vehicles across all the segments namely 2-wheelers, 3-wheelers auto, passenger 4-wheelers, light commercial vehicles, and buses. Presently, Phase-II of FAME India Scheme is being implemented for a period of 3 years from April 2019 with a total budgetary support of Rs. 1,00,000 million. In the first phase of the Scheme about 0.28 million hybrid and electric vehicles are supported by way of demand incentive amounting to about Rs. 3,590 million.
3	Corporate Average Fuel Economy (CAFÉ) Norms for Passenger Cars	2017-18	The standards relate the Corporate Average Fuel Consumption (in litres/100 km) to the Corporate Average Curb Weight of all the cars sold by a manufacturer in a fiscal year.
4	Guidelines for Charging Infrastructure for Electric Vehicles (GoI, 2022b)	2022	Amongst other things, the objective of the guidelines is to enable faster adoption of EVs, ensuring reliable, accessible and affordable charging infrastructure and ecosystem, affordable tariffs, generation of employment and income avenues, encouraging Electrical Distribution System to adopt EV charging infrastructure and promotion of energy security. The guidelines provide for concessions, financial incentives, tariff considerations, service charges, database creation and other relevant details pertaining to charging infrastructure creation.

Table 8.6 Agriculture Sector-specific policies furthering the transition of energy systems away from fossil fuels and towards low-carbon and green sources of energy

S.N.	*Policy*	*Year*	*About*
1	National Mission for Sustainable Agriculture (GoI, n.d.-e)		This is an initiative by the Government of India to transform the agricultural sector into an ecologically sustainable, climate resilient production system. The mission works through various sub-missions covering various mitigation and adaptation activities. Some of the crucial ones from energy transition's point of view are Sub-mission on Agroforestry and National Bamboo Mission.
2	Pradhan Mantri Kisan Urja Suraksha Evam Utthan Mahabhiyan Scheme (PM – KUSUM)(MNRE, n.d.)		The scheme was launched for de-dieselisation of the farm sector and enhancing farmers' income by providing energy and water security and also to decarbonize the farm sector. The scheme aims at achieving 30.8 GW solar capacity through installation of small solar power plants of capacity up to 2 MW on barren/fallow/pasture/marshy land of farmers, replacement of 2 million diesel pumps by standalone solar pumps, and solarisation of 1.5 million grid-connected agriculture pumps by 2022.
3	Mission for Integrated Development of Horticulture (MIDH) (GoI, n.d.-c)		This mission aims to develop the horticulture sector holistically by focussing on a wide range of crops including fruits, vegetables, flowers, spices, and nuts of which the fruit crops produce relatively higher biomass and are retained in the field for a relatively long period. This is poised to help in carbon sequestration both above and below the ground surface. The quantum of carbon sequestered from 2017-18 to 2018-19 is estimated to be around 108.96 MtCO2.

Recommendations

On the basis of the above, there are some useful, in our view, recommendations that can be made. These pertain to enhancing the effectiveness, efficacy, and reliability of the existing framework and modifications required to better realise the objective of energy transition in line with India's NDCs.

- *T-A-P Framework*: T-A-P stands for Transparency-Accountability-Participatory form of governance framework which can assess legislations, policies, and regulations for the degree of transparency, accountability, and participatory mechanisms being followed by the respective policies. The need for having such a framework is inevitable for enhancing the governance framework of energy transition in India by making the transition more informed, driven by ground realities, effective and responsible to sensitivities of various stakeholders. Such a framework can also help fast-track the progress of amending and modifying various legislations and policies from time to time.
- *Intra and Inter-sectoral Cooperation* – This is one of the key enablers for promoting energy transition in the country. Efforts need to be made to enhance intra-sector cooperation amongst various agencies and departments, as well as amongst different

Table 8.7 Waste Management Sector-specific policies furthering the transition of energy systems away from fossil fuels and towards low-carbon and green sources of energy

S.N.	*Policy*	*Year*	*About*
1	Regulatory Landscape for Waste Management (GoI, 2022c)	NA	A host of regulations provide for standards, penalties, institutional structures, and other details pertaining to waste management regulation in India.
2	Swachh Bharat Mission	2014	One of the implementation components under SBM is Solid Waste Management (SWM) which includes setting up of wet waste processing facilities and dry waste recycle and recovery facilities. The estimated potential to generate power from Municipal Solid Waste stands at 500 MW which would increase to 1071 MW by 2030 as urbanisation increases.
3	Atal Mission for Rejuvenation and Urban Transformation (AMRUT) (GoI, n.d.-a)	2015	One of the eligible components under this city-level mission is sewerage and sewage treatment plants, including recycling and re-use of wastewater. The mission also focuses on non-motorized transport and developing green spaces for the selected mission cities. Against the total planned size of Rs. 7,76,400 million of all the action points, Rs. 14,360 million (2%) was for non-motorized urban transport.

sectors which are working towards realising the goal of energy transition. There can be several ways of enhancing cooperation ranging from interministerial discussions and review meetings to creation of separate platforms for discussion and way forward for several related programmes and initiatives relating to the energy transition.

- *On Monitoring and Evaluation* – A comprehensive culture of having transparent, reliable, and real-time data on critical metrics and developments of energy transition is needed now, more than ever. This is because measuring the progress towards achieving climate goals correctly is the first step in learning from the progress thus far as well as planning for future steps of climate action. A robust system for monitoring and evaluation of the legislations, schemes, policies, and regulations pertaining to energy transition is another much-needed element for the energy transition policy landscape in the country. There are several advancements and modifications in M&E frameworks across the globe that can enhance the efficacy of M&E systems. Such developments may be checked for their relevance in the energy transition landscape in the Indian context and may be suitably adopted or adapted, if found relevant. This would enable a "learning-by-doing" culture which is paramount given the fast-changing landscape of energy transition.
- *On Transition Financing* – India has rightfully placed before the international community its demand on ensuring climate justice between the developed and developing nations. A key enabler of this is financial flows for enabling developing countries to mitigate and adapt better to the externalities of climate change so that competitive losses do not ensue while transitioning to a low-carbon scenario. Therefore, a realistic and result-oriented transition finance framework is required to foster an effective energy transition policy landscape in the country.

- *On Innovative Policy/Regulatory Instruments* – On the basis of international developments, there are several innovative policy mechanisms that aim at spurring energy transition. These include carbon taxation and a taxonomy of sustainable finance, amongst others. A need-assessment, pilot exercise, or case study may be started as a first step by the Government of India to bring these concepts into the Indian policy regime. In this context, several such innovative instruments are at the initial stages of getting on-boarded and pilot studies can better enable the decision-makers to integrate such regulatory mechanisms, both contextually and institutionally.
- *Just Transition Framework* – The policy landscape for energy transition in India needs to proactively embrace the principle of Just Transition in the structural and operational framework within each of the legislations, policies, and regulations. This would require a transformative shift whereby social dialogues and participatory forms of governance become central to the legislative, policy, and regulatory landscape of energy transition (see for example Chapter 7).

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Appendix 8A

Equitable Distribution of Market Risks – A Critique of the Electricity Act 2003

Simran Grover

The Electricity Act (EA) 2003 is a landmark legislation which paved the way for unbundling the electricity board, establishing the Appellate Tribunal for Electricity, defining powers of regulatory commissions and framing the market design for private sector participation. It facilitated many milestones of the last two decades, including a pan-India synchronous grid ("one nation, one grid, one frequency"), sufficiency in electricity generation through private sector participation, and significant improvements in the quality of supply. A critical evaluation of the Act, with respect to the efficiency of overall market design shaped by it and its impact on consumers, follows to serve as inputs to design legislative and policy interventions for clean energy transition of the power sector.

The nature of power sector demands long-term planning, overseen by State agencies under the purview of the Act. The push for private sector participation and competition was facilitated by safeguarding investors from long term demand risks. The Central Government was tasked with preparing the National Electricity Policy and Plan (Section 3, EA 2003) in consultation with the State Governments, for the development of power systems based on optimal utilisation of resources. The electricity regulatory commissions were accorded the authority to specify terms and conditions of tariff, commonly known as tariff regulations, for generation and transmission companies under Section 61 of the Act. Efficiency, economic use of resources, optimum investments, and safeguarding consumer interests are some of the key principles guiding the regulatory commissions. Further, Section 62 provides for the determination of the tariff for a power utility/company. Section 63 provides for adoption of tariffs discovered through competitive bidding mechanisms, wherein the bidding process shall be in accordance with the guidelines issued by the Central Government. The Act allowed prudent costs for supply of electricity to be passed to the consumers and recovered through electricity supply tariffs, as per the National Tariff Policy and subsequent regulations notified by appropriate regulatory commissions.

The resulting growth in market share of private sector across the three verticals of generation, transmission and distribution has been very different. Since the EA 2003 was notified, the private sector's share in electricity generation has increased to approximately 50%, while the rest is shared between the Central and State power generation utilities (MoP, n.d.). The contribution of the private sector in the transmission business has been increasing with a push for tariff-based competitive bidding, while the distribution sector is still dominated by state electricity distribution utilities.

While the power sector has grown significantly in the last two decades, the electricity distribution sector has lagged, with distribution companies accruing a debt of Rs. 5.5 trillion as of March 2021. This dismal state of distribution utilities is often attributed to poor management practices, need for modernization, growing regulatory assets, and high technical and commercial losses. However, a conceptual analysis of risk distribution across the three key verticals of electricity generation, transmission, and distribution and the fundamental structural issues in market design offer a critical understanding of the failures of electricity distribution sector.

Long-term electricity demand is a significant uncertainty in the power sector, especially in the context of power sector planning. Error in demand estimation on either side (over or under estimation) has significant economic implications. Energy deficits direct impact productivity and economic growth. Excess capacity, resulting from over investment in infrastructure, results in lower capacity utilization. Consequentially higher electricity tariffs required to be levied for recovery of costs, impact affordability, and industry competitiveness.

Power sector planning is typically done for a ten-year horizon, accounting for timeframes for commissioning power generation and transmission, especially interstate transmission lines. The Central Electricity Authority and, typically, State Electricity Departments forecast electricity demand, based on which, investments for electricity generation and transmission are approved. As distribution utilities are required to enter into long-term generation and transmission contracts to meet their current, near term and long-term electricity demand, the demand risk is solely concentrated in the distribution sector.

In the last two decades, India has experienced significant underutilization of generation capacity in because of low realization of demand growth, poor fuel linkages, poor planning, and other issues (Prayas (Energy Group), 2017). The investment in generation increased through private sector participation, while the public sector dominated distribution companies struggled to keep pace. The pass-through of investments in generation and transmission to electricity consumers ensured that the participating players were immune to demand risk. However, distribution companies are caught up in the political economy of electricity, bearing the burden of planning inefficiencies. It may be noted that the State Governments play a critical in shaping power sector planning, and the distribution companies have only a notional role to play in such matters.

Inefficiencies in power sector planning and over investments should create a negative market signal because of an increase in electricity tariffs. However, such signals are muted by using instruments such as subsidies and regulatory assets (delayed recovery of costs through retail electricity tariff). Inefficiencies in disbursement of subsidies and liquidating regulatory assets have consistently constrained cash flow of distribution utilities and inhibited necessary investments in infrastructure, technology, and human capital to strengthen the sector.

The distribution sector also has inherently high operational and business risks. These include large operational network, consumer behaviour and political economy risks. The latter often contributes to electricity theft and poor recovery of dues. Further, public distribution companies often do not enjoy appropriate autonomy in planning and management to navigate the complexities, as they are vulnerable to indirect control by the respective state governments.

It may be argued that in many states distribution companies are systemically forced into debt cycles and resource starvation, resulting in their deplorable condition. In this context, the discourse around privatization of public distribution companies has garnered mainstream support. While it is true that privatization may address some of the challenges faced by public distribution companies since they are inherently more autonomous, privatization does not address the structural issues of power sector governance, especially equitable distribution of risks across the generation, transmission and distribution sectors.

The power sector is witnessing a substantive increase in complexity. This is a function of the increasing renewable energy integration, distributed generation, sales migration, electric mobility, decarbonisation across sectors, technology risks, and climate risks. Demand risk has substantively increased across short, medium, and long term horizons. Planning and sectoral management inefficiencies are likely to pose a significantly higher cost to the consumers and the country's economic sustainability. In this context, while the role of public electricity distribution companies may shrink in the wake of privatization, displacing them completely may not be advisable. Instead, it is necessary to align incentives across generation, transmission, and distribution sectors to address the energy trilemma of affordability, reliability, and sustainability. Equitable distribution of market risks is paramount, lest we risk derailing India's energy transition and sustainability of its power sector.

Appendix 8B

Untapped Scheme Convergences for Promoting Renewable Energy in India

Sayantan Dey and Vinay Jaju

The government's enhanced support (Rs. 1.97 lakh crores) for various distributed renewable energy (RE) technologies over the past few years has led to a significant expansion of capacity (solar power capacity has increased by more than 11 times). For India's RE system to be strengthened, large public investments are also being made. A convergence between schemes will not only ensure the growth of renewable energy but also bring co-action between programmes with respect to implementation and will help in creating sustainable assets for the community.

Existing Renewable Energy Schemes from the Ministry of New and Renewable Energy

The Ministry of New and Renewable Energy (MNRE) began operations in October 2006 and is principally in charge of increasing the country's share of clean power produced by renewable sources like solar, wind, bio, hydro, and geothermal energy. Its goal is to make energy available, inexpensive, and accessible to everyone.

Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM) – The Ministry began its flagship programme, the PM KUSUM, in 2019. Its goal is to decarbonize the agriculture industry. The goal is to solarize 10 lakh agricultural pumps that are connected to the grid; as a result of this programme, the government hopes to add 25.75 GW of solar power by 2022.

Small Hydro Power Program: The scheme's goal is to set up modest hydro structures in states and IPPs to attain a capacity of 6000 MW by 2022. The government offers financial help for the renovation of the current infrastructure in addition to supporting new initiatives.

National offshore wind energy policy: India has a large potential for utilizing offshore wind energy because of its 7600 KM of coastline. The MNRE has a goal of installing 5 GW of offshore wind by 2022 and 30 GW by 2030.

NNBOMP (New National Biogas and Organic Manure Programme): To supply clean cooking fuel for kitchens and other thermal and small power needs of the agricultural community, the NNBOMP was launched. Government grants are made available to both households and states.

Need and Possibility of Scheme Convergence

Besides the ground-mounted RE, driven by MNRE, there is a huge potential for RE to be taken up for livelihood at the tail end of the grid through Micro Grids and direct user appliances. Linking adoption of RE to livelihoods is critical for promoting innovative and sustainable infrastructures at scale. To enable a market-oriented ecosystem and draw private sector investment for the deployment of dependable and fairly priced distributed RE-based livelihood applications that can lower the carbon footprint of the agriculture and MSME sectors, MNRE is pursuing interministerial scheme convergence. Various ministries, such as the Ministry of Agriculture and Farmers' Welfare, the Ministry of Micro, Small and Medium Enterprises, and the Ministry of Textile, are implementing various schemes that support livelihood directly or indirectly. Financial assistance in the form of credit linkage and direct subsidy is available which can ensure the growth of the RE (on grid and off grid). Some such schemes are mapped next.

Direct Subsidy Schemes

Agriculture Infrastructure Fund by Ministry of Agriculture and Farmers' Welfare: Aiming to increase post-harvest management infrastructure and community farming assets through financial support and incentives, this initiative aims to generate a medium-to-long-term debt financing facility for investment in viable projects. Projects to fund agriculture infrastructure at farm-gate and aggregation sites would be given a financing facility worth Rs. 1,000,000 crores (Primary Agricultural Cooperative Societies, Farmers' Producer Organizations, Agriculture entrepreneurs, Start-ups, etc.). Under this scheme, there is also a provision to converge with other schemes like PM formalization of Micro Food Processing Enterprises (PMFME) and *Pradhan Mantri Krishi Sinchayee Yojana* (PMKSY). This could help the farmers adopt distributed RE technology.

RKVY (Rashtriya Krishi Vikas Yojana) by Ministry of Agriculture and Farmers Welfare – A multisectoral scheme, RKVY, provides financial support to various sectors like Horticulture, Dairy, Fisheries, and Agriculture Financial support of the order of Rs. 10,433 crores for 2022–2023, offered for developing cold storage, processing units, chilling machines, solar pump sets, could be used to scale up Distributed RE Projects.

Entrepreneurship Development Schemes

Micro Units Development and Refinance Agency (MUDRA) Scheme by Ministry of Home Affairs – Convergence with the MUDRA scheme is relevant where solar energy systems and appliances cost less than Rs. 10 lakhs. These include refrigerators, digital service centres (printers, photocopiers, and laptops), crafts and textiles (sewing machines, hammers with power, and machines for manufacturing rope), tools for farm-based agriculture and animal husbandry, and small agro-processing units (farm-based solar-powered equipment – hydroponics, bio-fermenters, sprayers, and mills for grinding flour and chillies). Some interest subsidies are available for *Shishu* loans (smallest category). There are loans in the *Kishore* and *Tarun* categories for solar-powered livelihood solutions too.

10,000 Farmer Producer Organisations (FPO) Program by Ministry of Agriculture and Farmers Welfare – The 10,000 FPO scheme promotes the convergence of several schemes with the principle that projects funded by this financing facility may use any grant or subsidy available under any current or future scheme of the central/state government. Agricultural, allied, and off-farm industries are the program's thrust areas. Through equity grants and credit guarantee fund programmes, the government helps farmers expand their markets and use technology. Appropriate nudges may encourage the adoption of decentralised RE technology.

Self Help Group (SHG) Scheme by Ministry of Rural Development: Since its inception, the SHG Scheme has grown exponentially in terms of providing financial support to underprivileged communities. Recently, the Central Government has released Rs. 1625 crores of funds to SHGs, in addition to Rs 25 crores as seed money under the PMFME scheme. With over 4 lakh SHGs in India, providing financial support through this scheme for establishing green systems for business will be a significant breakthrough.

Credit Linked Capital Subsidy Scheme by Ministry of Small Scale Industries – The Scheme's goal is to make it easier for MSEs to upgrade their technology by offering a 15% upfront capital subsidy (on institutional financing up to Rs. 1 crore that they have accessed) for the introduction of established and enhanced technology in the designated 51 sub-sectors and goods. RE-based technology could be encouraged.

Ministry of Textiles – The Pradhan Mantri credit scheme for power loom weavers and solar energy scheme for power looms are salient schemes where RE is promoted. Under the solar energy scheme for power loom capital subsidy of around 50–90% on the upfront cost is being provided. Under the Pradhan Mantri credit scheme for power looms launched in 2017, the government provides a 50% subsidy for solar/hybrid charkha, solar looms, and solar sewing machines.

9 Industrial Policy 2.0

Policy Space and Decarbonisation

Mritiunjoy Mohanty, Saon Ray, and Naini Swani

With the passage in the US Congress in 2022 of $280 billion US Chips and Science Act (to recoup technology leadership in the manufacture of IC chips) and the $370 billion in subsidies for clean energy in the Inflation Reduction Act (to try and emerge as a leader in green technology), industrial policy, as a Financial Times editorial notes, is back in fashion in the USA (*The US Chips Act Becomes a Christmas Tree*, The FT Editorial Board, *Financial Times*, 5 March 2023). In response, the EU has come up with a proposal, currently at the draft state, to match the clean energy subsidies built into the US Congress's Inflation Reduction Act 2022, sparking a huge internal debate around the use of subsidies to attain clean energy goals (*EU Liberals Battle Big State Role in Plans for Green Economy*, Alice Hancock, Sam Fleming, Javier Espinoza, Andy Bounds, *Financial Times*, 13 March 2023).

Revival of Industrial Policy

Way before these landmark US legislations, however, industrial policy has seen a revival in both policy-making and academic circles. As Stiglitz et al. (2013), Haggard (2015), and Wade (2015) among others note, in policy-making circles, the revival of industrial policy was sparked by the 2008 financial crisis and the Great Recession that followed in its aftermath, as economies sought greater policy space. Perhaps what is equally noteworthy, today industrial policy is as likely to be practiced by developed as developing countries.

Empirically validating the increased use of industrial policy after the Great Recession, Juhász et al. (2022), using text-based analysis and methodological advances in empirical economics, establish "a clear upward trend for instances of industrial policy over our study period, expanding from 462 in2009 to more than 1000 in 2018" (p22). Equally important, given that normally industrial policy is discussed in the context of developing countries creating policy space to enable catch-up (see, for example, List (1856), Gerschenkron (1962), Amsden (1989), Reinert (2007), Wade (2015) Mathews (2016)) and Juhász et al. (2022)), they also establish that today it is developed countries that are as likely if not more to use industrial policy to achieve policy-making goals.

According to their analysis, the following countries are the top 20 users of industrial policy in the period 2008–2019, ranked by intensity of use; i.e., Germany is the most intensive user of industrial policy over this period: 1. Germany, 2. Japan, 3.Brazil, 4. USA, 5.Canada, 6.Russia, 7.India, 8. Switzerland, 9. Saudi Arabia, 10. Australia, 11. China, 12. UK, 13. Italy, 14. Spain, 15. South Korea, 16. France, 17. South Africa, 18. Belarus, 19. Turkey, and 20. Poland, (see Figures 9.5a and 9.5b, p31, in Juhász et al.

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(2022)). It is noteworthy that 11 out of the top 20 users are rich countries (according to the World Bank's 2010 current USD GDP per capita classification). Indeed, only five (Russia, India, China, S. Africa, and Belarus) are classified as lower-middle- or upper-middle-income countries. Therefore, as Juhász et al. (2022) conclude in this regard, "This pattern suggests one potential correlate of what type of countries engage in IP: *income*" (p23, emphasis added; IP is an acronym for industrial policy in the Juhász et al. paper).

Industrial Policy: A Reassessment

The revival of industrial policy within the economics discipline noted above is all the more remarkable given that despite its long and often successful history of use (see for example Johnson (1982), Zysman (1985), Amsden (1989), Wade (1990), Chang (2002), Reinert (2007), Haggard (2015), Mathews (2016) and Cherif and Hasanov (2019)), it has also remained controversial, particularly among mainstream economists – see for example Anne Krueger's celebrated contributions on the inefficiencies related to rent-seeking behaviour (1974) and on government failure (1990). Hsieh and Klenow (2009) is a more recent empirical re-statement of the Krueger rent-seeking related inefficiency hypothesis. In addition, using cross-country growth regression models, it has been argued that successful instances of industrial policy referred to above, such as the Asian "miracle economies" (South Korea, Taiwan, etc.) are statistical outliers with little policy-relevant informational content (see for example Easterly (1995)). As Cherif and Hasanov (2019) note, "Perhaps the consensus view among many economists is that industrial policy usually fails, so any resurrection of these ideas is taken with great skepticism" (p9).

Be that as it may, revival there has been in academic research as well, both reassessing past instances of the use of industrial policy and advocating its relevance in the current context. Within economics, new tools (for example, text-based analysis and machine learning) and methodological advances in empirical economics have led to a more granular understanding of the mechanics of industrial policy and thereby a reassessment of its outcomes. In addition, incorporating non-linear growth processes into the analysis has given it more theoretical and empirical heft.

As is well known, linear regressions suffer, among other infirmities, from endogeneity issues, making drawing causal inferences problematic (see for example Zhu (2022)). Little wonder Rodrik (2012) has argued that it is difficult to draw policy conclusions from linear-regression-based growth analysis. In this context, i.e., growth being characterised as a linear process, Cherif and Hasanov (2019) have argued that long-run growth is characterised by non-linear processes (particularly in the case of gross relative growth rates which are more relevant for catch-up) and that the Power Law[1] may be a better approximation of underlying tendencies (p16, p17). Using these, and given the fat-tail characteristics of power law distributions, they establish that this "would mean that the Asian miracles should not be dismissed and instead they would constitute an important source of information" (p17).

At the end of their cross-country analysis, Cherif and Hasanov (2019) conclude the following:

> We have come a full circle on income convergence toward the frontier and growth at the frontier. Producing sophisticated products provides productivity gains, spillovers, and other positive externalities needed to catch-up. At the same time, producing sophisticated products requires high R&D spending and innovation to keep up with

> the frontier. High spending on R&D by large domestic firms in high tech areas early on suggests a path to achieving high and sustained growth. (p50)

Cherif and Hasanov (2019: p50) go on to argue that Asia's miracle economies such as Taiwan and South Korea followed this path and that industrial policy was central to that growth strategy.

Finally, the new sectors in which economies have been successful in becoming internationally competitive using industrial policy are those in which they have relatively high revealed comparative advantage rather than those dictated by comparative advantage (either of the Ricardian or Hecksher–Ohlin type) (see Cherif and Hasanov (2019: pp36–39), Juhász et al. (2022: p26)). Similarly, Felipe (2015) argues that the key to achieving higher income and growth lies in finding niches in industrial products with high-income elasticities and modern services. Coming from a different tradition within economics, but with a focus squarely on non-linear processes, the nature of competition and technology-driven dynamic capabilities of firms, Andreoni and Roberts (2022) have argued that in dealing with network effects that characterise platform technologies in a manner that optimises growth and efficiency, it is of vital importance to devise a regulatory framework that brings together industrial policy and competition policy. Also see Mathew (2016) on the salience of non-linear growth processes (Kaldorian cumulative causation) and industrial policy.

The performance of South Korea's Heavy and Chemical Industry (HCI) drive in 1970s, which at one point had become the poster boy of industrial policy-driven inefficiency, has been reassessed as well. Lane (2021) uses spillover effects to establish that targeted sectors performed significantly better than those that were not. Similarly, Kim et al. (2021) and Choi and Levchenko (2022) also analyse the industrial policy effects of South Korea's HCI drive. Both papers note that growth effects persisted well after industrial policy subsidies were removed. Kim et al. (2021) also note that non-targeted industries gained from a lowering of input costs as a result of production efficiencies of the targeted industries. Kim et al., however, also note that whereas targeted industries saw labour productivity and plant-level TFP rise, they did not raise aggregate regional TFP, suggesting some misallocation of resources. They argue that had this misallocation been avoided, gains would have been significantly higher.

Criscuolo et al. (2019) look at the employment effects of the EU-funded investment subsidy programme administered by the UK Govt. called Regional Selective Assistance. They conclude that

> there is an economically large and statistically significant program effect: a 10 percentage point increase in an area's rate of maximum investment subsidy causes about a 10 percent increase in manufacturing employment and a 4 percent decrease in aggregate unemployment. These effects are *underestimated if endogeneity is ignored* … we show that these positive effects are not purely due to substitution of jobs toward eligible areas and away from neighboring (ineligible) areas. (p49) (emphasis added)

Finally, and important from our standpoint, Aghion et al. (2015), using a large Chinese data set of medium and large-sized firms between 1998 and 2007, study the effects of industrial policy and establish the following: "when sectoral policies are targeted toward competitive sectors or allocated in such a way as to *preserve or increase competition*, then these policies *increase productivity growth*" (p2; emphasis added). In other words, "there can be complementarity between competition and suitably designed industrial policies in inducing innovation and productivity growth" (p1).

Therefore, on the basis of the recent reassessment of industrial policy, as a result of new techniques in data analysis and methodological advances in empirical economics, it would be reasonable to conclude that appropriately designed industrial policy has significant and lasting positive output and employment effects, reiterating an older literature which has argued for both its necessity and its effectiveness. In line with this earlier literature, the newer one has also established that industrial policy makes possible catch-up and remaining at the technology frontier, creating technologically dynamic and competitive firms and industries. Equally importantly, as Aghion et al. (2021) have argued, industrial policy, by helping create sophisticated export industries and innovative firms that are both domestically and internationally competitive, contributes towards the creation of reasonably fair and inclusive markets, i.e., markets with low-income inequality and high and sustained growth.

While recognising that industrial policy has the potential to enable all this, it is also worth emphasising that today catch-up for developing economies is made much more complicated because developed countries are as likely to use it (industrial policy) systematically and extensively, as we have noted earlier, which is to say that industrial policy today is as likely to be a cause of growth divergence between developed and developing countries. This has serious implications for the diffusion of technological change induced by the need to cope with global warming, given that this knowledge, barring a few exceptions, is more likely to be generated in advanced economies given their extensive use of industrial policy.

Making Industrial Policy Rents Contingent and State Capacities

One of the reasons mainstream economics views industrial policy with "skepticism" is the supposed inefficiencies related to rent-seeking behaviour (see Krueger (1974)) and the related literature on government failure (see Krueger (1990)). Clearly in instances of successful use of industrial policy noted above this behaviour was controlled or tamed. However, given that these were dismissed as outliers, the dominant understanding was that industrial policy outcomes are normally marred by inefficiencies related to rent-seeking (see for example Hsieh and Klenow (2009)).[2] In contradistinction, as we have already noted, Cherif and Hasanov (2019) have established that the growth experience of Asian "miracle" economies has useful policy-relevant informational content.

More than inefficiency losses due to rent-seeking which in the static case tend to be small (see endnote 3), the more important issue is that *whereas market-created rents*[3] *(or quasi-rents) are incentives for accumulation and are* ex post, *state-created rents are* ex ante. As Mohanty (2000) has argued,

> [w]hen the state creates rents, they are not only supposed to be an incentive for accumulation but are also supposed to help achieve some policy objectives the state may have in mind (say in subsidising technological learning the state hopes to be able to foster industries which will help maximise the long run rate of growth). *It is this dual objective of state-created rents which is the source of potential problems. Rents are in this case, as it were, received ex ante to the fulfillment of the state's objective in allocating the rent.* That is the accrual state-created rents are not contingent upon

> the state's objective(s) being fulfilled and hence may be frittered away (say, a firm may refuse to grow out of infancy) … leaves the state with an enforcement problem … notice that making a *state-created rent contingent is a matter of policy design or institutional structure and not an a priori theoretical flaw in the argument*. (p11-12; emphasis added)

The inability to make state-created rents contingent can have dynamic consequences, which as we have already noted tend to be large (see endnote 3; as well as, for example, Mohanty (2000)).

The more relevant question therefore is that if a government chooses to implement industrial policy and thereby *necessarily creates rents*, does it have the *institutional mechanism to make those rents contingent on its objectives being fulfilled*? And the growth experience of France, Japan, South Korea, Taiwan, Brazil, and China tells us that indeed they do. Oftentimes these states have used leverage over the financial system to make state-created rents contingent (see for example Zysman (1985), Amsden (1989), Wade (1990), Chang (1994), Mohanty (2000), Andreoni and Tregenna (2022)). In addition to leverage over the financial system what development experience also tells is that domestic and international competition may be important ways of making state-created rents contingent (see for example, Amsden (1989), Wade (1990), Aghion et al. (2015), Cherif and Hasanov (2019), Aghion et al. (2021), and Andreoni and Roberts (2022)).

Be that as it may, addressing the issue as to why industrial policy succeeds in some countries and fails in others opened up debate around the role of the state and state capacities to promote development (see for example Evans et al. (1985), Evans (1995), Khan and Jomo (2000), Kohli (2004), Rodrik (2007), Rodrik (2014), Haggard (2015), Andreoni and Chang (2019), Andreoni and Tregenna (2020), and Andreoni and Roberts (2022)). Therefore, our understanding of the architecture of successful industrial policy as well as its institutional and political economy underpinnings is much better today than it was a couple of decades ago. Of course, the fact that we know this does not imply that these conditions and institutional architecture will necessarily obtain. These ultimately will be determined by the specific institutional political economy of the country in question. At least, however, our knowledge of necessary conditions is much better. And each country choosing to use industrial policy can then cut its cloth according to its coat.

The Entrepreneurial State

A lot of the discussion above has happened in the context of market failure, i.e., when markets misallocate resources as a result of the presence of negative or positive externalities.[4] Mazzucato (2013), using the USA's technological evolution and trajectory, introduces an entirely new dimension to our understanding of the institutional underpinnings of successful growth strategies by defining the notion of an "entrepreneurial state." An entrepreneurial state is one which invests in basic and allied sciences research and research infrastructure, thereby leading to a lowering of "Knightian uncertainty,"[5] particularly in the context of technological change. This reduction in Knightian uncertainty in turn aids the risk-taking appetite of the private sector and induces it to invest in new technologies and technological innovation in goods, services, and processes flowing from publicly financed basic science research. Finally, she describes technological change as being "path dependent and cumulative with a 'fat-tailed distribution' (Mazzucato (2016))". Therefore, she argues that "rather than having an equally likely probability of occurring at any time, innovation occurs in waves and clusters, a feature emphasised in the work of Schumpeter" (Mazzucato (2016)).

Perhaps equally importantly, going beyond market failure, Mazzucato demonstrates the state's role in *creating and shaping new markets and sectors*. In Mazzucato's framework, public institutions and the private sector form systems of innovation where the innovation process includes feedback loops between market and technology, applications and science, and policy and investment. Mazzucato highlights that the innovation required for growth is collective, uncertain, and tacit. Given the inherently unpredictable nature of innovation, the state, in its entrepreneurial role of lowering Knightian uncertainty, through long-term public investments in research capabilities and institutions, goes beyond the redressal of market failure and shapes the market's direction and the economy's dynamic technological trajectory (Mazzucato (2013) (2016)). Therefore, as she notes in Mazzucato (2016), "The winning IT revolution was 'picked' in the US in just the same way that the green revolution is being chosen by some countries today."

For developing a green economy, Mazzucato highlights the need for organizations that not only fix market failures but proactively create and shape markets. She states that the question of which direction the market should take requires extensive democratic debate. Acknowledgement of the critical and widespread role of the state should also stir the reimagination of indicators and tools of policy evaluation beyond static cost/benefit analysis. Institutional design for the green economy should promote risk-taking capacities in public organizations to respond to contemporary challenges. Importantly, the institutional design should also incorporate the equitable distribution of rewards for organizations across a value chain (Mazzucato (2016) (2021)). Finally, outside of the important task of lowering Knightian uncertainty, and bringing us back to the issue of leverage over financial systems noted earlier, Mazzucato also stresses the *historical and continuing* role of state investment banks in catalysing technological change. As she notes in Mazzucato (2016) in financing renewable energy projects "The four most active banks are (in order) the China Development Bank, the German KfW, the European Investment Bank (EIB) and the Brazilian BNDES." And, as she has argued elsewhere,

> *Governments play a critical role in catalysing and coordinating both public and private investment around common goals, not least transitioning to a green economy.* Industrial strategies must not be about subsidizing specific sectors but about catalysing transformation across all sectors in order to meet social goals: climate action requires sectors as diverse as digital, nutrition, transport and construction to innovate and collaborate.
>
> (Mazzucato (2021: p93) emphasis added)

Towards a Green Economy Framework for Decarbonisation and a View on India's Industrial Policy

Sound green growth policies require policies that fully internalize environmental costs. Hallegatte et al. (2012) provide the arguments for the trade-off between environmental protection and economic production. The production function (Y) is given by the equation

$$Y = \psi(P_E) f\left(A(P_E), K(P_E), L(P_E), E(P_E)\right)$$

where Ψ is the efficiency of the production function and lies between 0 and 1. A is the available technology, K is capital, L is labour, and E is environment.P_E is the effort towards the environment.

The trade-off arises due to at least three reasons:

(a) It can reduce productivity (A) by causing producers to use more expensive or less productive technologies. In the case of India, Ganesan et al. (2014) discuss the higher costs of solar, which has to be seen in comparison to the global avoided climate change.
(b) Result in the early retirement of physical capital (K) if capital is based on polluting technologies. This can take two forms: (i) either a decrease in capital or (ii) an increase in capital depreciation. Apart from direct costs, there is an increase in investment needed to replace retired capital. Maamoun et al. (2022) estimate the cost-saving potential of early retirement of coal plants to be $21 billion in the Indian context.
(c) increase the price of some goods and services and alter relative prices. This could have two outcomes: (i) change the structure of the demand or (ii) lead to a reduction in efficiency (Ψ).

Environmental policies can increase conventionally measured economic output if (Hallegatte et al., 2012):

(a) There is an increase in the effective quantity of production inputs i.e., K, L, and E.
    (i) L can increase through improved health and (ii) K can increase through well-managed natural risks e.g., lower K losses from natural disasters.
(b) There are productivity gains by correcting market failures affecting the environment and enhancing the efficiency of resource use (Ψ).
(c) There is a shift in the production frontier by accelerating the diffusion of innovations, leading to an increase in A.

In India, post-independence growth was state led and coordinated through five-year plans. However, in 1991, the Indian economy was liberalised after three decades of largely state-driven industrialisation (Singh, 2008). Post-economic liberalisation, trade, and industrial policy have focused on the reduction of import tariffs, increase in foreign direct investment, and enhancing Indian firms' participation in global supply chains. The critical changes in industrial policy during economic reforms included the delicensing of industrial activities and the expansion of private enterprises into sectors previously reserved for the state (see for example Aggarwal (2019), Chaudhuri (2021), Mani (2021) and Swathysree (2021)). Since 1991 economic reforms, coherent industrial planning in India has withered, with the growing influence of sectoral trade policies, as opposed to consolidated, cross-sectoral national planning (Mehrotra, 2020). For a critique of India's industrial policy from an institutional perspective and arguing that a lack of institutional coordination constrains its effectiveness see Swathysree (2021).

As highlighted by Mazzucato, green industrial policy is recognised as different from conventional industrial policy and requires different policy instruments and a more robust engagement of the state in markets (Swain, 2014). In India, concerns about energy access, energy security, and impetus provided by international climate negotiations have been the key drivers of national efforts towards decarbonisation. India's steps towards greening its economy appear most starkly in actions taken to promote renewable energy across different industrial sectors, including power generation, transport, agriculture, buildings, etc. Renewable energy promotion is undertaken through enabling provisions in the overarching policies governing the electricity sector in India, including the National Electricity Policy (2005), National Tariff Policy (2006), Integrated Energy Policy (2006), Indian Electricity Grid Code (2010), and the National Missions envisaged under the National Action Plan for Climate Change (NAPCC), see GOI (2008). Within this overarching policy framework, India has furthered renewable enhancement through various specific measures, including financial incentives, preferential tax treatment, R&D, demand stimulation, and manufacturing-linked incentives (Ganesan et al., 2014).

While India is taking essential strides towards renewable energy, researchers have expressed concerns about the gaps in the institutional arrangement needed for economy-wide decarbonisation. It is argued that the institutions focusing on decarbonisation in India have historically privileged developmental aims over emissions reduction, with an express shift towards convergence in the two goals being recognised for the first time in the NAPCC, see GOI (2008). The institutional arrangement arising from this approach entails nodal climate bodies across different sectors, with weak inter-ministerial and sectoral coordination (Pillai and Dubash, 2021). Dubash et al. argue that the success of renewable energy initiatives in India is owed significantly to bureaucratic champions who leveraged the promise renewables held for energy security. However, they did not create robust mechanisms for personnel capacity building or grants for subject experts to effectively deliver on the intent of decarbonisation. As a result, post the exit of the bureaucratic or ministerial champions, the climate institutions of the country saw a decline with a shift back to a sectoral focus. Presently, measures under various missions are undertaken through sectoral ministries, with insufficient inter-ministerial coordination. However, the prevailing institutional structure lacks equitable distribution of costs and benefits (see Pillai and Dubash (2021)). Therefore, as we move towards effective decarbonisation a reconfiguration of industrial policy is required with clear institutional underpinnings and focus such that goals of both development (including technological change) and emission reduction are met in a clear, time-bound manner.

Notes

1 "Power law distributions exhibit fat tails such that extreme events (multiples of standard deviations) are much more likely than with normal distributions" (Cherif and Hasanov(2019: p19)). See also the Wikipedia entry on Power law at https://en.wikipedia.org/wiki/Power_law. See West (2017) for an exploration of the ubiquity of Power Law in physical and economic processes and the related increase in complexity.

2 That is not to say inefficient rent-seeking has not been critiqued. See Fisher (1985) for the onerous assumptions under which it would hold. See Brooks and Heijdra (1989) who argue that it is not clear that the entire rent would be get dissipated away. Tullock (1989) establishes that waste from rent-seeking behavior is very small. Within a general equilibrium framework Varian (1983) has argued that rent-seeking costs are overstated. See also Leininger and Yang (1994) and Mohanty (2000). From outside the neoclassical paradigm see Samuels (1971), Samuels and Mercuro (1984) and Barzel (1985). As Brooks and Heijdra (1989) and Brooks, Heijdra and Lowenberg (1990) point out, rent-seeking costs are much more significant within a dynamic framework. It is that aspect of the problem that is addressed by Cherif and Hasanov (2019) and Andreoni and Roberts (2022), among others.

3 On market-created rents see for example Buchanan (1980) and Khan and Jomo (2000).

4 In the case of negative externalities because all costs are not internalised, firms tend to over-invest, from the standpoint of the overall economy. In the case of positive externalities because profits streams are not internalised firms tend to under-invest.

5 Named after economist Frank Knight (1885–1972) who was the first to distinguish between uncertainty and risk, Wikipedia defines it as follows: “Knightian uncertainty is a lack of any quantifiable knowledge about some possible occurrence, as opposed to the presence of quantifiable risk.” https://en.wikipedia.org/wiki/Knightian_uncertainty

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Appendix 9A

In-Situ Power Generation in Urban Spaces for End Users

Arunava Ghoshal

Five megacities alone (Delhi, Mumbai, Kolkata, Chennai, and Bengaluru) consume around 18.8 Gigawatt of power daily (which is 47% of India's rooftop solar target). Without being overambitious, for a start, around 1% of the area of the metro cities can be utilised under the On-Grid Solar Power system and equipped with net metering every year till 2026. At this rate, 4–5% of each megacity would be under solar panels thus generating the lion's share of their electricity requirement.

A panel that needs only around 100 square feet of shadow-free space can generate about 120 kilowatt-hour per month. In India, a typical home uses 260 kilowatt-hour per month. However, since this varies greatly across cities, a working estimate based on this author's consumption of 180 kilowatt-hour of energy per month during peak summer months (April-September) of 2021 and 2022 has been considered. This would require around 150 square feet of shadow-free space. This indicates that, on an average, small four-storied apartments are capable of generating enough power for household consumption.

Also, an on-grid network/infrastructure would be a better option for urban household electrification than an off-grid system that relies on batteries. Monthly Net metering would allow consumers who generate some or all of their electricity and to use that electricity anytime, rather than when it is generated.

Rooftop solar panels are up to 79% cheaper today than in 2010. A 1.5 kilowatt solar system may cost between Rs. 90,000 (On-grid) to Rs. 160,000 (Off-Grid/Hybrid). A typical vendor provides a 1-year warranty on the solar system, 2 years on the inverter, 5 years on the solar battery, and 25 years on solar panel performance. A middle-class urban family, however, might find an upfront investment challenging. Further, for a firm supplying solar rooftop systems, securing industrial or commercial consumers is more lucrative.

Thus, in situ power generation for urban end users would need appropriate policies to achieve scale. In addition, the following initiatives could complement rooftop solar

1) Solar-wind hybrid model for power generation in high-rise buildings.
2) Utilising space below the rooftop solar panel for Agri-voltaic farming and planting Air Purifying plants.
3) Replacing Liquefied Petroleum Gas with Solar Cookers (in standalone urban houses) or Electric Cooking Appliances (in multistorey residential apartments) and gradual adaptation of low-wattage everyday appliances.
4) Mandating the installation of Solar Panels in secure areas like offices of multinational companies.
5) Introducing Distributed Renewable Energy-based charging infrastructure for Electric Vehicles in existing fuelling stations.

10 International Experiences on Just Energy Transition Planning and Lessons for India

Madhura Joshi and Swati Dsouza[1]

The world is facing poly-crises: recovering from a global pandemic, rise in economic insecurity (recession and debt crisis), food security concerns, and rise in geopolitical tensions because of the Russian invasion of Ukraine. At the same time, impacts of climate change are becoming increasingly visible across the world with frequent droughts, episodes of devastating floods, raging forest fires, and record-breaking extreme temperatures. Numerous studies have highlighted the urgency to reduce greenhouse gas emissions to avoid more disastrous climate hazards. The recent IPCC AR6 assessment report (IPCC WGIII 2022) and UNEP's Emission Gap Report 2022 (UNEP 2022) highlight that the window to restrict global temperature rise to 1.5° C is rapidly narrowing.

According to the International Energy Agency (IEA), achieving net-zero emissions by mid-century will need a systems' level change – ensuring that both newly built infrastructure and old energy systems are transitioned towards clean energy (IEA 2022c). Phasing down fossil fuels will require massive economy-wide changes. The implications of such transitions will be higher on economies dependent on fossil fuels, particularly coal. As developing countries meet their SDG goals, accelerating investments in clean energy, phasing down fossil fuels, and planning for Just Transitions could help in addressing multiple objectives of a country – energy security, economic competitiveness, meeting developmental goals, building resilience, and fighting climate change. These initiatives could also help in mitigating the impacts of the poly-crises.

Every technological shift creates winners and losers. Thus, the concept of Just Transition centres around minimising the negative impacts of transitions and empowering communities and economies dependent on fossil fuels. Even if these transitions take place 20 years hence, such a planning exercise needs to start now to avoid future lock-ins of resources in high-carbon infrastructure. And more importantly, to prevent social disruptions from a forced transition.

This chapter presents an overview of the global phase-down trajectory, briefly discusses the history of Just Transition definitions and frameworks developed globally, followed by a look at specific case-studies. It concludes with key takeaways for India.

Section I: Tracking Global Phase Down Trajectory

Reaching net-zero emissions by mid-century will require phasing down all fossil fuels. While trajectories may vary slightly, studies (IPCC, IEA) project the need to rapidly phase down coal, followed by a phase down of oil and gas. For instance, according to IPCC's 6th Assessment report, scenarios that limit warming to 1.5°C with no or limited overshoot project a decline of 95% in coal, 60% in oil, and 45% in gas use by 2050 compared

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to 2019 levels; and low-carbon sources produce 93%–97% of global electricity by 2050 under 2°C and below scenarios (IPCC WGIII 2022). The move towards net-zero emissions starts with rapid decarbonisation of the electricity sector and increasing electrification of energy demand across sectors.

The IEA's net-zero study also points to falling fossil fuel demand across different scenarios. Under the Announced Pledges Scenario (APS),[2] global coal demand drops by 70%, and oil and gas around 40% by mid-century (IEA 2021). This is a result of meeting NDC pledges (announced and planned) which include decline in fossil fuel consumption and shifting to alternate fuels (hydrogen, etc.) in hard-to-abate sectors and investing in carbon-capture technologies such as CCUS. While under the net-zero emissions[3] by 2050 Scenario, global coal use falls by 90% by 2050 and complete decarbonisation of the power sector is accomplished in advanced economies by 2035 and worldwide by 2040 (IEA 2021). Phasing down coal, however, is not easy.

Section II: Key Trends

The first step towards achieving net-zero is stopping new unabated fossil fuel investments, with coal assets facing risk this decade (before 2030), and oil and gas by mid-century (IPCC WGIII 2022). The focus on coal is important because it is the single biggest source of CO2 emissions, has the biggest share in global electricity generation and cost-competitive alternatives are few. We discuss five broad global trends that highlight a decline in the coal pipeline, increase in no new coal commitments, efforts to decarbonise the power sector, the importance of renewables in strengthening energy security, and emerging finance mechanisms for energy transitions.

- **Declining Pipeline:** Despite recent increases in coal use, global demand has plateaued for a decade at or close to its highest levels (IEA 2022c). While the trajectory of phase down is not linear and will differ between countries, globally, there are efforts to reduce reliance on coal. Recent trends point towards a global retreat of new coal power plants – a key step in the pathway towards net-zero emissions and avoiding stranded assets. As of 2021, the pipeline of global coal projects contracted by 76% since the Paris Agreement in 2016 (Littlecott et al. 2021).
- **No New Coal:** 98 countries have committed to no new coal or had considered coal in the past decade but no longer have active projects in their pipeline (Senlen et al. 2023). Only 33 countries have proposed new coal plants. However, even amongst this group of countries, since June 2021, the scale of the proposed pre-construction projects has declined.
- **Decarbonising the Power Sector:** The move towards phasing down fossil fuels in the power sector was strengthened by the commitment made by the G7 to predominantly decarbonise its electricity sectors by 2035 (G7 Germany 2022). The Russian invasion of Ukraine in early 2021 and the sanctions that followed resulted in energy crisis in Europe with global ramifications on fossil fuel supply and massive price volatility. While this has led some countries in Europe to revive coal plants for back up generation, political commitments suggest that these will hopefully be short-term measures.
- **Renewables for Energy Security:** Increasing renewables are seen as the route to strengthening energy security. This is also highlighted in the 2022 G7 communique which stresses that accelerating energy transition and achieving a net-zero power system are priorities for both climate and energy security reasons. For instance, Germany

plans to extend the reserve status of coal-fired power plants till March 2024. At the same time, it has strengthened its commitment with a target to source at least 80% of its power requirements from renewables be 2030 (Kerstine Appunn 2022). Similarly, Portugal has committed to securing 80% of its power supplies from renewables by 2026 – 4 years earlier than its previous target (Goncalves 2022). These developments highlight that along with a coal phase out, these countries are preparing for a broader fossil fuel phase down.

- **Financing Mechanisms:** Across countries, different mechanisms are being explored to fund energy transitions. Apart from reallocating existing budget items and programmes, governments, multilateral development banks, development finance or green finance institutions, and private finance are working together to develop financial or market-based measures to incentivise mine and power plant owners to retire their coal assets. These measures include technical assistance/support (e.g., Coal Asset Transition Accelerator), transition support (Climate Investment Fund's Accelerated Coal Transition fund (CIF 2022), EU Just Transition Fund), buy outs of plants (ADB's Energy transition Mechanism), monetising emissions reductions, auctions, ratepayer-backed securitisation, concessional debt or refinancing, and sustainability-linked bonds (IEA 2022c). Just Energy Transition Partnerships (JETPs), supported by the G7 countries, are an emerging, historic international partnership to develop targeted support for just energy transitions.[4] Each JETP process is likely to be unique, with priorities and pathways determined nationally involving multiple actors and high-level diplomatic buy-in by G7 countries backed by initial finance commitments. These are emerging as a new approach to finance energy transitions.

Section III: Defining Just Transition

Global transitions away from a carbon-intensive economy will not be easy. Planning for and ensuring Just Transitions will be critical. The International Labour Organisation describes Just Transitions as a process "towards an environmentally sustainable economy, which needs to be well managed and contribute to the goals of decent work for all, social inclusion and the eradication of poverty" (ILO 2015). As a concept, the term "Just Transition" originated in the labour movement in the 1970s and 1980s when Tony Mazzochi, an American labour leader, proposed a superfund for workers who were at risk of losing their jobs. Over the decades, this perspective has broadened to include economic and social consequences, community resilience, and environment remediation as seen in the Silesia Declaration signed in Katowice (Silesia Declaration 2018).

Coal transitions require careful attention because of their deep linkages with employment and role in state-revenues. For example, in Germany, the lignite industry contributed 4.3% of the region's total gross value (BMWi 2019). In Colorado, the state's coal-fired power plants and coal mines paid an estimated USD 65 million in property taxes in 2019. When these coal facilities close, it would take nearly USD 2.75 billion in new commercial property value to generate the same value (CDLE 2020). The share of coal mining in the provincial GDP of East Kalimantan in Indonesia is 35%, while its share provincial employment is 8.6% (IEA 2022b).

Managing clean energy transitions will require involving multiple actors – local communities, trade unions, businesses, civil society, and different levels of government actors – and financial and technical support for developing social Just Transition packages, reskilling, creating new jobs and livelihoods, and developing alternate investment plans.

Recent international financial mechanisms mentioned above and international partnerships such as the Energy Transition Council launched in 2021[5] could help in supporting energy transitions. Such programmes can help in developing national decarbonisation pathways, develop a better understanding of the scale of investments required, and provide resources for implementing pilots and unlocking the scale of finance needed to support transitions.

Section IV: Mapping Just Transition Frameworks across the World

Past Transitions and Their Impact

Coal transitions in the past have been driven by a combination of factors including declining domestic demand, changes in relative prices of competing fuels, air pollution regulations, decreased competitiveness of domestic production, and productivity gains (IEA 2022c). Reactive policies or unplanned transitions have led to several negative consequences in the past. First, these resulted in substantial job losses. For instance in the UK, coal production peaked in 1913, while consumption peaked in 1956. At its peak, coal industry jobs in the UK exceeded 1 million or 7% of the total national employment. By the time of the miner strikes in 1984–1985, employment was 90% below its peak. In the Ruhr region in Germany, at its peak, the coal industry employed a little more than 600,000 producing 124 million tonnes (Dsouza 2021). The United States saw production peak three times, once in 1918, then in the 1940s after World War II and then once again in 2008. At its peak in 1923, the US coal industry employed 863,000 people, which decreased to 40,000 in 2020.

Second, the decline in production and jobs did not always result in policies to offset the negative impacts on the labour force, the local economy, and the environment. For example, in the US, the Appalachian Region commissioned a study in 2018 to study the impact of the decline, but it was after the actual decline had already happened in the 1960s. Similarly, in the UK, the Coalfields taskforce was constituted only in 1997, after the decline in production and job losses had already impacted the local economy.

Third, economic, institutional, and cultural resistance may delay transition and create unsustainable lock-ins. This may not be able to halt the decline. The provincial government in Ruhr, Germany attempted several re-industrialisation policies to protect the coal and steel industry in the 1970s including core industry cooperation; increased linkages between producers and consumers; consolidation via mergers; tax subsidies for the steel industry to use domestic coal; financial resources for social measures if layoffs were necessary; and, a special consumer tax from 1974 to 1994 on electricity-subsidised sales of domestic coal (coal penny). However, the decline of jobs and the coal industry continued. It took several decades and policy packages learning from mistakes to transition Ruhr from a hard coal belt to a knowledge-based economy with a thriving service sector (Arora and Schroeder 2022).

Current Just Transition Frameworks

Countries across the world, having learnt from past experiences, are exploring policies on Just Transitions that have certain common features (Figure 10.2):

- Who will be impacted: Defining coal/fossil fuel/transition workers and communities and carrying baseline surveys.

65 COUNTRIES ALREADY COMMITTED TO NO NEW COAL	33 COUNTRIES WITHOUT NEW COAL PROJECTS IN THE PIPELINE	33 COUNTRIES WITH PROPOSED COAL PROJECTS
OECD & EU: Austria, Belgium, Canada, Chile, Costa Rica, Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Poland, Portugal, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, United Kingdom	**OECD & EU:** Bulgaria, Colombia, Czech Republic, Norway, Romania	**OECD & EU:** Australia, Japan, Turkey, United States
Non-OECD: Albania, Angola, Azerbaijan, Brunei, Ecuador, Egypt, El Salvador, Ethiopia, Fiji, Grenada, Ivory Coast, Liechtenstein, Malaysia, Maldives, Marshall Islands, Mauritania, Mauritius, Montenegro, Mo rocco, Nepal, Niue, North Macedonia, Peru, Senegal, Singapore, Somalia, Sri Lanka, Tuvalu, Ukraine, Uruguay, Vanuatu, Viet Nam, Zambia	**Non-OECD:** Argentina, Belarus, Democratic Republic of Congo, Djibouti, Dominican Republic, Georgia, Ghana, Guatemala, Guinea, Honduras, Iran, Jamaica, Kosovo, Moldova, Myanmar, Namibia, Nigeria, North Korea, Oman, Panama, Papua New Guinea, Sudan, Syria, Taiwan, Taji kistan, Ukraine, United Arab Emirates, Venezuela	**Non-OECD:** Bangladesh, Bosnia and Herzegovina, Botswana, Brazil, Cambodia, China, Eswatini, India, Indonesia, Kazakhstan, Kenya, Kyrgyzstan, Laos, Madagascar, Malawi, Mongolia, Mozambique, Niger, Pakistan, Philippines, Russia, Serbia, South Africa, Tanzania, Thailan d, Ukraine, Uzbekistan, Viet Nam, Zambia, Zimbabwe
		TOP 6 COUNTRIES (90% OF THE GLOBAL PLANNED COAL CAPACITY)
		Next 5 countries (18%): India, Indonesia, Laos, Mongolia, Turkey
		China (72%)

Figure 10.1 Global Pipeline of Coal Projects.
Source: Senlen et al., 2023.

- What will be the impact: The total cost of transitioning workers, compensating fossil fuel asset owners for early retirement, reskilling, upskilling, economic diversification, etc.
- How to finance the transition: Reallocating existing domestic funds from budgets, creating new domestic funds, and raising additional funds through bilateral/multilateral programmes (JETP, ACT, etc.).
- How to govern: Institutional mechanisms such as an independent agency or commission to manage the transition process and engage different levels of the government and various stakeholders.
- Building bottom-up consensus: This has become an important pillar, particularly given fears of job loss and security benefits.

The IEA analysed that of the 21 countries that rank highest in the IEA Coal Transitions Exposure Index, only 5 countries (Canada, Germany, Korea, Poland, and South Africa)[6] which represent only 4% of the world's coal workers have announced, initiated, or implemented Just Transition policies (IEA 2022c). In the USA, the interagency working group on coal and power plant communities identified 25 impacted regions as priority energy communities based on direct coal-related jobs as a percentage of the total number of jobs in the region. The Inflation Reduction Act (IRA) in the USA strengthens this by defining (Raimi and Pesek 2022):

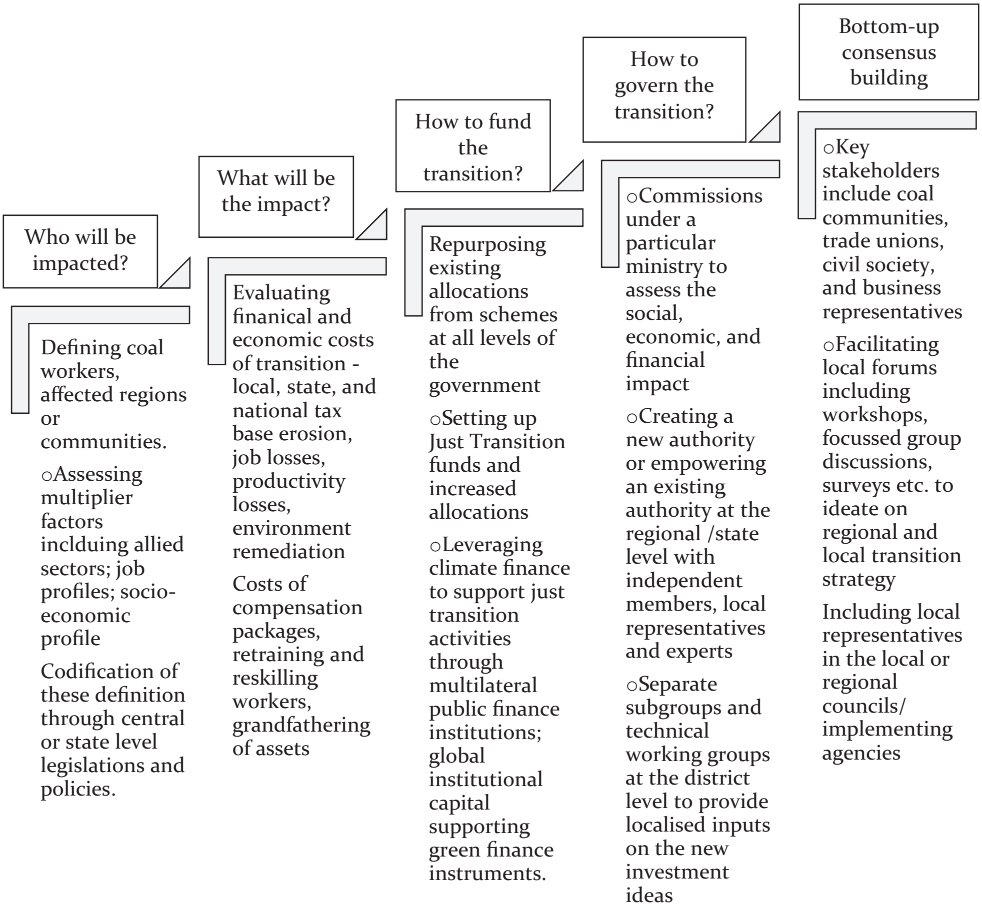

Figure 10.2 Framework of Just Transition Policies across Different Countries.

Source: Dsouza 2021.

- Brownfield energy communities: small parcels of pollution-contaminated land.
- Coal communities: any census tract where a coal plant has shut down since 2010 or a coal mine has closed since 2000.
- Jobs and tax revenue: metropolitan or non-metropolitan area where "0.17 percent or greater direct employment or at least 25% of local tax revenues [are] related to extraction, processing, transport, or storage of coal, oil, or natural gas," and unemployment is at or above the national average in the previous year.

In Germany, the government had conducted auctions to incentivise power plant owners to shut down and retire their coal plants earlier than technical closure dates.[7] Simultaneously, the government also announced adaptation payments for older workers in lignite mines and coal and lignite power plants, which would amount to a maximum of €5 billion by 2048.

Preparing and implementing Just Transition policies have undergone a vigorous process which includes the formation of a Just Transition taskforce or coal commission and/or multiple consultations with stakeholders including affected communities, labour unions, coal workers, asset company owners, local businesses, civil society, and local governments. In some countries (e.g., Germany), it was a top-down process with the central government forming a Just Transition Task Force/Coal Commission which convened meetings and focus group discussions between different stakeholders. While in countries like South Korea and the US, subnational governments such as Chungnam and Colorado, respectively, are leading the discussions on transition planning. Whereas in South Africa, discussions began through a bottom-up process, with coal unions and civil society taking the lead before it was picked by the national discourse.

Section V: Case Studies

1. **South Chungcheongnam-do (Chungnam) Province, South Korean: A Case Study on Subnational Planning:**

   Chungnam, the coal power heartland of South Korea, in 2018 called on the national government to phase out coal power and started working on plans to phase-out coal within its jurisdiction; Chungnam has a population of about two million. With 18 GW of coal-fired power plants, it has around half of South Korea's total coal capacity – 29 of South Korea's 57 coal plants are situated in the province – and it has the highest share (22% in 2019) of South Korea's total GHG emissions (PPCA 2022).

   Chungnam's emissions targets are more ambitious than the national ones. Chungnam is working towards faster transitions than the national South Korean national net-zero and coal phase-out goal of 2050 (Lee 2021). While the coal-to-clean transition story in Chungnam is still evolving, a look at the steps taken by the province helps in understanding their planning process.

   Political Leadership: The province engaged both national and international platforms to drive ambitious climate action. It has convened an annual international conference on coal phase out since 2017, and it was the first province in South Korea to join the Under 2 Coalition and the Powering Past Coal Alliance in 2018.[8] It declared climate change as an emergency in 2019 – a year before the national government, and it unveiled an ambitions carbon neutrality plan. In 2019, the province declared a climate emergency and made coal phase-out policies central to their 2045 Carbon Neutrality Strategy unveiled in December 2021 (Binnu Jeyakumar and Joojin Kim 2018). This includes early retirement of coal power plants and phase out of coal power generation. While not formally announced, the province is working on a 2030 coal phase-out target. The province has also acted as a domestic champion, urging the national and other provincial governments to step up climate action.

   Policy Levers: Provincial governments have limited control over the power plants developed and operated within their jurisdictions (Binnu Jeyakumar and Joojin Kim 2018). However, the national *Air Environment Protection Act* allows provincial governments to set local ambient air quality standards and concomitant emission standards, even if they are higher than national ones. Chungnam used its authority in this act to regulate coal power plants within its jurisdiction by introducing the strongest air pollution standards in South Korea. Clear policy signals through target setting, defining pathways, and undertaking consultations have helped in building support for the state's carbon neutrality vision.

Stakeholder Engagements and Transparency: The province set up the Chungnam Carbon Neutrality Committee which included experts, civic organizations, and businesses. It organized subcommittees in eight sectors including climate, economy, transition, transport, and architecture to prepare a foundation for reaching net-zero emissions. The subcommittees undertook several meetings to develop the final "Chungnam 2045 Carbon Neutrality Vision." The province is also setting up a "Carbon Neutrality Training Center," to share more information on carbon neutrality plans, lessons, practices, and offer environmental training programmes for provincial residents. Chungnam has committed to transparent reporting on its process.

Finance: In 2021, the province enacted an ordinance to collect funds for enabling a just energy transition, with a target of KRW 10 billion (USD 7.5 million) by 2025; with fundraising underway. The fund will aim to address and mitigate the impacts on regional economies (cities and counties) and the loss of jobs occurring from coal phase out and early retirement. While this is a positive start, more funds will be required as the transition progresses.

Nationally, the province announced an initiative for subnational administrations to add a "coal phase out" criterion while identifying banks to deposit public funds. This initiative now has 69 administrations across the country worth USD 200 billion annually. This eventually prompted the national government to ban new public financial support for overseas coal-fired investments. Chungnam's example highlights how subregional governments can take leadership in planning regional transition and also encouraging more ambitions national action.

2. **Colorado, United States – Subnational Case Study on Phasing Down Coal**

Colorado is rich in both fossil fuels and renewable energy sources. It has a population of 5.8 million and is the seventh largest energy producer amongst states in the USA. It also has the eighth largest coal deposits among states in the USA.

The state has a long history of mining. In 2010, coal-fired power plants provided more than two-thirds of the state's electricity generation (EIA 2022b). The share of coal, however, has been declining over the years. In 2021, the state's electricity generation mix included: 41% coal, 25% natural gas, 3% hydro, and around 30% renewables with wind having the maximum share (EIA 2022a).

The share of coal in the USA as well as Colorado has been declining as referenced above. With an eye to the future, Colorado is working towards a coal-to-clean transition. The planning process followed by the state offers some lessons.

Political Commitment: Colorado's Governor, Jared Polis, ran on a platform that committed 100% renewables by 2040 – making a clean economy and Just Transitions central to his campaign (Polis Administration 2019). This commitment is driving the state's energy transition policy with ensuring Just Transitions as one of the central pillars. The Governor's roadmap lays out the vision of the state and reports on planned and executed measures to meet the commitment.

Policy levers: A set of legislation empowers the Public Utilities Commission to facilitate rapid coal-to-clean transitions by working to ensure that the transition process provides safety nets for a declining share of revenues from coal mining and power generation. The state passed a *Bill for An Act Concerning a Just Transition From Coal-based Electrical Energy Economy* legislation in 2019 – the first of its kind in the USA (Colorado General Assembly 2019). The goal of this legislation is to develop policies to support workers and communities affected by the loss of coal-related jobs as well as communities affected by coal industry pollution.

The legislation clearly defines a "coal transition community" to include regions that have been or will be affected by transitions, and a "coal transition worker" to cover mining, power generation, manufacturing, and the transportation supply chain.[9] The legislation also created two institutional mechanisms: the Office of Just Transition (OJT), housed in the Department of Labour and Employment, and a Just Transition Advisory Committee (JTAC). The Just Transition office is set up to drive investments to communities to help diversify their economies, coordinate state and local policies and provide support to coal transition workers (CDLE 2020). The JTAC is tasked with developing a consultative, state-wide Just Transition plan.

The state has also passed an act to facilitate the securitisation of uneconomic coal-fired power plants, a refinancing mechanism, to enable early retirement and add funds for Just Transition activities.[10]

Just Energy Transition Plan: The Colorado Just Transition Action Plan was developed after extensive study and deliberations that involved multiple stakeholders including communities, experts, state agencies, and members of the public. The plan clearly outlines the need for regularly updating the plan as Colorado progresses on its energy transition – likely to span over a decade or more. The plan presents sets of clear strategies for communities and workers and proposes three initial funding strategies.

The six community strategies focus on creating alternate investments to stimulate local economic growth, building requisite infrastructure, and developing resources to empower communities. Worker strategies highlight the need to engage them early in the process, offer support to develop individual financial, career, and/or retirement goals while maintaining or achieving economic self-sufficiency and developing a detailed state programme to help displaced workers build skills, find good jobs, or start businesses. The funding strategies provide an estimate of possible loss of tax revenues and estimates of how much funding would be needed to finance social packages for workers. The strategies include the need for direct financial assistance for communities and workers and solutions such as securitisation of power plants.

Implementing Colorado's ambitious commitments will require strong regulations and substantial financial resources. The focus of the current plan is also limited to coal transition workers. However, the key to ensuring a gradual phase-out of coal (even if a decade down the line) is building enabling frameworks, institutional structures, and planning process needs to start now.

As the state progresses on its energy transition goal, the state will need to expand Just Transition planning to include those impacted by phasing out natural gas and petroleum resources.

3. **Mpumalanga, South Africa: National and Subnational Discourse on Just Transitions and JETP**

The South African Just Transition process is considered a benchmark for countries in the Global South. Further, given it was the first country that signed a JETP, South Africa's internal planning process and experiences offer useful insights for other countries. Coal is the dominant source of energy for South Africa, both for domestic use and exports. Unlike India, coal production in South Africa is geographically concentrated with more than 80% occurring in Mpumalanga, predominantly in the four towns of eMalahleni (Witbank), Steve Tshwete (Middelburg), Govan Mbeki, and Msukaligwa (Ermelo). Coal industry jobs have declined from 130,000 jobs in the 1980s to 50,000 in 2000 before rising to 90,000 in the 2010s (PCC 2022).

Political and Social Leadership: Labour unions, in particular, the Congress of South African Trade Union (COSATU), took the lead in South Africa to mainstream the need for just energy transitions since 2009. COSATU recognised climate change and its disproportionate impact on workers, poor and developing countries as the greatest threat and the need to ensure Just Transition. This was followed by a convention which was attended by labour unions and civil society in 2010 where discussions led to a comprehensive policy position on climate change and Just Transitions (COSATU 2011).

This social pressure forced the national government to release a white paper on the national climate change response (DEA 2012). In 2012, the National Planning Commission (NPC) included a chapter on environment sustainability and equitable transitions in the country's first National Development Plan. This chapter also indicated some guiding principles for a "just" transition. This legwork of five years meant that South Africa was the only country to mention initiatives meant "just" transitions in its Nationally Determined Commitments in 2015.

Based on the recommendations from the White Paper, the NPC embarked on a process of Social Sector Dialogues in 2017 with stakeholders from civil society, businesses, government, and labour. This involved high-level social partner dialogues and progressed to a series of workshops in each province and engagements with various constituencies, such as youth, labour, and business, through bilateral meetings and roundtables convened with partners (NPC 2019). Stakeholder consultations also pointed to the need for an institutional mechanism to coordinate and oversee the Just Transition process, which led to the establishment of the Presidential Climate Change Commission (PCC) in 2020. The commission comprises representatives from government departments and state entities, business organisations, labour, academia, civil society, research institutions, and traditional leadership. At the provincial level, the Mpumalanga premier's office, as well as Eskom (South Africa's largest utility), has created a division on Just Transition to oversee the process.

Policy and Stakeholder Engagements: The 2012 White Paper and the subsequent dialogues highlighted the need for more detailed baseline assessments including, vulnerability assessment of the impact of climate change on different sectors; developing a Sector Jobs Resilience Plan (SJRP), and developing a 2050 clean energy pathway.

Between 2015 and 2020, the national government undertook multiple studies to understand the impact of transitions. For instance, a vulnerability analysis under the National Employment Vulnerability Assessment found that that four municipalities in the Mpumalanga province – eMalahleni, Steve Tshwete, Msukaligwa, and Govan Mbeki – were highly vulnerable to economic (gross value added by coal in comparison to other activities), financial (number of people employed in coal versus other industries), and social (education, gender, and skill profile) impacts due to transitions away from coal. This was a result of undiversified local economies heavily reliant on coal mining and power generation, the financial benefits of these industries, relatively low skills, and limited mobility in the labour market (Makgetla et al. 2019).

Similarly, different ministries developed SJRPs in parallel. The SJRP for the coal sector value chain drew inputs from the vulnerability assessments. The recommendations covered a range of solutions such as collaborating with municipal and provincial governments, building renewables, and the need for local economic diversification. Along with this, SJRPs also recommended skill and needs mapping to develop active labour and social policies and providing income support to vulnerable communities and workers during the transition.

Subsequently, the Department of Mineral Resources and Energy (DMRE) updated the Integrated Resource Plan (IRP) in 2019. The PCC also convened a series of public debates and commissioned policy briefs on South Africa's electricity sector to create an energy transition plan as an input into the process.

Simultaneously, COSATU joined hands with another union – the Federation of Unions of South Africa – to propose ways for the public electricity utility, Eskom, to reduce its debt that will avoid the retrenchment of workers. Along with debt reduction solutions, the plan includes provisions for the company to engage in reskilling programmes for its workers and develop a Just Transition plan for its workers (COSATU 2020). All of these processes and developments helped create South Africa's Just Energy Transition Framework in May 2022 (PCC 2022).

Just Energy Transition Partnership: In the IRP in 2019, Eskom submitted a schedule for decommissioning between 2020 and 2050 – 5.4 GW by 2002, 10.5 GW by 2030, and 35 GW by 2050 (DoE 2019). Initial estimates by the company for the decommissioning and Just Transition process over the next three years range between ZAR 8–10 billion (USD 553–692 million). The domestic consultative architecture, recommendations, and discussions on Just Transitions ongoing since 2009 helped inform the discussions with international partners on support to resolve Eskom's escalating debt, South Africa's unemployment issues, and lack of capital to initiate energy transition reforms. Discussions between the International Policy Group (IPG), which includes the USA, Germany, UK, EU, and South African governments began in early 2021 to discuss international aid to ease the transition process. The international process resulted in the first-of-its-kind, Just Energy Transitions Partnership declaration at the Glasgow COP in 2026. The political declaration provides that the IPG will mobilise an initial USD 8.5 billion between 2023 and 2027.

The South African JETP declaration was followed by a domestic process of creating a detailed investment plan. The South African investment plan released ahead of COP27 in 2022 is for five years (2023–2027) and identifies electricity, new energy vehicles, green hydrogen, skill development, and municipal capacity as priority sectors. Grants constitute about 4% of the total USD 8.5 billion, while concessional loans make up 63%, with the balance coming from commercial loans and guarantees (GoSA 2022).

However, the investment plan assesses that USD 98.7 billion will be needed in the next five years for the transition process. It also identified specific allocations needed for capacity building of municipal areas as one of the key priority areas in its investment plan as part of the JETP (GoSA 2022). While there is still a lot that is unclear about JETPs, particularly around finance, at its heart JETPs are a diplomatic and political process for aligning the interests of multiple stakeholders at the country level and internationally to trigger the mobilization of billions of dollars of climate finance needed.

Section IV: Key Takeaways for India

In India, discussions on Just Transitions amongst different stakeholders are only beginning. India has set massive renewable energy goals – 450GW by 2030 (total non-fossil fuels at 500 GW by 2030) (PIB 2021). Recent government reports project an increase in new coal plants despite high renewables targets (CEA 2022). Energy security and meeting

India's growing energy demand and affordability are some of the key arguments used for investing further in coal. However, how much of this new planned capacity will come online is questionable given the poor economics of new coal plants. Renewables, especially solar, are already the cheapest electricity options, and renewables backed by storage are also cost competitive (Uma Gupta 2020). Several studies also show that building coal capacity may not be necessary and increasing investments in coal could create expensive lock-ins for the country (Lolla, Fernandes, and Raj 2021)(Shah 2021).

The need to start planning for Just Transition in India is important because of three broad trends. First, projections show that meeting India's net-zero goals and global temperature goals will require an eventual coal phase out. The IEA in the World Energy Outlook 2022 projects that under Stated Policy Scenario (STEPS)[11] coal consumption will peak in the early 2030s. In an ambitious scenario like APS, coal consumption peaks by the late 2020s. However, rather than discussing the peak year, it is useful to understand that the slope of decline in each of these scenarios is steep. This means that while some of India's coal-bearing regions may continue production in the short term, the social and economic impact may be harsher for a steep decline, without proper planning.

It is here that India must heed to experiences of countries which have faced transitions in the past. It took the Ruhr region almost 40 years to reach its previous level of economic growth, and even then, unemployment in northern Ruhr which transitioned later is higher than in Southern Ruhr. Similarly, the UK despite an overall high economic growth until 2008 has seen higher unemployment (disability) numbers in the coal regions than in other parts. In South Africa as we have seen, it took over 10 years to build consensus on a Just Transition framework and approach.

Second, India also plans to retire old and inefficient coal-based power plants and close a large number of economically unviable coal mines. Thus, developing transition national- and state-level plans are critical. Third, as the boxes indicate, several Indian companies are gearing up for transitions. Given this context, we offer a few recommendations for India to consider as it meets its net-zero trajectory.

Expanding Just Transition Discussions to beyond Coal Mining

Currently, discussions on Just Transitions are centred around coal mining and specially closure of economically unviable mines. Just Transition planning will need a whole-of-economy approach. Clean energy transitions and coal phase down will have implications on power, railways, and industries. Technology shifts on the path to decarbonising the economy will also impact employment. While the timescale of these impacts will likely vary, there is a need to expand discussions on Just Transitions to beyond coal mining. For instance, the Central Electricity Authority has prepared a list of thermal power plants which will be shut down in this decade. These areas and power plants also need to come under the ambit of Just Transition policies. Simultaneously, as India progresses on its net-zero goal, transitions across sectors will occur. Hence, broadening discussions to cover power and transition sectors will be helpful.

Defining Coal Workers, Energy Transition Workers, and Energy Transition Communities

The scope of informal workers dependent on the coal economy in India complicates transitions. This is not only limited to the coal industry but also associated industries where coal labour is informal or contractual and low skilled and educated (Dsouza and Singhal

2021). This makes defining coal workers paramount to ensure a “just” and “equitable” transition. Going ahead, defining energy transitions workers and energy transitions communities will also help in instituting dialogues, assessing needs, and ensuring policy support. Colorado Just Transition Action Plan also highlights the need to develop plans for the eventual fossil fuel phase down as it progresses on its clean energy goals.

Developing a Governance Architecture for Just Transition

The discussion on Just Transitions, while nascent, has gained some momentum with the Ministry of Coal. The ministry partnered with the World Bank at the end of 2021 to develop a mine closure framework centred around institutional governance, people, and communities, and environmental reclamation and land repurposing on the principles of Just Transitions (MoC 2021).

The Ministry of Coal has also started a Just Transition division and mandated coal companies to form a multi-disciplinary Just Transition taskforce to formulate and implement ideas of Just Transition. A US–India inter-ministerial committee comprising the coal and mines ministries, electricity authority, from India, national and international experts, and US Department of Energy officials released a report on the Just Transition requirements in the coal mining sector (Niti Aayog 2022). The comprehensive report underlines key issues to be addressed such as livelihoods, community health, physical and social infrastructure, repurposing resources, and public finance. Some of its recommendations include developing a national coal transition policy, regional development plans, and granular analyses to inform policy measures, creating “Green Energy Transition India Fund” and developing a tiered institutional structure to implement Just Transition in the coal sector. At the state level, some coal-bearing states are setting up committees/bodies (i.e., Just Energy Transition Taskforce in Jharkhand or the Green Energy Council in Chhattisgarh) and looking to develop a state-level roadmap.

These are positive developments. Going forward, translating the recommendations into action will be critical. Just Transition as a concept needs to be included formally in the government lexicon and planning process. The South African experience highlights the value of early policy guidelines on transition planning and constituting tiered, multi-actor bodies to fill data gaps, create a knowledge base, and develop informed solutions.

Accelerating efforts to develop an inter-ministerial, multi-level, and multi-stakeholder governance architecture to synchronise efforts at the central level policies to state- and district-level efforts. This is necessary for a few reasons. First, while decision making on coal takes place at the central level, the consequences (employment, pollution, and fiscal dependence) are felt at the state and district levels. Second, given the federal nature of India ensuring that states, districts, and key stakeholders have the requisite resources for planning and are a part of the transition process will be important.

Implementing Pilots on Just Transitions

Past experiences of closure of economically unviable coal mines in India highlight that coal towns can face persistent financial and economic issues due to depletion of the resource, the labour force, and the local economy (Chatterjee et al. 2022). Developing Just Transition-based pilot programmes can help assess the success and weaknesses of policy measures. As in the case of Ruhr, transition planning can often be a phased and iterative process. For a country as diverse as India, increasing the pace and scale of pilots will help understand the investment and social needs and develop a strong Just Transition pathway. In addition, India's participation in the Accelerated Coal Transition programme can help in implementing Just Transition focussed pilots repurposing old infrastructure.

Indian JETP and Planning for Development

Indian JETP negotiations, announced earlier in 2022, are still in the early stages. While India is not in the same financial or fiscal position as Indonesia or South Africa, India does face the challenge of transitioning its labour force to high-skilled jobs and moving them away from agriculture. The Indian JETP discussions could provide an opportunity to rapidly build out clean energy infrastructure, direct domestic capacities for new emerging technologies such as green hydrogen, but also provide packages for community and workers impacted by transitions by focussing on reskilling, livelihood support, and community welfare.

Whether an IJETP will be formally announced still remains to be seen. However, transition planning at the national level (similar to plans developed in South Africa and in the works for Indonesia) and developing local investment plans, even without a formal IJETP process can help in mobilising capital, build on regional strengths, and create alternate jobs. For example, Jharkhand's expertise in coal chemistry can be utilised and the state can be redeveloped as a hub for battery recycling and secondary usage. Similarly, all coal-bearing states have a cement or steel cluster in a 100 km radius. These can become areas of growth for new technologies such as green hydrogen, where research shows that costs can be reduced through a cluster approach (Chatterjee et al. 2022).

Nationally, starting a multi-stakeholder process to create a development plan that identifies priority/target industries and regions and clear investment opportunities can help create greater buy-in of stakeholders and provide more surety for targeting investments and policies.

Section V: Conclusion

International experiences highlight that planning for Just Transition requires substantial time, money, and dedicated resources, and, more importantly, it needs to be an iterative process. Hence, pilots, planning, and policies need to be developed now. For this, greater collaboration to share experiences and increased financial and technical support will be needed. It is also helpful to draw inspiration from other sectors – health, education, digital to learn how to structure the administration and institutional aspects of such collaboration. Successful implementation of pathways and policies that leave no one behind and transitioning in time to mitigate climate impacts will be one of the biggest tests of our times.

Notes

1 Views expressed in this chapter are the authors' own.
2 The Announced Pledges Scenario includes all recent major national announcements as of September 2022 for 2030 targets and longer term net zero and other pledge, assuming full implementation of 2030 and 2050 national targets. It shows to what extent the announced ambitions and targets, including the most recent ones, are on the path to deliver emissions reductions required to achieve net-zero emissions by 2050 (IEA 2022d).

3 The net-zero emissions by 2050 Scenario shows a pathway for the global energy sector to achieve net-zero CO_2 emissions by 2050 It is consistent with limiting the global temperature rise to 1.5 °C with no or limited temperature overshoot in line with reductions assessed in the IPCC AR6 (IEA 2022d).
4 Since the South African announcement, G7 countries have supported working together on similar initiatives with partner countries such as Indonesia, Vietnam, Senegal, and India (G7 Germany 2022),
5 The Energy Transition Council is a dialogue process bringing together over 30 governments and institutions offering global political, financial and technical leadership in the power sector (ETC 2022).
6 This does not include Indonesia since the report was released ahead of the Indonesia JETP signed in Bali
7 A temporary freeze has been announced on the auctions given Russian invasion of Ukraine and the resultant gas supply crisis
8 South Korea is not yet a member of PPCA.
9 The legislation defines a "coal transition community" to include "municipality, county or region, that has been or will be affected by the loss of fifty or more jobs in total from a coal mine, coal-fuelled electrical power generating plant, or the manufacturing and transportation supply chains of either," and a "coal transition worker" to include workers laid off from employment in a coal mine, power plant or manufacturing and transport supply chains. *Ibid*.
10 For more on securitisation see: (WRI 2021).
11 IEA's STEPS provides a more conservative benchmark for the future, because it does not take it for granted that governments will reach all announced goals. It takes a more granular, sector-by-sector look at what has actually been put in place to reach these and other energy-related objectives, taking account not just of existing policies and measures but also of those that are under development. The STEPS explores where the energy system might go without a major additional steer from policy makers (IEA 2022d).

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11 Grounded Perspectives on Energy Transition – The View of Panchayat Members on Energy Transition and Impact of Climate Change

Jahnavi G. Pai, Munna Jha, and Vinuta Gopal

Background

India signed the Paris Agreement at COP21 and committed to reduce the emission intensity of its GDP by 33–35% by 2030. It has also pledged to increase the share of non-fossil fuel–based electricity generation. From an international mitigation standpoint, this transition is inevitable to keep GHG emissions and resulting climate catastrophes in check. As India stands at the crossroads, questions on livelihood security of already marginalised coal-dependent communities arise. Most of the deliberations, decisions, and commitments on climate have been top-down taken at the national or international level. As local communities increasingly face not just the repercussions of state policies but also the direct impacts of a changing climate, there is an urgent need to build a grounded discourse on climate change that takes into account the lived experiences, challenges, and adaptation measures of local communities. In this chapter, we present an analysis of these grounded perspectives on these issues of local Panchayat members from Jharkhand, in Eastern India. The state is often touted as one of the richest mineral zones in the world, which heavily depends on coal for state revenues and local livelihoods. This study is an attempt at understanding the challenges faced by the local governments and the steps they are taking to tackle the twin vulnerabilities arising from climate change itself and transition to renewables.

Methods

This section is an analysis of the conversations with Panchayat leaders as part of our ongoing work in the region. The views of local leaders were assimilated in two separate processes:

1. **Conference of Panchayats (CoP)**

   In March 2022, in partnership with Policy & Development Advisory Group (PDAG), ASAR conducted a Conference of Panchayats (CoP) on Climate Change and Just Transitions. The two-day conference was organised with full-day sessions for local elected representatives (Mukhiya and Pramukh) and representatives of NGOs/CSOs from North Chotanagpur (Bokaro, Dhanbad, Hazaribagh, and Ramgarh) and South Chotanagpur (Ranchi, Khunti, Gumla, and Simdega) divisions.

   This conference aimed to foster a discussion around climate change mitigation strategies at the grassroots level and key issues and challenges to ensure Just Transitions in the regions impacted by coal mining in Jharkhand.

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2. Interviews and Focus Group Discussions

In order to fine-tune and supplement the narratives from the COP, in October 2022 we visited Bokaro, Hazaribagh, and Ramgarh districts, where we held focus group discussions and interviews with elected representatives and other local leaders from seven Panchayats of the region. We specifically asked questions on their experience of climate change, their dependence on coal, and their opinions on renewables and Just Transition. The Panchayats were selected based on their dependence on coal:

i. Coal-dependent districts: Jarangdih North, Jarangdih South, and Kurpaniya Panchayats in Bokaro District; Barughutu North in Ramgarh comprise communities that are heavily dependent on coal.
ii. Temporarily closed mines: Balia Panchayat in Bokaro District.
iii. Newly-proposed mines: Dari Panchayat in Hazaribagh District.

The key findings from the study are presented in the following sections. This is an attempt to foreground the voices of the most impacted communities, whose opinions and experiences are often overlooked and even silenced in the larger discourse. We have synthesised their comments and suggestions and supplemented with published literature, only to provide a larger context, wherever necessary.

Dependence on Coal

Jharkhand is considered the leading producer of minerals in the country. The state has 40% of the country's mineral reserves and 27.3% of coal reserves. It is also the sole producer of coking coal, which is used to make coke, as essential raw material for the manufacture of steel. Iron and steel is another key industry in the state, which was the single largest exported item from Jharkhand in FY 2021–2022 (India Brand Equity Foundation, 2022). The state earns about 8% of its revenues from coal-mining taxes and royalties (Nandan and Panigrahi, 2022). Coal is also used in thermal power plants for generating electricity.

Revenues aside, the state is also heavily dependent on coal and allied industries for both the formal and informal livelihoods of people. Coal-dependent communities are also dependent on housing, electricity, education, and healthcare provided by the mining companies.

Informal Livelihoods

> *"Our area is only Coal – we cannot do without coal. Our lives revolve around coal."*

These words of a member of Kurpaniya Panchayat echoes the sentiment of coal-dependent communities across Jharkhand.

The participants of Conference of Panchayats said that according to a study conducted by local leaders in the Bokaro district, around 39 categories of occupations were identified in the coal-mining region which will be directly or indirectly impacted by the closure of coal mines. One of the Mukhiyas said that around 50% of the population in the coal-mining areas of Chotanagpur regions are dependent on coal extraction business both formally and informally for their livelihoods.

The leaders we interviewed in the villages spoke about the various ways in which people are dependent on coal. As explained by the leaders of Jarangdih, Balia, and Barughuttu Panchayats, those who are informally dependent on the mines collect coal, break it, fill it in sacks, transport it on cycles, and sell it to businesses such as restaurants. According to them, nearly 99% eke out a living in this manner. In most cases, the entire family is involved, and they earn about Rs. 500 in a day, which is lower than the minimum wages. They also earn wages by loading trucks after an auction takes place at the mines. In Barughuttu, women largely play this role. They buy coal from what is known as "road sales" and sell. In direct contrast, women in Kurpaniya have no means of livelihood and sell coal only if there is no male member in the house.

People are aware that this is considered illegal and know that they are labelled "coal thieves," but they continue to do it. They say it is because of a combination of the lack of other means of survival along with the government's tacit willingness to allow it rather than seek to regulate this trade.

The case of Balia, where mines have been temporarily closed while awaiting environmental clearance, shows the extent to which people are dependent on mines and shine a mirror to what is in store for all those who face an imminent closure of mines. They say that people are waiting for the mines to open as they have no other means of livelihood. When asked if agriculture is practised, one of the Panchayat members said,

> *Agriculture has also stopped because people are getting rice for one rupee. It has made people lazy. If they grow, it will cost them at least five rupees a kilo. Why will they work hard and lose money?*

Cooking

Coal is extensively used as cooking fuel in all these regions, an insecurity expressed by women of Panchayats especially when asked about their opinions of closure of mines. They also shared how the Ujwala Scheme, which started with lofty promises, is now almost inoperative. In Jarangdih, for instance, under this scheme, about 360 new connections were given with a gas stove and one cylinder for free for the first time. They were promised that the cost of the subsequent cylinders would be credited to their account. However, no money was credited to their accounts and people eventually went back to using coal. Now only small families which can afford to buy gas, do so. The cost of a refill now costs about Rs. 1,150, which is too steep as it means spending their income from two days.

In contrast, coal is available for almost free or even if they need to buy, a bag costs about Rs. 300, which lasts them for at least a month. As a social worker from Jarangdih Panchayat remarked,

> *The freedom that was promised never came.*

Other Benefits

Most of the literature points that local communities are dependent on health and education facilities provided by the mining companies. This seems to be far from the truth in the Panchayats we visited, especially around the mines operated by Central Coalfields Limited (CCL). As Chandramani Devi, the Pramukh of Mandu, comprising 36 Panchayats explained, even though the government has opened schools, there are no teachers. She says that the mines operated by Tata Iron & Steel Company Ltd in Ghatto provided better health and education facilities.

People of Kurpaniya shared how they need to spend anywhere from Rs. 50–150 to reach the nearest hospital in Jarangdih bazaar even for the smallest of ailments. If that is not resolved, they will need to travel further. Some of them said earlier when they had access to the forests, they would get herbs from there for treatment but now even that option is not available.

Access to clean drinking water is also an issue in most villages. In Barughuttu, for instance, those who have the means buy water. Others depend on groundwater from borewells or open wells. We were told that the groundwater here turns red after a few hours and has been declared unfit for consumption. Yet, the local community has no access to potable water.

Impacts of Coal Mining

Several studies such as Gasparotto and Da Boit Martinello, 2021 have pointed out the multiple health effects of exposure to various hazardous substances from coal and its by-products. These include adverse effects on the major organs and even damage to the DNA.

> *Those who have economic constraints will not think of the future. For now their needs are met … they do not have the luxury to think of its consequences. They are helpless. They have no alternatives.*

These words of Sudes Bhooyan, who served as the Mukhiya of Jarangdih South, capture the harsh reality of people living in the coal fields who are forced to bear the impacts of coal mining, often on their health and on their immediate environment, as they have no other means of survival.

Pollution

The participants of Conference of Panchayat said transportation, extraction, illegal utilisation of water resources, and untreated waste disposal have severely polluted the rivers. The region is also facing a serious crunch of depleting water table levels because of water extraction by the coal-mining companies. Water scarcity has led the farmers in the area to move from multi-crop to single-crop cultivation. Development activities in the region are also leading to illegal sand mining from river beds, causing some rivers such as Khanjo River in North Chotanagpur to dry up.

Impacts of Dust

The dust produced by mining and transportation of coal cover the nearby villages with a layer of white powder. Dust generated in the process, results in occupational hazards for miners such as pulmonary diseases, chronic obstructive pulmonary disease (COPD), and silicosis. The CoP participants claimed that dust attracts pests and impedes the growth of farm produce, especially vegetables. In addition, soil organisms are also not able to survive this pollution, leading to degradation of the soil quality. They also claimed that the pollution caused by mining has adversely affected the quality and taste of the produce.

Women of Kurpaniya Panchayat claimed that even though they clean their homes every evening, it is covered with black soot the next morning.

Land Degradation

The mukhiyas at the conference also stressed on the dangers of pits from open-cast mining that have been left open even after the closure of mines. These open sites are often taken by villagers to extract coal illegally resulting in fatal accidents. Participants expressed their concern asking for rehabilitation of villagers and filling of open-cast mining pits.

Displacement

One of the harshest impacts of coal mines is large-scale displacement leading to landlessness and unemployment. Entire villages have been wiped out by the mines. As Chandramani Devi, the Pramukh of Barughuttu (North) says,

> *only the names of the villages remain on paper but all other forms of identity have been erased.*

Several participants of the conference raised the issue of migration, wherein the men migrate to other places in search of employment opportunities to sustain their families. The extent of migration to find work is such that villages are found to be inhabited by mostly women, children, and the elderly.

Tarumanji, a 70-year-old senior local leader associated with a political party and belonging to the displaced Santhal community in Parej East, says when the mines were proposed, representatives from the World Bank and some NGOs visited their village. They were promised either jobs or lands or economic compensation for their lands. They were also promised that the land that has been taken away from them would be returned after reclamation. He says, they have no bargaining power and end up losing everything for short-term gains.

> *If we give land to a company, there is an agreement with us. They gain but we lose. They give us an assurance of 40 years of employment. For instance, they take lands in this region through loans from World Bank, we will think that it would good for us. But how long? 40 years! If they give money, they will decide on the rate depending on the land and employment. Even the land chosen for resettlement is decided by them. Everything will get over. You see the hill there? It was all a village. Now there is nothing.*

Any dissent or disagreement by the villagers is countered in the name of national interest, an opinion that was echoed by leaders of all villages. In Tarumanji's words,

> *CCL says this is nation's asset. All this is in national interest. People who live here how long can they sustain? 40 years … what can they do in such a short time? Will they build a house or educate their children?*

All the leaders also know that CCL is supposed to reclaim the mines, but it is not done. They expressed their inability to demand for the same.

Other Impacts

Lakhanlal Mahato of Dadi Panchayat says there because people from across the country live around coal mines, it affects the local culture and food habits. He even attributes an increase in alcoholism to mining.

Perceived Impacts of Climate Change

Apart from the challenges that come with living in the coal-bearing areas, the communities here are additionally burdened with having to deal with the vagaries of climate, like everyone else.

At the conference, which was held before monsoons, the leaders discussed how they perceive these changes. They said, the leaves of Futkal (*Ficus geniculata*), which used to shed only once a year earlier, sheds twice a year now. Tender leaves of this tree are consumed by the Adivasis as food and medicine. The participants also discussed how patterns of irrigation activities had changed from thrice a month to only once a month, due to weather unpredictability and channelisation of depleting water resources for mining purposes.

Due to changes in the rainfall pattern, agricultural produce, and soil productivity have been severely affected. They are able to grow only paddy but no other vegetables in these areas. In some places, agriculture has changed from multi-crop to single crops cultivation. Badkagaon, once known as Dhaan ka Katora (rice bowl), now finds it difficult to justify the name. They are also concerned about forest produce like Mahua, Futkal, Marua, and Gundli as they are an important source of income as well as nutrition.

During interviews in villages, which were conducted post monsoon, most of the leaders said that rainfall this year has been especially unfavourable. During the sowing season, there was a long dry spell, but it rained heavily during harvest. They feared that if rains continued, they would not be able to sow for the winter crops as well.

They also perceive the changes in the seasons. Winters have become shorter. Typically, winter would set in during Durga Pooja and by Chaath pooja, it would be too cold to step out. But now they need fans even during Diwali, which falls after Durga Pooja.

Summers too are unbearably hot, they say. Without the fan or cooler, it is impossible to stay indoors without being drenched in sweat.

They attributed ill health and reduced immunity to the changing weather patterns.

Interventions for a Just Transition

The interventions in Jharkhand to tackle climate change needs to be multi-pronged in its approach. The region's heavy dependence on coal calls not just for switching to renewables but also for securing the lives and livelihoods dependent on coal, or for a Just Transition. It has been long established that the closure of mines and Just Transition need several years of meticulous planning. We explored the current status of interventions in these areas (Bhushan et al., 2020).

Despite India's ambitious goal of phasing out coal by 2070, those who live around the coal fields are completely in the dark about this. In fact, in several Panchayats like Dadi and Jarangdih, there are plans to open new mines. The respondents claimed that coal mines are only expanding. Some mines have temporarily closed as they are awaiting environmental clearance, like in Balia, while some others have permanently closed because of economic reasons.

When asked about their opinions on possible closure of coal mines, despite the hardships they face because of the mines, all respondents were unanimous in their stand that closure of mines would lead to large-scale unemployment and hunger as they have no other means of survival. Some say migrating to big cities in search of employment would be the only way out.

However, some of the respondents did express that in case of better livelihood options, they would gladly give up their dependence on coal.

Switching to Renewables

Renewables, especially solar-powered lights and water pumps are being promoted by various agencies such as CSR divisions of mining companies, CSOs, and by the state government across Jharkhand.

Most participants of conference said that the use of solar energy in their region is limited to solar streetlights, and pumping underground water to jal minars (overhead water tanks). They said that only a few villages, funded by the Central Coalfields Limited's CSR, use solar energy. All the Panchayat leaders who were interviewed too confirmed the same.

We explored if and how government institutions like Jharkhand State Livelihood Promotion Society (JSLPS) are promoting clean energy systems. The participants said there is no such presence of any Government institution for promoting innovations for clean energy systems. They also discussed the lack of awareness among community members about the schemes and programmes rolled out by Jharkhand Renewable Energy Development Agency (JREDA), which they say is the key reason for people not availing benefits from the solar programmes launched by the government.

On being asked about the Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM) Scheme, participants lacked awareness of the centrally funded scheme aimed at ensuring energy security for farmers in India.

In some places in Chotanagpur, CSOs are providing solar-powered water pumps and inverter batteries for irrigation at subsidised rates. However, the participants of the COP expressed their concern that these measures are not viable as small-scale farmers find these technologies unaffordable, unless made available at a subsidised rate.

One of the elected leaders from Jarangdih told us that a major disincentive for switching to renewables at home is that electricity in most of the coal-field areas is free, while they will have to buy batteries and solar equipment if they need to switch.

Generating Alternate Livelihoods

Even though most respondents initially expressed hopelessness regarding alternate livelihoods, with some encouragement, they came up with solutions.

Panchayat leaders highlighted that the awareness among local communities regarding the transition from fossil fuels usage is critical to ensure Just Transitions. Since a large population is dependent on coal-related activities, it is important to provide training in new skills to the unskilled and semi-skilled workers.

They were of the opinion that coal-mining companies should train local people on repairing solar equipment as this would promote the usage of solar power and also generate green jobs in the region. They also recommended the use of over burden (OB) for generation of solar power, trench-cutting to stop the overflow of rainwater to conserve water resources.

During the interviews, some leaders said the first step is to raise awareness among the community. They said if they have access to land and water, they could get back to farming, basketry, fish rearing, and dairying as they already have the necessary skills. Some felt that there is scope for industries such as IT, garment factories, and also for promoting tourism.

DMFT Funds

In 2015, the Mines and Minerals (Development and Regulation) Act (MMDR) of 1957 was amended to establish District Mineral Foundation (DMF) in mining-affected districts. The DMF is a non-profit Trust funded by royalties from allocated and auctioned mines in the district. The objective of this trust is to improve the living conditions of communities affected by mining by providing clean drinking water, education, health, and skill development, among others. These funds are referred to as DMFT funds. A small portion of the fund is allocated for infrastructure work like creating irrigation canals and watershed development only in cases where the district has not been allocated state funds for infrastructure development (Tiwary et al., 2020).

There is a high potential to use these funds for Just Transition. Even though the local leaders are aware of DMFT, most of them expressed helplessness in being able to utilise it.

Participants discussed the usage of DMFT funds to mitigate the potential impacts of the proposed transition from coal to renewable sources of energy. The participants seemed well-informed about the fact that a total of 33% of the revenue generated through coal mining goes into DMFT funds, which could be utilised for providing new skill sets that could ensure Just Transition in the mining-affected areas. Expressing their concerns, they said the funds collected from mining districts are utilised mostly for infrastructural development, such as building flyovers, bridges, renovation of government buildings, and parks outside the region where the funds are generated. Because of this, villages directly impacted by mining do not receive the benefits from DMFT fund, despite contributing to it. They said that the DMFT fund would only serve its true purpose if it were utilised to strengthen livelihood options for women, the Adivasi communities, and other vulnerable groups.

During interviews too, the local leaders expressed similar views. They said the funds get spent at the Zilla Panchayat level or by MLAs and MPs and they have no say in the matter. In Kudapaniya Panchayat, the leaders claimed that 250 crores from DMFT were sanctioned last year by the DC without the involvement of any of the Panchayats. They also said that the funds are being used to build schools and hospital buildings, but they are largely dysfunctional because of lack of staff and because they are being constructed in remote areas which are hard to access. Most leaders attributed misuse of funds to lack of accountability. They feel there is a need to increase awareness among the community regarding the use of these funds.

Lakhanlal Mahato of Dadi says that half the Prakhand has coal-bearing areas and the focus should be on improving health, education, and environment. With this in mind, they have sent suggestions from the gram sabhas for the funds to be utilised for building local libraries which will aid students to prepare for competitive exams so they can find jobs for themselves. They have suggested the fund be utilised for creating ponds and planting trees to improve the local environment and preserve biodiversity. However, he says, they can only send proposals from the Gram Sabha but have no final say in how the funds will be utilised. Their Panchayat has received Rs. 2 crore from DMFT which is being used to make the local school into a model school and for roads.

This is illustrative of the wide gap between understanding of the needs by the local leaders versus the pressures and perceptions of bureaucrats who are implementing the schemes.

Other Government Schemes

Currently, institutions like *JSLPS* are providing training on livestock farming and forming groups which can avail loans for any livelihood purposes. Such groups, under JSLPS, are involved in small businesses like bee-keeping, mushroom farming, basket-making, and other similar small business enterprises. In some Panchayats like Jarangdih North, women have been provided training and required machinery for tailoring, making detergents, leaf plates, and sandals. However, in Barughutu, even though tailoring machines have arrived, training programmes have not been conducted.

There is scope to strengthen this intervention as it could play a key role in weaning people away from coal-based livelihoods.

They further underlined the crucial role *MGNREGA* could play in creating assets and generating local jobs in their region. They say pisciculture, sustainable agriculture, reclaiming closed mines, check dams, plantation, and creating trenches to improve water-holding capacity, are some of the works that can generate jobs for the adversely affected communities. Some of them felt that promoting tourism can also be a way of increasing livelihood opportunities and asset generation. Some respondents said that loans must be made easily available to all the community members including those who are not directly employed by CCL.

However, some respondents said that several government schemes such as PM Awas Yojna or MGNREGA are never implemented in several coal-bearing districts. For instance, in Kurpaniya, among 29 Panchayats, PM Awas and MGNREGA are implemented in only one Panchayat.

Any intervention to create alternative livelihoods must take into account the large migrant population, who, according to the local leaders, comprise nearly 50% of the population.

Strengthening Local Self-Governance

At the Conference of Panchayats participants suggested the formation of committees in which youth and senior citizens can participate in conservation of Jal-Jangal-Jameen (water, forest, and land) by strengthening local institutions like the Gram Sabha, implementation of the Forest Rights Act, 2006 (FRA), and Panchayats (Extension to the Scheduled Areas) Act, 1996 (PESA).

The local leaders of Jharkhand have a keen awareness of what is needed for the welfare of the people. Given the special laws that operate in mining areas, they do not enjoy the freedom or the constitutional powers vested on them. Most Panchayat leaders say that the government conceives schemes without knowing their needs. As the Mukhiya of Kurpaniya says,

> *If you give us options, we can tell you what is best suited to the local conditions here. We don't know what plans the government has.*

Lakhanlal Mahato strongly agrees. He says plans are often made in Delhi without understanding local conditions and forced down on them to be implemented. He gives an example of the local school which has strict instructions to buy only packaged milk sold by big companies even though the milk produced by a dairy just 300 m away has no buyers. He asks,

> *If we want our villages to become atmanirbhar and not depend on outsiders, with this situation will they ever become independent?*

Conclusion

This study, along with the Perinjanam Case Study (see Appendix 11A), highlights the crucial role played by gram Panchayats. Despite the differences between the two states, local leaders have demonstrated that they understand the pulse of the people and place they represent, which is key for implementation of any new schemes or programmes related to climate change or otherwise.

Kerala is a prosperous state, whose economy does not depend on mining. However, by juxtaposing the case study from Kerala, we highlight that when Panchayats are provided with information and support and empowered to imagine what alternatives exist, there could be new ways in which the communities build and plan their futures. The Perinjanam case has proved successfully how decentralised power and autonomy in the hands of a gram Panchayat coupled with political will can ensure a better outcome for the whole community. Replicating the same model in Jharkhand might be challenging given the socio-economic and political reasons. However, our conversations with local leaders have shown that there needs to be a lot more engagement on the issue to truly empower them and make them active discussants in the plans for their regions. The Gram Panchayat Development Plans also provide a process through which the local governance mechanisms can shape their futures if provided support. There is a need to reconfigure some of the current realities that govern mineral-rich lands belonging to multidimensionally poor people. As suggested by local leaders, there is a need for skill development in sectors other than mining and creating livelihoods that are in tune with the current challenges and future needs. If these communities are not involved, the danger of once again marginalising their lives and needs in the transition is an ever-present danger. One that could also become a contentious issue forcing a narrative that pits them against any transition.

As India takes steps towards phasing down coal, it urgently needs to listen to the voices on the ground and take measures to ensure a just and equitable future, especially for those who have already paid the price for it. Decentralising power and empowering local governments would be a step in the right direction.

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Appendix 11A

Decentralised Electricity Generation using Rooftop Solar: A Case Study of Perinjanam Village

Hari Subbish Kumar Subramanian

The prevailing public perception that the major share of electrical energy generated in Kerala is clean and green as it is sourced from Hydro is incorrect. As on September 2022, hydro constitutes only 30% of the total energy mix and Kerala imports 52% of energy from other states and central sector utilities. Despite not having a coal power plant or coal mines, Kerala sources 37.8% from coal and lignite thermal power plants through Power Purchase Agreements (PPAs) (Central Electricity Authority, 2022a). The shift to Renewable Energy (RE) offers the state a way to fulfil its energy needs while improving its energy security and minimising its power-based environmental footprint. There has been a 161% additional growth in the RE sector since March, 2020 (Central Electricity Authority, 2021), predominantly driven by solar uptake in the state (Central Electricity Authority, 2022b).

Local self-governance (LSG) and experiments in the decentralisation of power have been unique aspects of Kerala's development model. Perinjanam is a classic example of empowered LSG leading to a successful model of decentralised rooftop solar at the Panchayat level. We document a Panchayat-led energy transition in detail below for Perinjanam village.

The Perinjanam model

Perinjanam, a small coastal village in Thrissur district, which is vulnerable to the severity of climate change, has installed a cumulative capacity of 1.16 MW over 727 households in the Panchayat. This gram Panchayat conducted a series of seminars to educate residents about solar rooftop energy. This extensive public awareness campaign was initiated by the then-Panchayat president KK Sachith. A notice detailing the project and its environmental, and financial benefits were sent to every single home in the Panchayat. A 14-member Samithy (Users Representative Committee) was chosen from among the members registered in order to manage the project implementation. The Samithy negotiated with the Solar Energy Corporation of India (SECI) for a subsidy, SECI agreed to provide a subsidy (30%) of Rs. 19,500/ kW, while the total cost of one kW was Rs 65,000. Thus, the consumer paid only Rs. 45,500/ kW. The gram Panchayat arranged and acted as guarantor for loan facilities from the Perinjanam Cooperative Society for collateral-free loans up to Rs. 50,000/kW at 8–9% interest.

The Samithy also negotiated with the solar installer to provide a 9.5 kW complementary rooftop solar system on top of their government school to power the local CSR-funded streetlight initiative. The maintenance of the LED streetlight is done by an 11-member Kudumbashree (women's self-help group) unit, whereas the maintenance of rooftop solar systems is done by local youngsters who have been trained and coordinate their activities via a WhatsApp group. On 23 September 2019, the project was inaugurated by Mr Pinarayi Vijayan, the Chief Minister of Kerala. This also marked Perinjanam Panchayat as the first of its kind in India, with a 1.16 MW rooftop project on individual residences.

Role of Panchayat

The Panchayat played a key role in public awareness regarding the environmental and financial benefits by conditioning seminars, sharing detailed project notifications, and bringing together stakeholders to initiate this project. No financial aid was provided by the Panchayat for the project; it only acted as an enabler while the consumer paid the full cost. The Panchayat acted as a guarantor and facilitated collateral-free loans from the cooperative bank to ensure a just and equitable opportunity for all to access decentralised RE solutions.

Role of Samithy (Users Representative Committee)

A 14-member Samithy was chosen from among the members registered in order to manage the project, with the Panchayat President as the chairman, and a convener from among the users. The committee was approved by the gram Panchayat. The Samithy is re-elected annually. The Samithy is responsible for general supervision of project installation, coordinating through the warranty period, preparing documentation, facilitating feasibility study with Kerala State Electricity Board (KSEB), submission of completion certificates and coordinating with KSEB inspectors, SECI regarding subsidy, cooperative bank for loan facilitation and contractor for timely completion of the project.

Impact of the Model

Ex-Panchayat president, Mr KK Sachith who was instrumental in implementing this project claimed that from a bi-monthly electricity bill of Rs. 7,000, he now pays only the fixed charges/ metre rent after installing a 4-kW rooftop solar system. In addition, he gets an annual compensation of approx. Rs. 1,000 from KSEB for the excess energy exported to the grid.

The Perinjanam model is being used as a pilot to replicate across all 941 gram Panchayats in Kerala. Representatives from the Perinjanam Panchayat and Samithy presented their model to the Tamil Nadu State Planning Commission, igniting the idea of doing a similar pilot in Tamil Nadu. To kickstart this process, 37 proactive Panchayat presidents from each district were selected, the State Institute of Rural Development Tamil Nadu and Kerala Institute of Local Administration (KILA) arranged an exposure visit on 18 October 2022. A very detailed and interactive session followed by a field visit was arranged by the Perinjanam Panchayat and Samithy members to clarify doubts and discuss how this model can be adopted and replicated. There has been a preliminary discussion to explore a similar model customised for Jharkhand.

Key Takeaway

The importance of capacity building and decentralising the power of the local self-governing body is evident through the Perinjanam model where the Panchayat played an enabling role. Not only has this project saved 1,308 tonnes of CO_2 emission per year, local youngsters, both men and women, are also gainfully employed in maintenance activities. Moreover, decentralised RE, in a financially attractive and viable package, is one of the major solutions at the grass-root level to tackle climate change.

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Part 3

Industry: Opportunities and Challenges – an Introduction

Mritiunjoy Mohanty and Runa Sarkar

In addition to the broad macroeconomic implications of transitioning towards a more sustainable energy mix and the associated governance and policy landscape, there is a need to focus on the ins and outs of the transition process and challenges from the point of view of the industry. This is the subject matter for this section. We focus only on the coal mining sector and coal-based power plants in light of the challenge of transitioning away from coal. Further, our attention is limited to the supply side of the coal and power industry and therefore excludes associated hard-to-abate sectors like steel and cement on one hand and the thorny sector of electricity transmission and distribution on the other. Needless to say improving the energy use efficiency of processes and products outside the domain of the power industry is also outside the scope of this section. Given India's growth imperative coupled with the abundance, access, and affordability of indigenous coal, the Indian power sector will continue to rely on coal in the near future. Thus, we take a pragmatic approach in this section. Thus, we consider improvements in the efficiency of existing coal-fired power plants in addition to investments in renewable energy and energy storage technologies for the near future.

Understanding the business economics in favour of retiring and/or retrofitting and repurposing select coal-fired power plants and coal mines in the context of the newer business models of renewable energy is key to assessing the opportunities and challenges facing fossil fuel–intensive industries. This helps identify and prioritise criteria to determine which coal-fired power plants to retire or retrofit with new technologies. Further alternate models of repurposing need to be listed and assessed, so as to ensure that the impact on communities' dependence on operations of the mines and power plants directly and indirectly is minimized. We also assess the performance of coal-fired power plants terms of energy and environmental efficiency through a production theoretic framework to determine the scope of efficiency improvement within the existing energy production landscape. The dominance of large state-owned enterprises in this sector cannot be ignored, and we specifically focus on two such large firms, Coal India Limited and NTPC, to assess how resilient they are in the light of the imperative of a transition away from coal and make recommendations of diversification strategies for them. The emergence of new opportunities in renewable energy and energy storage, and how these opportunities can be embedded into the energy sector so as to enable a Just Transition is also focused upon. Finally, for Indian utilities transitioning to clean energy, the transition experiences of their international counterparts can be instructive. Short case studies of three such firms are presented.

In Chapter 12, *Bhattacharjee and Sen* visit the challenges associated with the process of decommissioning and reutilising old thermal power plants in India and discuss

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various options for repurposing these units by drawing on interventions in India and across the globe. Alternative revenue-earning and employment-creating investments in place of coal-fired power plants include setting up solar parks, alternate fuel-fired units, industrial parks, or infrastructure hubs to leverage the available resources such as interconnection lines, generators, synchronous condensers, and substations. Depending on its location, the opportunity cost of continuing to operate a pant could be high enough to dictate its being redeveloped for housing schemes, eco-parks, or museums. The possibility of retrofit decarbonisation, an umbrella term that includes adding carbon capture, fuel conversion, and the replacement of coal boilers with new low-carbon energy sources, in each case re-using as much of the existing equipment as economically practicable, is also discussed. Their finding, that the forecasts in favour of repurposing thermal power plants provide an optimistic indication of the financial and other benefits, is reassuring, in the sense that a transition away from fossil fuels can be economically viable, sustainable, and inclusive.

However, at present, there is no formal mechanism for decommissioning of power plants, either at the state or central level, that guides us about the return or redevelopment, or repurposing of land where thermal power plants operated, to be utilized for the welfare of the local community or the workforce that was rendered jobless due to the decommissioning. This is of grave concern given the implications of closure and repurposing on the environment, workers in these plants and the society at large. The authors conclude with a possible roadmap to ensure a just decommissioning and repurposing process for a conventional fossil fuel–based power plant. In two associated boxes, Jindal and Shrimali suggest a simple framework for identifying plants suited for repurposing in an eponymous box *(Framework for Identifying Plants Suited for Repurposing);* and principles for monetising coal plant retirements through repurposing (*Monetizing Coal Plant Retirements through Repurposing*).

The strategically important and dominant position of Coal India Limited and NTPC in India's energy sector cannot be ignored. With the growing pressure from cost-competitive clean energy sources and India's global decarbonisation commitments, these businesses are likely to face challenges, thereby opening up the possibility of translating into a loss for the Indian state at large and necessitating expensive mitigatory strategies. *Khurana, Sarkar, and Viswanathan* identify and evaluate business diversification strategies for these firms in Chapter 13. Through an analysis of publicly available data from their balance sheets, the authors identify the cash flow at risk for these two firms for different business scenarios considering a transition away from carbon. They then identify suitable business segments for diversification of these firms through a SWOT analysis coupled with a Porter's diamond analysis to prioritize them. Suitable businesses to invest in within the identified business segments are identified through a multi-criteria decision analysis framework, and finally, the identified businesses are synthesized into a portfolio by factoring in business life cycles using a growth-share matrix. Thus, the diversification strategies take into consideration business alignment, technology maturity, market potential, and financial attractiveness to develop competing investment scenarios. This analysis enables medium-to-long-term business planning for future proofing of these PSUs. The key contribution of this chapter is the development of a framework that any fossil fuel–intensive firm could use to develop a strategy to move away from carbon in a systematic manner. Appendix 13 A (*Economics of Coal Fired Power Plants*) by Abhishek Raj makes the case for retiring or repurposing old or inefficient plants, while Appendix

13B (*Collaborations Among Indian Firms as a Business Strategy to Foray into Green Hydrogen*) by Vibhuti Garg highlights the business opportunity presented by hydrogen as a clean fuel and suggests means of sharing the associated risks of a new technology.

Chapter 14, by *Sabuj Mandal*, assesses the performances of the Indian thermal power plants at the level of states in terms of energy and environmental efficiency through a production theoretic framework with the objective of highlighting which state requires immediate intervention for modernizing and improving efficiency for carbon-sensitive electricity generation in their coal-fired power plants. Following a Data Envelopment Analysis (DEA) approach and using state-level data on electricity generation and fuel used for the study period 2018–2019 and 2019–2020, Mandal demonstrates that, for the year 2018–2019, the average energy efficiency of the states is 79.55% and it falls to 72.24% for 2019–2020. This leads him to conclude that at the current level of technology, inputs, and electricity production, there was a scope for reducing energy input by 20.45% and 27.76% in 2018–2019 and 2019–2020, respectively. This implies that, in addition to transitioning to renewable power, another low-carbon strategy that does not compromise gross annual electricity generation could be an improvement of the energy use efficiency of power plants. However, given that this study should ideally be conducted with unit-level data, the optimism may need to be tempered.

Having discussed repurposing, diversification strategies, and energy efficiency measures for existing coal-fired power plants, Chapter 15, by *Thakare and Sreehari*, explores issues related to the adoption and scaling of emergent energy storage technology, which plays a critical role in grid stability as the share of renewables increase in the energy basket increases. They focus on bridging the gap between energy storage systems technology and its outlook on India's short-to-long-term energy transition goals. They discuss the evolving energy storage technologies in use today, namely thermal, electrochemical, and mechanical storage, as well as mapping their characteristics with possible applications for grid stability and discuss constraints with respect to the adoption and scaling of these technologies. Further, prevailing policies that support energy storage systems implementation in India are studied. Investing in energy storage systems as a means of thermal power plant repurposing is introduced as an opportunity. The authors infer that while there is a huge scope for developing energy storage systems in India, the lack of policy convergence and financial viability is a dampener. To conclude, the chapter makes policy recommendations to strengthen the implementation of energy storage systems in the context of India's electricity transition to achieve net zero.

Chapter 16, by *Shubh Majumdarr*, *Abhinav Jindal*, *Shantanu Srivastava and Vibhuti Garg*, concludes the section with experiences of transitioning away from coal for three coal-fired power conglomerates in the USA, Italy, and Spain. There is limited information on specific experiences, whether successful or not, of firms as they embark on a transition pathway in energy transition literature. Industries rarely lead energy transition from the front as a result of the significant, front-loaded, and risky investments associated with it. However, when they do, the lessons and experiences of the companies can help identify internal and external factors for firms to keep in mind. The first discussion in the chapter centres around lessons that Indian firms can draw from Enel's unique Creating Shared Value model. This is followed by tracing the decarbonisation pathway for Nextera Energy, a Florida-based energy conglomerate, which, instead of relying on carbon capture systems or offsets, used clearly articulated interim targets to attract investments and help managers develop strategies to transition away from fossil fuels.

Finally, the authors take a detailed look at *Iberdrola,* which stands out as a very recent successful energy transition experience. Set in 2017, *Iberdrola* tackles the dilemma and challenges of decommissioning coal plants sequentially, a situation that all Indian utilities must also face up to. They discuss how the company transformed its portfolio's last two coal-fired power plants into clean energy assets amid political and economic challenges, not dissimilar from the Indian context.

12 Retrofit Decarbonisation and Reutilisation of Thermal Power Plants

Sucharita Bhattacharjee and Trinayani Sen

Background

The conventional Indian power sector has been responsible for a substantial percentage of Green House Gas Emissions. As a consequence, the carbon footprint (Seetharaman, 2020) of the Indian energy sector has always been on the global radar. Hence, attaining the targets set by India at the COP26 and facilitating a transition away from coal-based power generation necessitates adopting greener pathways that are in conjunction with its growth and human development targets.

However, the relevance of conventional coal-based energy systems like thermal power plants cannot be ignored since more than 70% of India's electricity comes from these thermal-based electricity generation plants dependent on coal (Seetharaman, 2020). The power demand is set to rise even further as the economy recovers from the blows of the pandemic. Predictions say that the overall coal demand for the power sector may increase from 672 Mt in 2017 to 827–1,277 Mt by 2030 (Ali & Tongia, 2019).

Hence, given this context, it should come as no surprise that any energy transition from conventional coal-based energy to renewable energy systems will take place with severe social, economic, and environmental impacts. Despite these impediments and in light of the high vulnerability index of the country in the face of climate change, India aims to replace 30 GW of thermal power generation capacity with renewables by 2026 – a move aimed at reducing emissions from coal-fired power plants (Modi, 2022). The decision is part of the country's broader plans to achieve 500 GW of renewable power capacity by 2030. India is lagging in terms of meeting renewable energy targets. India's renewable energy capacity stood at 114.9 GW by June 2023, far from its target of 175 GW by this year and well below the target of 500 GW by 2030 (PTI, 2022). The centre has notified 81 thermal units which will replace coal with renewable capacity by 2026. This includes generation units of state-owned NTPC, and privately owned units of Tata Power, Adani Power, CESC, and Hindustan Power, among others (Jai, Power ministry earmarks 81 thermal units to move coal to renewable by 2026, 2022).

A recent study by independent climate change think tank E3G has found that since 2015, 326 GW of proposed coal projects in India have seen cancellations, which means a 92% decrease in the pipeline (Vanamali, 2022). The transition from fossil fuel to renewables is not only about the decarbonisation potential and cost-competitiveness of modern technologies but also about their overall impact on all stakeholders involved. This includes the impact on people employed directly and indirectly by conventional power plants and communities built around these. Repurposing coal power plants for other alternative revenue-earning and employment-creating activities is a key consideration for

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Just Transition as it provides means to reinvest in communities dependent on the thermal plants for their livelihood.

Coal power plant repurposing offers a number of benefits for diverse stakeholder groups. The available resources like land and infrastructure and equipment such as interconnection lines, generators, synchronous condensers, and substations can be reused if planned in a structured manner. Not only are the old plants already well connected with the transmission system, but they also have a workforce that can be re-employed in dismantling as well as cleaning the decommissioned thermal plants and the alternative revenue-making activities. The old coal plants therefore can be used for renewable energy and other projects that can simultaneously create local employment opportunities. The sizeable parcel of land owned by these conventional power plants should be put to productive use for facilitating the energy transition in a just manner.

The conventional plants can also explore the possibility of *retrofit decarbonisation* which is an umbrella term that includes adding carbon capture, fuel conversion, and the replacement of coal boilers with new low-carbon energy sources, in each case re-using as much of the existing equipment as economically practicable while reducing or eliminating emissions (Qvist, Gladysz, Bartela, & Sowiżdżał, 2021). This enables the power plant authorities to recover their investment while reducing the cost of power system transformation. Hence retrofits are particularly relevant for regions with a young fleet of fossil-based power plants.

The Current Situation and the Dilemma

The Indian coal fleet is ageing rapidly. According to a study by iForest, between March 2016 and June 2021, 126 coal-based power-generating units with a combined capacity of 11,995 Megawatt (MW) were withdrawn from operation citing techno-economic and commercial reasons (Bhushan, Singh, & C, 2022). Further, in consideration of India's energy transition goals, the power ministry has directed all conventional coal-fired power plants that are older than 25 years to be decommissioned (Bhushan, Singh, & C, 2022). While this is in stark contrast to the nation's usual practice of replacing its outdated power plants with newer, more efficient ones, in the face of India's net-zero commitments and decarbonisation efforts, clean energy production is naturally given priority.

While a shift to clean energy is a welcome move, a matter of grave concern is the lack of any legislation that addresses the end-of-life management issues associated with retiring coal-fired thermal power stations. Instead, planning, designing, construction, operation, and refurbishment of generation capacity have always been the focus of India's energy sector legislation, policies, and regulations. In such a situation, there is a chance that retired plant sites will be left unattended since Indian laws and regulations do not clearly define the clean-up and rehabilitation responsibilities. This is particularly true, if energy firms are under financial strain and lack the means to redevelop these facilities.

Additionally, there are no dedicated regulations under the labour statutes or accompanying federal, state, or local policies for planning a "just labour transition," when the thermal power plants are shut down. Decommissioning coal-fired plants on such a large scale can be counterproductive as they will result in mass unemployment accompanied by the loss of about 50,000 MW of coal-based energy capacity (Singh, 2022).

On the other hand, the extreme competitiveness of the renewable energy sector was demonstrated by India's solar energy rates dropping below Rs. 2 per unit at the Solar Energy Corporation of India (SECI) auction in November 2020 (Jai, Solar power tariff touches record low of Rs. 2 per unit in SECI auction, 2020). Solar tariffs in India are currently less than what it costs to run the majority of the country's coal-fired power facilities, and given the continued cost reductions of renewable energy sources, coal-fired power is simply uncompetitive. As a result, investments are moving away from the thermal energy business and towards the low-cost renewables sector. Global Energy Monitor's (GEM) data show more than 601 GW of coal-fired power projects have been cancelled in the last decade in India (Shah, 2021). Even the International Energy Agency (IEA) has predicted a sharp fall in coal's proportion in Indian power generation by 2040 in its most recent report (IEA, 2021).

Thus, as India races towards its climate commitments, owing to a lack of funding and capital investment, much of India's coal-fired capacity runs the danger of being stranded, along with the people who are directly and indirectly involved with it. Since the industrial decommissioning of any thermal power plant has huge impacts on the environment, labour, land, and finances, this situation creates an urgent need for a structured end-of-life management policy to be put in place for making the process fair, equitable, and sustainable.

In light of the revenue and employment loss resulting from the gradual retirement of distressed thermal power plants, this piece highlights various ways in which decommissioned and retiring thermal power plants can be repurposed for RE generation or other industrial, commercial, or residential uses.

Case Studies – An Overview of Some National and International Repurposing Efforts

In this section, a few examples of thermal sector decarbonisation, both domestic and international are discussed. The focus of these cases is on strategies for reutilisation of retired units along with retrofit decarbonisation wherein functional thermal plants have incorporated carbon capture technologies to bring down emissions and recover some of the cost of power transformation. While some of the examples are for completed projects, others report on work in progress for different power plants.

Badarpur Thermal Power Station (BTPS), Delhi NCR, India

Badarpur Thermal Power Station (BTPS), a central PSU plant, was constructed on land leased to NTPC Limited by the Government of India for a period of 50 years at a predetermined annual lease rent. If the power generation activity stopped on this land or the land was used for any other purpose, the Central Government could review the lease contract. When the units were decommissioned, the Central Government decided to turn the Ash Pond area into an Eco Park as a Public Place and the remaining land portions were given back to the Ministry of Housing and Urban Affairs, Government of India. However, NTPC was supposed to return the entire land levelled, "re-grassed," and "remediated" for the executive and non-executive employees who were formally employed at the plant, NTPC made appropriate transfers to alternate project locations. However, the plant closure was met with social unrest owing to insufficient transition support by the plant authority, especially for the informal/contractual employees. Thankfully, due to the close proximity to the National Capital Region, these laid-off workers managed to explore alternative livelihoods (Bhushan, Singh, & C, 2022).

Guru Nanak Dev Thermal Power Plant (GNDTP), Punjab, India

Punjab State Power Corporation Limited (PSPCL), a state government-owned PSU, had ownership over the freehold land on which the Guru Nanak Dev Thermal Power Plant (GNDTP) in Bathinda had been constructed. After the units were decommissioned, several proposals were floated to redevelop and repurpose this land. The idea to convert two of the retired coal-fired units into biomass-based (paddy straw fired) units was rejected by the state government, citing the huge investment that was required for having the infrastructure to ensure steady procurement and supply of raw materials throughout all seasons, while conforming to the pollution norms. Redeveloping this land as a Solar Park was also rejected. Finally, the PSPCL board, as instructed by the state government, decided to hand over the 1,320 acres (534 Ha) of plant land (except the area of the residential colony spread over 280 acres (117 Ha)) to Punjab Urban Development Authority (PUDA). A Pharma Industrial Park is supposed to be developed there and sold with an 80:20 profit-sharing arrangement with some structured pre-decided understanding between PUDA and the state government. The decommissioning process was met with demonstrations and protests by various interest groups like unions of farmers, labourers, employees, and students as it was not made legally binding upon the plant authority to resettle them or provide alternate employment opportunities (Bhushan, Singh, & C, 2022).

Rihand Thermal Power Station, Uttar Pradesh, India

As part of their "Renovation and Modernization" strategy, NTPC has decided to expand the capacity of Rihand Thermal Power Station in Sone Bhadra, Uttar Pradesh. Various interventions are being made to improve its efficiency and cut emissions through the installation of modern pollution control technologies. At present, NTPC is planning to co-fire biomass along with coal to reduce CO_2 emissions by the plant. Additionally, a 20 MW Solar PV project at Rihand will be developed on approximately 75 acres of land of the erstwhile Ash Pond area of this Power Station. The project is the first of its kind in India and involves the reclamation of a large land parcel at the Ash Pond area (NTPC, n.d.). The project was won by NTPC under the Tariff Based Competitive Bidding conducted in 2019 by Uttar Pradesh New & Renewable Energy Development Authority (NTPC, n.d.) and is in line with the power company's plans of installing 60 GW of RE by 2032 (Menon, 2021). Further, NTPC is also committed to creating carbon sinks, around its power plants planting 10 million trees (including Rihand) over the past year, in addition to 22 million trees planted previously (Proctor, 2017).

Vindhyachal Super Thermal Power Station, Madhya Pradesh, India

Apart from investing in the conversion of decommissioned coal-powered thermal plants into renewable energy sites – NTPC is also engaged in the effective reduction of carbon emissions at functional plants and incorporating carbon capture infrastructure. One such example is the 500 MW coal-fired power plant (Unit-13) at Vindhyachal Super Thermal Power Station in the Singrauli district of Madhya Pradesh. This plant is designed to capture 20 tonnes of carbon dioxide (CO_2) per day which will eventually be combined with hydrogen to produce 10 tonnes of methanol per day through a catalytic hydrogenation process (Carbon Clean, 2022). This is expected to create potential new business opportunities and revenue streams for the company. The pilot project, built for NTPC Energy

Technology Research Alliance (NETRA), is part of an initiative unveiled in 2020 to build a CO_2-*to-Methanol* plant at a coal-fired power plant. Examples like this are surely a step in the right direction for plant closure and diversification of businesses in a sustainable, environmentally friendly manner.

Recent Studies in Tamil Nadu and Maharashtra, India

Last year, the Ministry of Environment Forest and Climate Change served a notice to a number of lesser economically viable coal plants of a cumulative capacity of approximately 3,990 MW in Tamil Nadu, for either upgrading their infrastructure with pollution control-compliant modern technology or shutting down by 2024. A think tank, Climate Risk Horizons, has done a cost–benefit analysis for these old coal plants, including Tuticorin I, II, and III of 1,050 MW, Mettur I and II of 840 MW, North Chennai Stage-I of 630 MW and NLC-II Stage-I of 1,470 MW. The report says that the financial benefits associated with reutilising these coal plants as solar energy–generating units would be significantly higher than the projected costs of decommissioning these units. After covering a substantial proportion of the new capital expenditure required for solar, batteries, and related machinery, benefits from using the old plants' pre-existing land and grid connection facilities would total Rs. 2400 crores, which is a considerable increase over the decommissioning costs of Rs. 1300 crore (Construction World, 2022).

Similarly, a new analysis undertaken by the same think tank indicates that redeveloping and repurposing some of Maharashtra's oldest and most expensive coal plants at places like Bhusawal, Chandrapur, Koradi, Khaparkheda, and Nashik can earn the state huge financial benefits worth Rs. 5,700 crores (Free Press Journal, 2022) (Climate Risk Horizons, 2021). This can be achieved through re-using the existing resources like land and infrastructure for clean energy and grid stability services.

Teruel Coal Power Plant, Teruel, Spain

At present, a Spanish multinational electric utility company, Endesa is repurposing the Teruel Coal Power Plant in Spain. The Action Plan presented by them had components of new renewable energy capacity along with a unique hybridisation of technologies, green hydrogen projects, and a synchronous compensator. This is to be further complemented by a foolproof socio-economic development plan. The erstwhile fossil fuel–based power production will now be replaced by renewable energy with a total installed capacity of more than 1,800 MW. The conversion is expected to recover almost 90% of the materials that were left behind from the decommissioning of the thermal power plant. The new hub also intends to maximise land use by growing food in the soil beneath the solar panels. Provisions for training for target groups like vulnerable communities, youth, and people with disability to ensure employment in the primary and services sector through economic diversification and optimum utilisation of the region's resource endowment have been emphasised in the plan. The plan also focuses on creating alliances to employ the maximum local people possible to retain them in local economic activities and stop out-migration. Additional measures are being taken to protect bio-diversity while ensuring inclusivity. Industry collaborations are being explored for manufacturing solar components, developing a recycling centre for wind turbines, developing an industrial zone for allied businesses, and of course, maintaining the circularity of these industrial elements (Endesa, 2020), (Endesa, n.d.).

Power Plants across the United States of America

In the last two decades, the energy scenario across the United States has changed due to several reasons including the development of greener energy technologies, economic challenges of keeping up with environmental compliances of ageing coal-fired power plants, and community demands for moving towards sustainable power generation. According to the EIA, at least 546 coal-based power plants have been decommissioned in the USA between 2010 and 2019 and more thermal power plants with a combined generation capacity of 17 GW are scheduled for retirement (U.S. Energy Information Administration, 2019). These plants, after decommissioning have been repurposed in several ways depending on the site location, suitability, infrastructure availability, and community perspective. While many have been converted into natural gas-fired power plants (U.S. Energy Information Administration, 2020), several other sites have been redeveloped as alternative energy plants, commercial or residential facilities, community spaces such as museums and parks, or infrastructure projects such as ports or warehouses (Delta Institute, 2014). Many of these sites, redeveloped for commercial purposes, have thus been successful in creating new livelihood opportunities and replacing some of the jobs lost due to the closure of the power plant. The pillars of success have been early planning with a long-term vision, effective stakeholder engagement, and active support from the government. Two examples of successful repurposing initiatives are provided next.

B.C. Cobb Power Plant, Muskegon, Michigan

The plant, named after Bernanrd Capen Cobb, one of the presidents of Consumers Energy (erstwhile Consumers Power Co.) began its operations in 1948 with two generation units. It was located on a 300-acre plot of land on the edge of the Muskegon Lake where it meets the Muskegon River. The plant had a total of five operational units. Units 1 and 2, which generated 60 MW of electricity each, were first decommissioned in 1990, converted to natural gas units in 2000, and permanently closed in 2008. In 2016, Units 4 and 5, with a combined capacity of 320 MW were permanently closed due to environmental considerations and tightening of emission standards. At the time of closure, the facility had 116 employees, who were either retired or transferred to another facility owned by Consumers Energy (Bissel, 2016). The closure led to a major loss in tax income for Muskegon, and also impacted port operations since freighter activities were ceased (Delta Institute, 2017).

Prior to the plant closure, Consumers Energy conducted a study to understand the possible future uses of the site. The recommendations of the study were redevelopment of the site as

a) a deep-water port
b) a centre for agri-business
c) a centre for sustainable manufacturing

However, since the plant was built on marshy land, it would be difficult and expensive to conduct large-scale construction activities on the site, making redevelopment as a port the most feasible option. Thus, with the objective of repurposing, Consumers Energy sold the site to Forsite Development Inc. in 2017 (Lofton, 2017). The plant has since been demolished and a port facility has been developed on the site by Verplank Family Holding Co (which acquired the site from Forsite in 2020). The port which was inaugurated in August 2022, is one of the largest deep-water facilities in that region with an annual handling capacity of 1 million tonnes of freight (Forsite Development Inc., 2022). Thus the repurposing of the power plant into a large-scale infrastructure project has led to the creation of multiple localised livelihood opportunities and has been a development milestone for the people of Muskegon.

Potomac River Generating Station, Alexandria, VA

Owned by GenOn Energy (now acquired by NRG Energy), the PRGS plant with a generation capacity of 482 MW started its operations in 1949 to supply power to Washington D.C. However, since the 2000s the plant ran into trouble with the local community of Alexandria due to the environmental pollution caused by it. After going through multiple rounds of litigation the plant was finally decommissioned in 2012. This was followed by a lengthy remediation process which lasted till 2019 (The Goodhart Group, 2021). At the time of closure, the plant had around 150 employees, the fate of whom is unclear from the media reports. However, a plan for redevelopment of the site to build riverfront housing, an energy centre and open-air amenities was drafted by the American Clean Skies Foundation. It was estimated that this form of repurposing would create employment opportunities for approximately 2200 people (Delta Institute, 2017). After remediation, the 18-acre plant was subsequently purchased by Hilco Redevelopment Partners (HRP) in 2020 and the repurposing plan was put in motion as a part of the Old Town North Small Area Plan (approved by the Alexandria City Council in 2017). Since then, HRP has adopted a participatory approach towards redevelopment and organised over 45 stakeholder consultations with the community members and government officials to develop a Coordinated Development District plan for mixed-use of the site. Going forward the abatement process is estimated to begin sometime in 2023 and the site is envisaged to be demolished in 2024 (Moore, 2022).

Nanticoke Generating Station, Canada

Nanticoke, the largest coal-fired power plant in North America, was converted to a 44-megawatt solar farm with 192,431 photovoltaic panels spread across 260 acres, by the electric utility Ontario Power Generation (OPG) in 2019 after the generating station closed down in 2013 after more than 40 years in operation. The idea to use part of the coal facility's property for a new solar farm was spearheaded and paid for by OPG, the Six Nations of the Grand River Development Corporation, and the Mississaugas of the Credit First Nation. The facility, situated along Lake Erie in Haldimand County, was put into service in March 2019, on schedule and budget. The newly constructed solar-generating station uses the existing switchyard to connect to the power grid and still employs towers, capacitors, and even buses from its predecessor (Mining.Com, 2019).

A Proposed Roadmap

From a review of the national and international examples of decommissioning and redevelopment of thermal power plants, it is evident that the strategies for repurposing a power plant begin even before its closure. First, one has to identify which plants are to be decommissioned, as discussed in the box.

Framework for Identifying Plants Suited for Repurposing

Abhinav Jindal and Gireesh Shrimali

Old, polluting and expensive coal plants are increasingly being considered for decommissioning worldwide. Here, we develop a framework to identify several quantitative and qualitative factors, which would be helpful in selecting coal plants suitable for repurposing.

As a coal plant ages, not only it undergoes a deterioration in equipment and machinery but also it becomes increasingly inefficient. In the Indian context, units aged 25 years or more are assessed for retirement or replacement of plant and machinery under Renovation and Modernisation schemes. Another significant criterion for retirement is energy (or variable) costs, as plants with higher energy costs are not prioritised in least-cost dispatch and, therefore, operate at lower capacity utilisation levels. Accordingly, coal plants with energy costs greater than Rs. 3.0/kWh (say for India), a threshold established in lieu of the existing tariffs for the main competition for coal plants i.e., renewable energy sources, may form a suitable choice for repurposing. Therefore, in line with the global norm, we suggest the use of age and (variable) energy costs for identifying a long list of plants to be considered for repurposing.

In addition to the quantitative factors mentioned above, state-level qualitative factors also merit consideration. These include willingness of stakeholders (i.e., state governments), RE potential, and availability of cheap land. The last criteria will enable targeting coal plants located in rural locations, where land is cheaper as highly urban coal sites may find utilisation of their land for repurposing less remunerative in comparison to other options like real estate.

Based on high vintage, high energy charges, and key qualitative factors, this representative framework can be utilised to identify coal suitable for repurposing in countries with significant coal capacities. Thus, in addition to India, this framework may be applied to countries such as South Africa, Chile, and Indonesia.

The announcement of closure is usually followed by the gradual discontinuation of power production at the plant. Following that, a decommissioning process is initiated whereby equipment is removed and buildings demolished. During this stage, it is essential for compliances with all necessary environmental permits to be maintained. After decommissioning the plant goes into the remediation phase, where the hazardous material on the site is cleaned up as per regulatory requirements. At this stage, a reuse framework of the plant is also finalised to ensure the remediation is carried out in accordance with the reuse requirements. The different reuse options are evaluated for their feasibility and ideally the best possible use is identified.

After remediation, the plant moves into the redevelopment phase where it is repurposed into its new avatar depending on feasibility and funding.

Monetizing Coal Plant Retirements through Repurposing

Abhinav Jindal and Gireesh Shrimali

Countries across the globe are looking to retire their old, polluting, and uneconomical coal plants by repurposing them for productive end uses. Repurposing could play a key role in the success of coal retirement programmes and accelerate the scale adoption of renewables in countries with sizeable coal capacities.

We undertake a cost–benefit analysis using a representative Indian coal plant (1000 MW) and examine the value proposition of repurposing over plain decommissioning coal plants across several repurposing options. While repurposing coal plants looks beneficial, it may encounter resistance for a number of reasons such as the costs involved, impact on communities and livelihoods, and other system flexibility considerations. To avoid this pushback and to create a win-win situation for all stakeholders, our study undertakes a component-by-component analysis for a representative coal plant (1000 MW) and tries to establish the utility of repurposing over plain decommissioning for coal plants in favour of a combination of repurposing options such as solar, battery energy storage system and synchronous condensers (Jindal & Shrimali, 2022).

Coal plants can be repurposed in numerous ways, such as solar plant for energy; biomass plants for both energy and capacity; pumped hydro or battery storage for providing frequency control ancillary services, energy storage, and capacity; and synchronous condensers for delivering reactive power and inertia. The direct costs are incurred by the utility or the plant, whereas the indirect costs accrue to the system due to the closure of coal plants. The key assumption while computing the costs and benefits is that while the plant has competed its economic life i.e., 25 years, it could still run for an additional 10 years.

We show that the benefits of repurposing outweigh the corresponding costs of decommissioning – while the direct, indirect, and total decommissioning costs are \$58.11 million, \$59.31 million and \$117.42 million; the corresponding repurposing benefits are up to \$122.79 million, \$605.94 million and \$728.73 million, respectively; and they cover a significant part (at least 22.50%–31.32%) of the capital expenditure of the repurposing option(s). The benefits accrue due to re-using assets, retaining ancillary services and some employees and avoiding some of the clean-up costs (e.g., ash ponds) that would otherwise be required for a retired coal plant. Our findings reveal a strong economic rationale for repurposing coal plants in developing countries including India.

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While at the outset this may give an impression of a seamless process, in reality it often takes a huge amount of time, coordination between multiple stakeholders and considerable funding. Given the strong community linkages of a power plant and the multitude of people whose livelihood is dependent on its operations, it becomes imperative to actively involve them throughout the decommissioning and repurposing process, to ensure a Just Transition.

Drawing from the different case studies, the roadmap in Figure 12.1 provides a comprehensive strategy for ensuring a "Just Transition" for a power plant. It focuses on

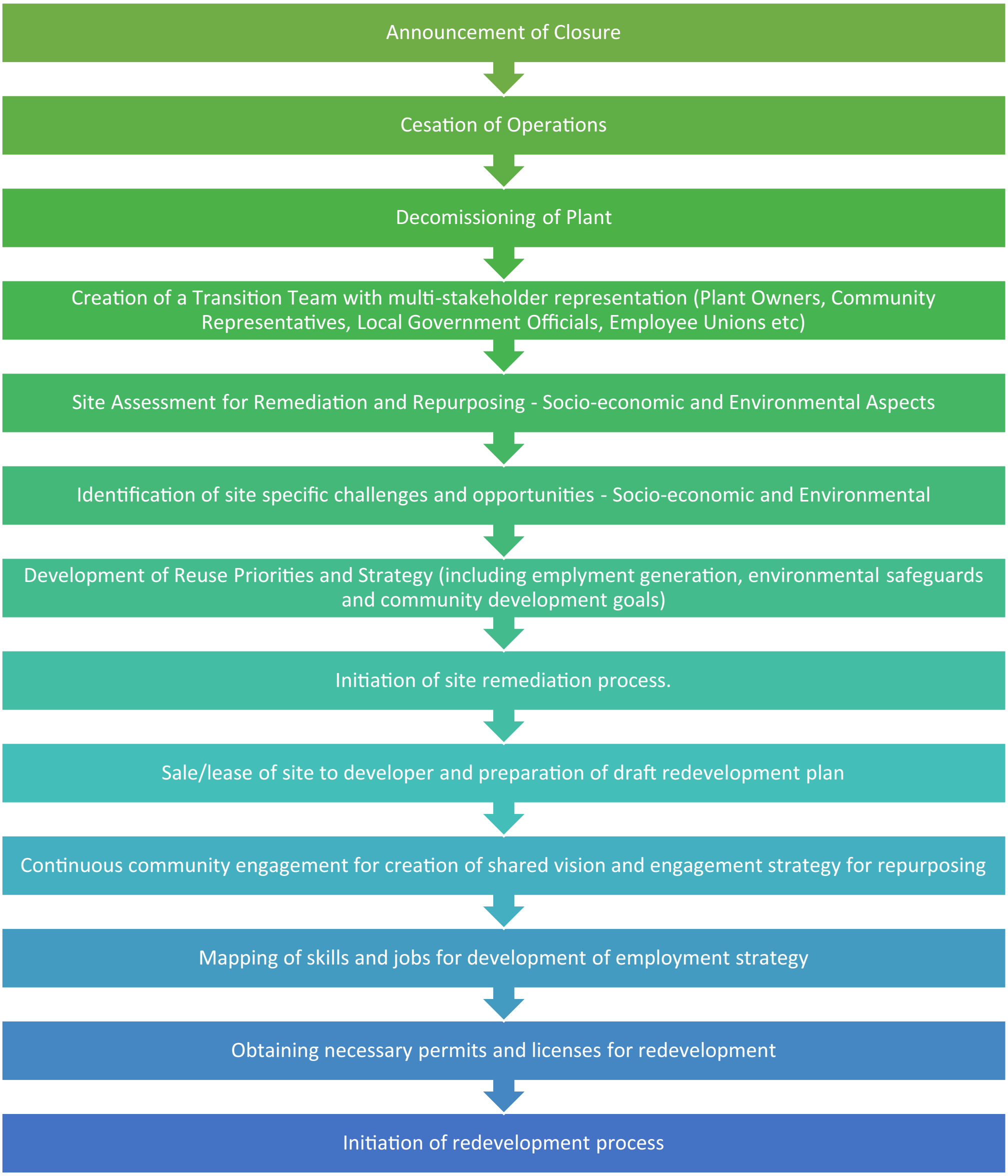

Figure 12.1 Roadmap for repurposing of a thermal power plant.

Source: Author compilation.

ensuring the social, environmental and economic aspects of decommissioning and repurposing are co-prioritised throughout the process.

Decommissioning Thermal Power Plants in India: Key Considerations

At present, there is no formal mechanism for decommissioning of power plants, either at the state or central level, that guides us about the return or redevelopment or repurposing of land where thermal power plants operated, to be utilised for the welfare of the local community or the workforce that was rendered jobless due to the decommissioning. Neither existing nor upcoming labour laws or labour codes deal with the closure of any large-scale industrial establishment including thermal power plants. There is, therefore, a lot of ambiguity around compensation and social security packages to be offered. The sale value of scrap material is far below the transition costs to be borne by the plant authority. Additionally, as the number of thermal power plants slated to retire continues to grow, the associated loss of employment will also see a steep increase. Direct and indirect income opportunities will also shrink with severe adverse implications on the regions that have been mono-industry (coal/ thermal power) dependent.

The decisions regarding decommissioning of thermal power plant units and repurposing the associated land should therefore follow an inclusive process by taking into account the stake and voice of the local community (see chapters 7 and 11). Since a thermal power plant develops an ecosystem surrounding its premises, with small and medium local businesses and other facilities including education, health, banks, and markets, an institutionalised framework should be in place to legally safeguard all workers – both formally and informally employed in the ecosystem.

When units of a thermal power plant are decommissioned, not only do millions of people lose their livelihoods but also a number of other factors like reutilising the same land, and removing toxic scrap material become major concerns. Studies by iForest point out that in the coming decade, approximately 50–60 GW thermal power plants will be decommissioned leaving almost 20,000 hectares of land abandoned (Bhushan, Singh, & C, 2022). Without an appropriate regulatory framework guiding this transition and an institution monitoring the process of closure of mines or retiring thermal power plants, it will be difficult to ensure a just energy transition.

The respective role of state, centre, and private sectors need to be formally laid down in a decommissioning policy. This poses a challenge as energy policies and regulations in India have always focused on the generation side – conceptualising, designing constructing, operating, and renovating the capacities of power plants rather than on end-of-life management. The board of directors of a thermal power plant industry has to announce their decision to discontinue power units to the Central Electricity Authority, who in turn would update their database of installed capacity. An environmental and social impact assessment for decommissioning a thermal power plant should also be mandated. Further, funds need to be earmarked by most of the power plant authorities for the end-of-life activities in India.

A sense of justice can only prevail when the retired thermal power plant sites can be completely remediated, the workforce either duly compensated or absorbed in other revenue-generating activities and the socio-economic and environmental losses experienced by the dependent local community addressed. After all, a Just Transition is one which is "of the people, for the people and by the people."

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13 Future-Proofing India's Coal PSUs

An Analysis of CIL and NTPC

Saarthak Khurana, Arnab Sarkar, and Balasubramanian Viswanathan

Context

State-owned enterprises (SOEs), known in India as Public Sector Undertakings (PSUs), hold a strategically important position in India's energy sector. They account for over 90% of coal mined, 50% of power generated, 90% of the electricity distributed, 57% of crude oil refined, and nearly all of petroleum products sold (Viswanathan et al., 2021). They make up 7 of the 11 "Maharatnas" and deliver significant financial returns to the Government of India, their major shareholder (MoF, 2022). Further, they employ millions of citizens, engage in community building, and take on activities of strategic importance.

With the growing pressure from cost-competitive clean energy sources and India's global decarbonisation commitments, the businesses of Indian energy PSUs are expected to face challenges due to their carbon-intensive nature. This can translate into a loss for the Indian state at large. Hence, this creates a need for mitigatory strategies. This chapter focuses on two central-level PSUs facing the most imminent challenges: Coal India Limited (CIL), the largest national coal miner, and NTPC, the largest thermal power producer. These two PSUs have been selected given the thematic focus of this volume.

Profile: Coal India Limited (CIL)

CIL is under the administrative control of the Ministry of Coal (MoC) and operates in 84 mining regions across eight states (CIL, 2022a). As of 1 April 2022, CIL has 318 mines and produced 662 million metric tonnes in FY22, making it the single largest coal producer in the world (CIL, 2022b). It has ten fully owned subsidiaries with seven functioning as regional mining businesses (CIL, 2022a). CIL aims to significantly reduce national coal imports by increasing production to 1 billion tonnes by 2024 and explore new coal-based technologies like coal gasification and coal to chemical projects (MoC, 2022). Its estimated cumulative Scope 1 and 2 greenhouse gas emissions are 4.96 $MtCO_2e$ in FY22 (CPI, n.d.).

In FY22, CIL registered a net profit of Rs. 17,378 crore with gross coal sales reaching Rs. 1,52,667 crore, both record highs. CIL's capital expenditure stood at Rs. 15,401 crore in FY22 having doubled since FY17 and net worth going up 75% in the same period (CIL, 2022b). Currently, CIL is a profitable business with significant contributions to the economy. The Government of India remains CIL's largest shareholder with 66.13%. Other major shareholders include the state-owned Life Insurance Corporation (9.75%) and the State Bank of India (0.51%). The cumulative dividends paid by CIL in FY22 were Rs. 10,476 crore (CIL, 2022b).

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In May 2022, CIL released an Action Plan 2022–2023 which indicates its long-term plans and an acknowledgement to "diversifying into non-coal, secure new businesses, productively utilise sizeable reserves/funds in their Balance Sheet" (MoC, 2022). CIL has set a target of installing 3 GW of renewable capacity through Special Purpose Vehicle (SPV) additions to achieve operational net zero by FY24, signed agreements with NTPC and Solar Electrification Corporation of India Ltd (SECI) towards developing SPV projects, and submitted a bid under Production-Linked Incentive (PLI) scheme for setting up an integrated 4 GW SPV module manufacturing facility (Aggarwal et al., 2022; Viswanathan et al., 2021). CIL has also set up two subsidiaries towards these diversification efforts – CIL Navi Karniya Urja Limited and CIL Solar PV Limited (CIL, 2022a).

CIL has a large social footprint with nearly 250,000 formal employees and several times more through contractors and informal jobs (CIL, 2022b). Through its subsidiaries, CIL is a key developer in several remote mining communities. In FY22, the total corporate social responsibility (CSR) expenditure of CIL was Rs. 586 crore. Any diversification efforts by CIL must account for the impact it has on workers and local communities.

Profile of NTPC Ltd

NTPC is under the administrative control of the Ministry of Power (MoP) and India's largest power utility (NTPC, 21 Nov 22). It operates 69 GW or 17% of India's power generation capacity generating 24% of national electricity produced in FY22 (NTPC, 2022). Thermal power plants (TPP) using coal account for 57 GW including the 2.87 GW added in FY22 (NTPC, 2022). NTPC has announced plans to diversify its mix with a goal of reaching 130 GW of installed capacity by 2032 which includes 85 GW in coal capacity (NTPC, 21 Nov 22). Following the energy price crisis of 2022, NTPC announced its intent to award 4.8 GW of coal projects in the next three years (Goswami, 2022). Its estimated cumulative Scope 1 and 2 greenhouse gas emissions are 304 $MtCO_2e$ in FY22 (CPI, n.d.).

In FY22, NTPC registered a net profit of Rs. 16,111 crore with gross power generation of 300 billion units, both record highs. NTPC's capital expenditure stood at Rs. 21,036 crore in FY22 and has averaged over Rs. 25,000 crore in the last 8 years making it one of the largest developers of infrastructure projects (Raizada et al., 2022). The Government of India remains NTPC's majority shareholder with 51.1%. Other major shareholders include the state-owned Life Insurance Corporation (10.36%) and the State Bank of India (1.39%). The cumulative dividends paid by NTPC in FY22 were Rs. 6,933 crore (NTPC, 2022).

NTPC has emerged as a leader among major energy PSUs in expanding business to clean energy. In June 2021, under the Energy Compact submitted to the United Nations, NTPC has set a target of 60 GW on renewable capacity by 2032 (NTPC, 21 Nov 22; UN, 2021). This requires a rapid expansion from the 1.8 GW operational and 3.4 GW under construction renewable capacity as of April 1, 2022 (NTPC, 2022). To achieve these goals, NTPC has created a subsidiary, NTPC Renewable Energy Ltd, with an intention of making it a standalone publicly listed company. NTPC has identified a need for Rs. 2.5 lakh crore investment to meet RE goals; signed MoUs with several PSUs and started exploring emerging clean technology including battery storage, green hydrogen, and offshore wind (Aggarwal et al., 2022; Viswanathan et al., 2021, 2022). NTPC has also signed a collaboration with NITI Aayog to develop a net zero roadmap (NTPC, 2022).

Lighting one in four households in India, NTPC is a pillar of energy access and crucial for energy security. They operate at higher efficiency levels than competitors and can raise capital, both domestically and internationally, at favourable rates thereby lowering electricity prices. In FY22, the total CSR expenditure of NTPC was Rs. 357 crore. The role of NTPC in a changing energy landscape is critical for energy access, security, and affordability.

Need for Future-Proofing

As discussed in the "Context" section of this chapter, India's energy future has multiple pathways. However, a common element for net zero by 2070 and 1.5-degree aligned pathways is the dramatic reduction of coal in the energy mix. This poses a significant business risk to CIL and NTPC. Building on the foundational work by Köberle et al. (2020), Viswanathan et al. (2022) studied this through the impact on future finances. The methodology developed by the study has been used in this chapter to illustrate the need for future-proofing India's fossil-dependent PSUs.

Approaches for Identifying Financial Risk

Forward-looking studies like the International Energy Agency's (IEA) India Energy Outlook 2021 typically identify energy pathways linked to key conditions. A business as usual (BAU) scenario considers no further interventions. Additional scenarios consider a deviation from BAU based on conditions like announced pledges, net zero, or aligning with IPCC's 1.5-degree pathways. If India were to follow these climate aspirational pathways, there is a significant reduction in coal as a part of the energy mix when compared to BAU. It must be observed that there are multiple studies identifying climate aspirational pathways with varying estimates of coal usage. The methodology proposes two scenarios linked to available research and the difference between the two scenarios represents a "risk spectrum" faced by the PSUs operating in this sector.

Viswanathan et al. (2022) used the green economy model (GEM) to model India's energy sector over 2020–2050. GEM follows a systems dynamic approach where various actors are interlinked through explicit cause–effect relationships and feedback loops. For further details on GEM, its design and assumption, readers are recommended to refer to Golechha et al. (2022). Two pathways were developed in GEM using IEA's energy scenarios as a reference (IEA, 2021; Viswanathan et al., 2022).

- BAU: Aligned with the IEA's Stated Policies Scenario (STEPS) and captures trends based on existing plans, including reaching 450 GW of renewable energy capacity by 2030.
- Aspirational: Aligned with the IEA's Sustainable Development Scenario (SDS), which corresponds with reaching net-zero emissions in the 2060s.

These pathways generated from the economy-wide GEM are used as an input for the firm-level financial analysis. This is done by considering existing market shares of firms and stated targets between 2020 and 2050. The inputs from GEM are supplemented with annual reports and financial statements published by the firms (see Figure 13.1).

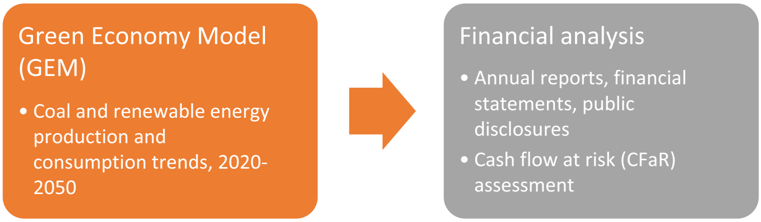

Figure 13.1 Framework for identifying financial risk to energy PSUs.

Source: Recreated from: Viswanathan et al. (2022).

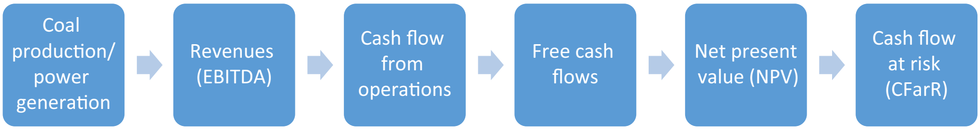

Figure 13.2 Framework for estimating cash flow at risk for energy PSUs.

Source: Recreated from: Viswanathan et al. (2022).

The financial analysis follows a sequence as shown in Figure 13.2. First, the inputs from GEM are used to identify future revenues and expenses under both scenarios. Using this, the annual cash flow is estimated for 2020–2050. Using the cost of finance as a reference, the future cash flows are adjusted to present values. The difference in cash flows at present values across both scenarios (BAU and Aspirational) gives the cash flow at risk (CFaR).

In the next two sections, the methodology has been applied to CIL and NTPC. The results are indicative and based on publicly available information. A more rigorous assessment can be done by the PSU themselves using internally available data.

Estimated Cash Flow at Risk: CIL

CIL's financial flows are integrally tied to the amount of coal produced domestically, which in turn is linked to the domestic coal demand. Under a BAU case, the total coal produced nationally crosses 1 billion tonnes in line with current production targets and peaks by 2035. However, under the aspirational scenario, the peaking takes place by 2025 and reduces dramatically after 2030 (Viswanathan et al., 2022). IEA analysis released in November 2022 supports this trend where under the Announced Pledges Scenario (APS), India's coal production falls by 80% between 2030 and 2050 (IEA, 2022). Consequently, the biggest reduction in CIL annual free cash flows can be seen from 2030 (see Figure 13.3).

When discounting at 12%, the estimated cumulative CFaR is Rs. 24,438 crore in 2030 and Rs. 2.1 lakh crore in 2050, a nine-fold increase (see Figure 13.4).

Estimated Cash Flow at Risk: NTPC

NTPC finances are fundamentally tied to the amount (units) of electricity sold, regardless of the source of power generation. While NTPC operates nearly 70 GW of

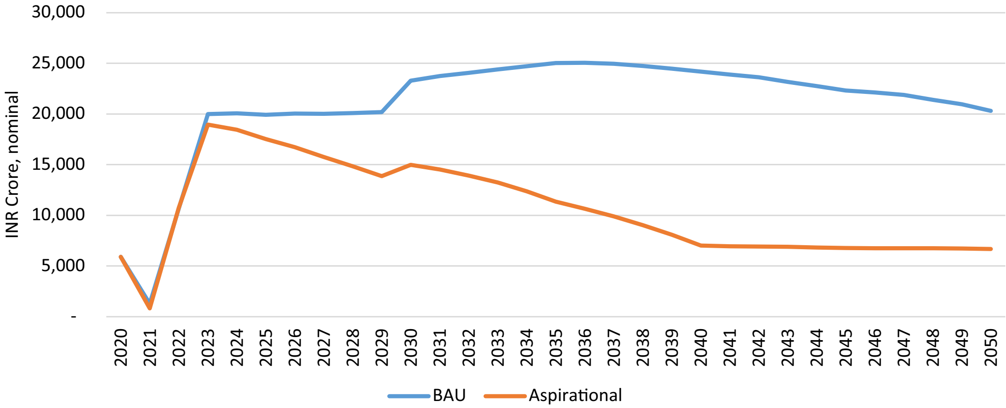

Figure 13.3 Annual free cash flow, CIL, 2020–2030 (Rs. crore, nominal).

Source: Recreated from: Viswanathan et al. (2022).

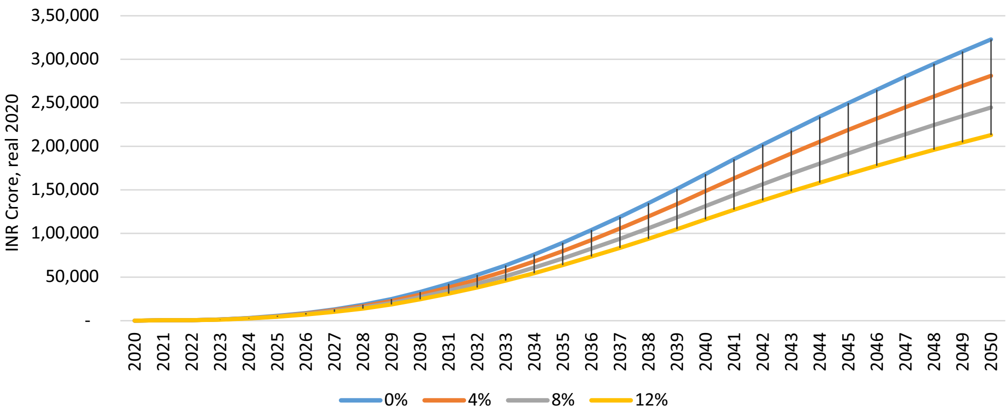

Figure 13.4 Cumulative cash flow at risk adjusted for varying cost of finance, CIL (Rs. crore, real 2020).

Source: Author compilation.

thermal power plants, it also has plans to dramatically scale up its renewable assets. For NTPC under a BAU scenario, the power generated from coal peaks by 2035, and by 2045, renewables start generating more than coal. Meanwhile, in an aspirational scenario, power generation from coal is matched by renewables in 2035 and falls to zero by 2050 (Viswanathan et al., 2022). Due to these changing trends, the annual free cash flows fall between 2030 and 2045 before the renewables start taking over (see Figure 13.5).

Despite an overall increase in free cash flows over the period, NTPC faces a considerable cumulative CFaR. When discounting at 12%, the estimated cumulative CFaR is Rs. 13,072 crore in 2030, Rs. 1.5 lakh crore in 2040, and Rs. 1.8 lakh crore in 2050 (see Figure 13.6).

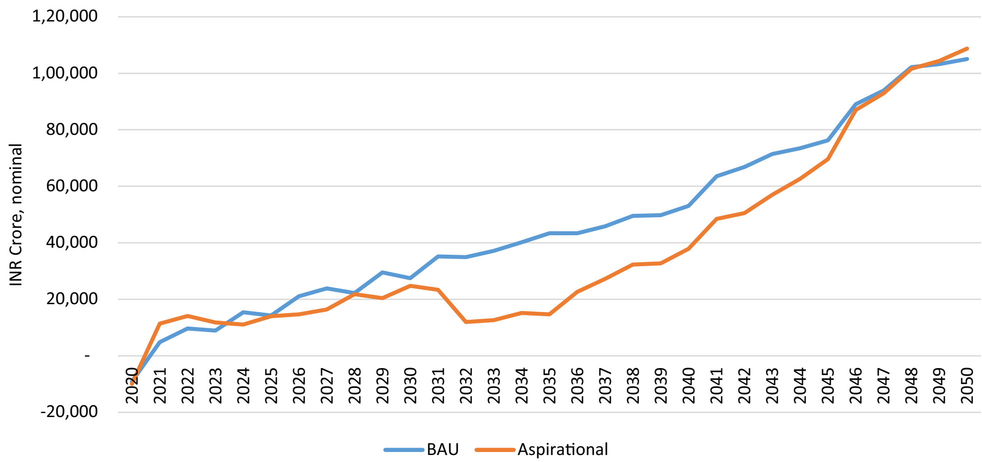

Figure 13.5 Annual free cash flow, NTPC, 2020–2030 (Rs. crore, nominal).

Source: Recreated from: Viswanathan et al. (2022).

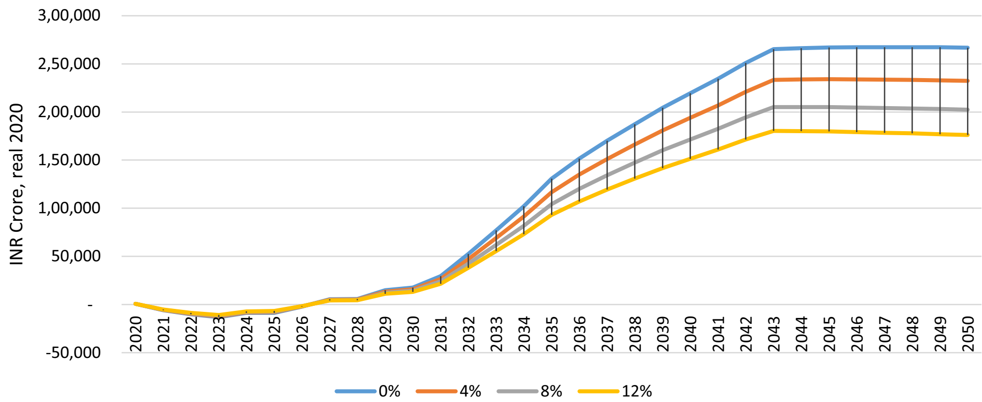

Figure 13.6 Cumulative cash flow at risk adjusted for varying cost of finance, NTPC (Rs. crore, real 2020).

Source: Author compilation and analysis.

These findings indicate that both NTPC and CIL face significant financial uncertainty if India were to follow a more aspirational pathway. To be prepared for a changing energy system, these PSUs must develop a diversification strategy. In the next section, a framework has been described which can be used to future-proof the PSUs.

Building Diversification Strategies

Approach and Methodology

For the evaluation of suitable businesses for diversification and to develop strategies to decarbonise a PSU's business operations, a two-step approach is proposed. The first step towards a diversification strategy could identify suitable business segments through a SWOT analysis coupled with Porter's diamond analysis to prioritise these identified business segments for investment. The second step could identify suitable businesses within the identified business segments which would be facilitated through a multi-criteria decision analysis (MCDA). These identified businesses could be synthesised into a portfolio by factoring in business life cycles using a growth–share matrix.

Step 1 – Approach for identifying diversification segments.

A SWOT analysis assists in the identification of business segments aligned with the firm's present business profile and market conditions, incorporating a systematic evaluation of internal factors (strengths and weaknesses) that are within the PSU's control and external factors (opportunities and threats) that emanate from the environment and impact a business's sustenance and growth. Porter's diamond analysis (Porter, 1998) guides investment prioritisation in the identified business segments. Additionally, it also lays the foundation for detailed business-level analysis within each diversification segment. This approach is highlighted in Figure 13.7.

Step 2 – Approach for analysing business opportunity within diversification segments.

MCDA is a tool that can help in the comparative suitability assessment of businesses by weighing various criteria to reflect their relative importance. Consolidated scoring under MCDA for each business can help in the rating of businesses in the order of suitability. While there may be multiple suitable businesses identified through MCDA, the time sensitivity of investments in these businesses requires an additional augmentation tool. The growth–share matrix is a tool that can be used to develop suitable investment profiles for each PSU, based on related market share and growth over a considerable period.

This analysis can help in the development of suitable business diversification strategies for PSU to achieve the goal of decarbonisation while ensuring long-term

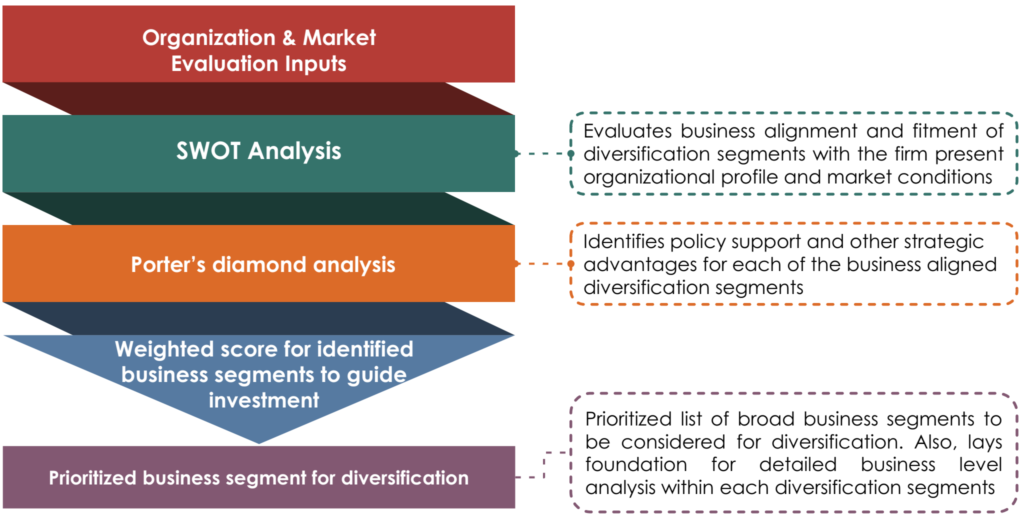

Figure 13.7 Approach for identifying diversification segments.

Source: Climate Policy Initiative.

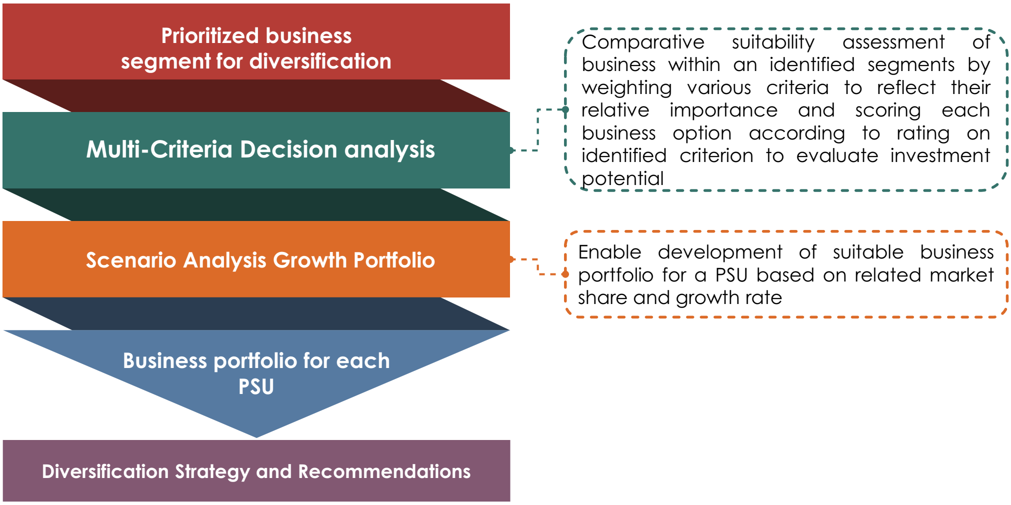

Figure 13.8 Approach for analysing business opportunity within diversification segments.

Source: Climate Policy Initiative.

financial viability of PSU business operations in related areas. This approach is highlighted hereunder in Figure 13.8.

Mechanism for Identification of Suitable Diversification Segments

SWOT Analysis to Analyse the Business's Alignment and Fitment with the Firm Present Business Profile, Plans, and Market Conditions

Strengths and Weaknesses

Strengths and weaknesses are intrinsic attributes of a business that determine its alignment with the organisation's existing business profile and plans. Strengths and weaknesses are responsible for endowing an organisation with or depriving it of a position in the market related to the business and stature within its environment. To assess these dimensions, various factors can be considered such as financial health, existing investments, expertise, experience in businesses/operations, market share, organisational inertia, and availability of skilled workforce.

Opportunities and Threats

This evaluates the external market conditions which impact the business. Market competition, technology maturity, growth potential, and access to financing are the several factors that can be considered. By assessing these factors, the business segment(s) suitable for diversification can be identified based on the combination of strengths and opportunities such that the organisation could capitalise on its strengths to exploit the opportunities available in the market by minimising its internal weakness and counteracting market threats.

SWOT – PSU Perspective

The inherent strengths of Indian PSUs like NTPC and CIL include their strong financial positions with cash balance, dominant market positions, Government of India support, and large skilled workforces. Amongst the key weaknesses that they face towards diversifying their business are organisational inertia towards existing core businesses and lack of experience with inorganic growth. Considering opportunities and threats in the market such as rapid growth in RE, international commitments to reducing emissions, and growing cost competitiveness of storage, PSUs could consider businesses up and down the value chain of their core business for diversification.

Porter's Diamond Framework-Based Assessment of Policy and Government Support for Business Enablement

Porter's Diamond framework helps identify the competitive advantages amongst businesses for industries which operate in a regulated environment and do not enjoy open/free market conditions. The framework does so by factoring in government support through various regulations and policies by considering four major factors to determine the competitiveness of a specific industry in a country: factor conditions; demand conditions; related and supporting industries; and firm strategy, structure, and rivalry along with the government influence on these factors. The analysis can be applied to each investment segment identified under SWOT for the respective PSUs to develop business segment-level priorities.

Factor Conditions

Factor conditions represent the factors (inputs) available in the country to enhance the competitive advantage of the industry. Availability of natural resources domestically on which industry has a major dependency, adequate infrastructure development by the government to assist the industry, and ease of financing the projects through preferential capital are the factors that may be considered in the approach.

Demand Conditions

Demand conditions define the nature of domestic demand for the product or the services provided by a particular industry. There are broadly three significant factors that may be considered in the approach: domestic market size, policy and regulatory support by the government to develop the demand for the product, and the number of business-to-business customers to estimate market demand.

Related and Supporting Industry

This aspect defines the presence of various supporting industries that can contribute to the value chain of a specific industry by sharing intersectoral activities. Factors that may be considered are adequate availability of suppliers which drives market competition and innovation, incentives to suppliers by the government to drive the growth in production, and international competitiveness of the supplier to access its global market acceptance in terms of product performance and pricing.

Firm Strategy, Structure, and Rivalry

This dimension determines the firm's strategic alignment with specific industry and market competitiveness. Factors that may be considered are: organisational targets to determine its alignment with the business, initiatives, and actions undertaken by the firm for market penetration (formation of subsidiaries) and understanding (pilot projects and MoUs) and the number of players in the market to evaluate market competitiveness.

Government

Government policies and regulations have a direct and indirect influence on the three determinants to determine competitiveness: factor condition, demand condition, and related and supporting industry. Through various policies and regulations, government may influence factor condition by developing supporting infrastructure, demand condition by developing demand for the product, and related and supporting industry by providing incentives to attract businesses in the segment and increase market competitiveness.

Framework

To identify the attractiveness of the industry for each PSU, a weight of 5 may be assigned to each of the four conditions adding up to 20. A rating scale with values 0–2 and 0–1 may be considered for each of the sub-conditions, depending on the range of responses; a higher rating indicates that there is a higher degree of compliance with that factor. On a rating scale with values of 0–2, a score of 1 signifies limited agreement with the particular factor. An illustrative example is provided in Table 13.1.

Government support to the industry may also have an indirect weightage of 5. Adequate supporting infrastructure from factor condition, incentivising policy for demand creation in demand factor, and production-linked incentives to the supplier in the related and supporting industry can have a weightage of 1, 2, 2, respectively, which portrays the government support to the industry to determine national competitiveness of a particular industry (see Figure 13.9).

Porter's Diamond PSU Perspective

Most of the business segments in which the PSUs operate are regulated and are significantly influenced by government priorities. Business segments like renewable energy, e-mobility solutions, and energy storage are also some of the business segments to have government support, and therefore PSU strategies may be aligned to investing in the same. Therefore, Porter's diamond analysis emerges as a useful framework for identifying business segments' attractiveness as it factors in the influence of government policies, targets, and decisions.

Table 13.1 Determinants of Porter's diamond analysis

Determinants	*Response*	*Weight*
Factor condition		5
Domestic natural resource adequacy	Yes, no, limited	2
Adequate supporting infrastructure	Yes, no	1
Access to preferential capital	Yes, no, limited	2
Demand condition		5
Domestic market size	USD billion	2
Incentivising policy for demand creation	Yes, no, limited	2
No. of B2B customers	Less than three or more	1
Related and supporting industry		5
Adequate domestic suppliers	Yes, no, limited	2
Production-linked incentives to suppliers	Yes, no, limited	2
International competitiveness of suppliers	Yes, no	1
Strategy, structure, and rivalry		5
Company target	Yes, no	1
Initiative/action taken (pilots, MoU, etc.)	Yes, no	2
Number of market competitors	<2, 2, >2	2

Source: Climate Policy Initiative.

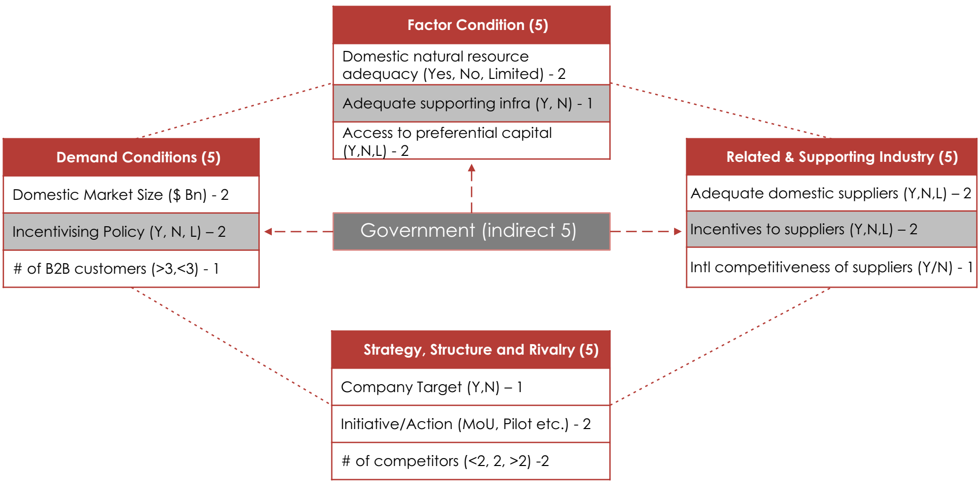

Figure 13.9 Structure of Porter's diamond analysis.

Source: Climate Policy Initiative.

Mechanism for Identification of Suitable Businesses within the Identified Business Segments

Multi-criteria Decision Analysis to Identify Suitable Business Diversification within the Business Segment

To determine the suitable business for diversification for each PSU within the business segment, multi-criteria decision analysis (MCDA) approach may be applied considering various environmental, economic, and technical factors. MCDA provides a comparative suitability assessment of businesses within an identified segment by weighting various criteria to reflect their relative importance and scoring each business option according to rating on identified criteria to evaluate investment potential. Factors that may be considered in MCDA can be classified into two criteria categories: qualifying criteria and scoring criteria. Considering these factors, suitable businesses can be identified for diversification to mitigate energy transition risks and decarbonise their business operations.

Qualifying Criteria

The qualifying criteria aim to serve as a checklist that can inspire the development of business diversification and decarbonisation strategy based on technical maturity, government support in the form of policy, and carbon mitigation potential. Businesses that meet threshold requirements may further be considered in the scoring criteria for diversification.

Scoring Criteria

The scoring criteria give guidance on how the identified businesses may be ranked based on the suitability for diversification, considering factors like investment potential, return on equity, and business-related risk to evaluate investment potential.

Framework

A business, to be considered suitable under this proposed framework for diversification, with an aim to decarbonise business operations, should satisfy all the following factors:

a. *Technology maturity* – Commercial viability of the specific technology related to the business demonstrated successfully either domestically or globally.
b. *Presence of policy support* – Direct and indirect support to the business from the government be present in the form of policies, regulations, and incentives.
c. *Carbon mitigation potential* – Business operations be carbon neutral or have carbon mitigation potential or assist carbon-mitigating business by providing supporting infrastructure and sharing intersectoral activities.

Table 13.2 Qualification criteria

Factors	*Yes*	*Partial yes*	*No*
Technology maturity	Advanced domestically	Internationally advanced	Technology demonstration stage
Presence of policy support	Policies and incentives present in support of the business	Indirect presence of policy support and incentives	Absence of supporting policies and incentives
Carbon mitigation potential	Business with carbon-mitigating potential	Carbon neutral business and carbon mitigation assisting business	Carbon emitting business

Source: Climate Policy Initiative.

A business to be considered for further evaluation under the proposed framework should satisfy all the above-mentioned factors. To gain an overall impression of the business and to rank the businesses in order of suitability for diversification, the following scoring criteria may be considered:

a. *Domestic investment potential* – This is determined using various national targets and projected domestic demand. Sizeable market/investment potential propels business growth and provides opportunities for market penetration and growth to the market players.
b. *Return on equity* – This can be determined from industry averages, regulated returns, and expert inputs (in new businesses). The higher the return, the more lucrative the business for shareholders.
c. *Business risk*
    i. *Capital work-in-progress (CWIP) period* – CWIP refers to the time required for the construction of the project. As the beginning of the recovery of the cost happens after the CWIP period, a lower CWIP period would be encouraging.
    ii. *Market competition* – Competitive market results in a fall in price and reduces profit margins. Competition in business can also shrink a company's market share. Therefore, lower market competition would be desirable.
    iii. *Organisational experience* – Initiatives undertaken by the organisation through business investments, MoUs, pilot projects, and joint ventures demonstrate organisation's willingness and experience.
    iv. *Import dependency* – A business becomes more vulnerable to geopolitical risks and foreign exchange volatility risks with high import dependency. This builds upon the government's Atmanirbhar Bharat initiative and therefore low import dependency would be desirable.

To rank the businesses by suitability for diversification, each criterion can be assigned desired weightage and a rating scale of 0–5 can be considered. Considering the range of responses, a higher rating would indicate that there is a higher degree of compliance with those factors in support of the business.

MCDA – PSU Perspective

This MCDA goes deeper into business-level analysis and considers critical factors for these PSUs such as policy support, carbon mitigation and technology maturity. These are critical for PSUs as they are owned by the government and need to remain aligned to the direction of public policy, including on initiatives like Atmanirbhar Bharat and commitments on carbon mitigation. Also, PSUs need to be more mindful than private sector peers when venturing into new businesses on account of their lower risk appetites, thereby a preference for lower risk mature technologies.

Growth–Share Matrix Analysis to Determine Suitable Business Portfolio

The growth–share matrix (BCG, 1970) may be applied to determine a strategic business portfolio for diversification. The growth–share matrix classifies businesses into four diverse groups based on the attractiveness of the industry and its competitive position, classified as "Pet, Question mark, Cash cow, and Star." This proposed framework characterises businesses on the basis of expected growth rates and likely market share over a 2 × 2 matrix capturing potential to classify them in the four groups mentioned.

"Pet" businesses are likely to have both low growth rates and low market share. These businesses may therefore generate limited revenues which would be required to maintain their operations. There would be limited chances for these businesses to grow bigger or more profitable in near future.

"Question mark" businesses are likely to have high growth rates but low market shares. These businesses can explore untapped opportunities and may be attractive because of the high market growth they enjoy. However, these businesses would need to capture significant shares of their respective market for them to be valuable.

"Cash cow" businesses are likely to have low growth rates but a high market share. These businesses can offer stable sources of revenue for the organisation. As these businesses have low growth, they may not be able to power the organisation's growth ambitions, but because of their high market share, they can generate significant revenue, which can be utilised for developing other businesses within the firm.

"Star" businesses are likely to have both high growth rates and a high market share. These would be highly attractive businesses that generate a large amount of revenue by leveraging their successful market dominance status. But to achieve this state, these businesses may also require significant capital investment to sustain the growing market.

The growth–share matrix can offer a powerful and compact picture of the strengths of businesses in the firm's portfolio by identifying the capacity of each business to generate revenues and also revealing the requirement of investment for each business, thereby assisting in balancing the firm's financial flow by assessing the distinct characteristics of each business and suggesting strategic directions for each business.

While developing the firm's business portfolio for more than one period, movement of businesses within the growth–share matrix can also be considered. The ideal sequence may be one where a "question mark" business captures the market to become a "star" at the first stage, and in the second stage there may be saturation leading to a decline in growth rate but retaining of competitive strengths required to become a "cash cow." In the final stage, a business may lose its market relevance and become a "pet," and the firm could consider divesting from such businesses.

An effective strategy for expediting the process of business diversification and developing a suitable business portfolio may emphasise businesses where there is a strong growth rate accompanied by potential to achieve high market share ("star" businesses and "question mark" businesses which may become "star") (see Figure 13.10).

Growth–Share Matrix – PSU Perspective

NTPC (with its subsidiaries) has a 27% share of India's thermal installed capacity and generated 24% of the total country's electricity generation during 2021–2022. CIL carters 80% of its total supply to the power sector and produces over 83% of the country's total coal output. PSUs enjoy a dominant market share and are likely to invest strategically in the businesses to establish their presence as a relevant market player and maintain their economic relevance. The growth–share matrix can factor the time sensitivity of a business considering related market share and growth over a considerable period to help develop a business portfolio for PSUs by guiding investment into businesses that may offer high growth and large market share.

Recommendations and Way Forward

Business Recommendations

Considering this global shift, along with India's climate commitments, PSUs like CIL and NTPC will need to factor in the transition-linked impacts on their businesses and growth plans. Such diversification would not only de-risk the long-term financial position, particularly cash flows, but also provide the opportunity to become a lead change maker and thereby uphold their dominant position in the energy and economic sphere of India. Keeping this in consideration, key recommendations for strategic realignment are:

- ***Addressing climate-related physical and transition risks by*** evaluating existing and planned investment in assets judiciously, factoring in their long-term potential and necessary costs on transition technologies or future market compliance.
- ***Remaining relevant and maintaining competitiveness by*** prioritising low-carbon investments at an early stage to gain market dominance to deliver sustained growth and avoid competitive pressures.
- ***Incorporating national targets in business strategy and leading the change by imbibing*** the government's initiatives, targets, and climate commitments alongside their objectives of fuelling the country's growth and ensuring its energy security.

Way Forward

Any strategic action and investment decisions taken by the country and in turn by these public sector enterprises to decarbonise their operations will have a significant impact on the pace of India's transition to a low-carbon economy. Indian PSUs can leverage their current position to invest and gain dominance in businesses likely to benefit from transition. Riding on the growing policy support and a strong financial base, reformulation of existing and future business models could lead to significant strategic advantages. Such

Figure 13.10 Growth share matrix to determine suitable business portfolio.

Source: Recreated from: BCG (1970).

diversification would not only de-risk their long-term financial position of the PSUs, particularly cash flows, but also provide them the opportunity to become a lead change maker and thereby uphold their dominant position in the energy and economic sphere of India.

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Appendix 13A

Economics of Coal-Fired Power Plants

Abhishek Raj

The capacity utilisation of India's coal-fired power plants (called coal plants henceforth) has declined over the last decade due to excess capacity, lower-than-expected growth in demand, and rapidly increasing share of renewables. The Central Electricity Regulatory Commission prescribes a Plant Load Factor (PLF) of 85% for recovery of capacity charge, whereas the average PLF of coal stations in India was 58% in FY22 and has been below 80% since 2010, and continuously declining (Ministry of Power, 2023). Apart from excess generation capacity in the system, renewables also have must-run status. As a result, high renewable energy generation periods necessitate coal plants backing down generation. As India embarks towards its 2030 target of 500 GW of non-fossil capacity, the PLF of new coal plants is likely to remain low. The draft National Electricity Plan 2022–2027 estimates a PLF of 55% in 2026–2027 marginally increasing to 62% in FY 2031–2032, under optimistic demand growth conditions (CEA, 2023).

To determine the future electricity mix that minimises the cost of generation, it is important to replace the practice of assuming an 85% PLF while estimating the cost of electricity from new coal plants with more realistic assumptions on utilisation and conditions of operation. Low-capacity utilisation significantly increases the per-unit cost of coal generation. Per-unit fixed cost of electricity increases as capacity charges are paid for plant availability and not actual dispatch. Variable costs also increase due to lower efficiency on account of increased station heat rate.

With a future electricity mix dominated by renewables, especially solar, coal plants will often be forced to operate at a technical minimum during the daytime, with significant flexibility in operation. Operating in low-loading conditions will add to Operation and Maintenance (O&M) cost and will require investments for retrofitting to meet flexibility requirements.

It usually takes 5–7 years for a coal plant to complete construction. Any new coal plant construction starting in 2023 is unlikely to commence operation before 2028–2030.

Table 13.3 depicts levelised cost of electricity (LCOE) of hypothetical new coal plants at different load factors, based on capital expenditure requirements specified in the National Electricity Plan.

Table 13.3 Levelised cost of electricity of coal plants

Pithead coal plant	*Year of commencement*		
(Rs./kwh)	2028	2029	2030
LCOE at 85% PLF	5.31	5.43	5.56
LCOE at 60% PLF	6.41	6.56	6.72
LCOE at 55% PLF	6.75	6.91	7.07

Scalable Renewable Energy (RE) Alternatives to Coal Power Plants

Solar and wind energy have a lower per-unit cost of electricity when compared to coal but are infirm sources, subject to variability. Energy storage technologies solve these limitations and can serve as an effective replacement for new coal plants being built to meet demand peaks that cannot be met by RE. The price of lithium-ion batteries has declined significantly over the last decade and is expected to decline further. However, in 2022, battery prices went up due to the rise in the price of raw materials. This price rise is expected to be temporary, but it has led to an increased focus on developing alternative chemistries for grid-scale storage, such as sodium-sulphur, sodium-ion, and liquid metal amongst others.

In 2020, ReNew Power won a bid put out by Solar Energy Corporation of India to supply Round-the-Clock (RTC) power at Rs 3.6/kWh levelised tariff. The project will supply power at an 80% PLF with a minimum 70% monthly utilisation, comparable to coal plants. The 400 MW RTC project is likely to be supplied by 900 MW of wind and 400 MW of solar, supplemented by 100 MWh of battery storage (Mercom, 2022). The project oversizes the RE project to supply the contracted amount of RTC. Oversizing RE projects without storage is also possible but the size of RTC supply will be smaller. Oversizing RE projects for RTC supply have limitations, as reliable alternatives for selling excess generation are required for project feasibility. In addition, there have also been auctions that blend renewables with conventional sources such as hydro and thermal power, with a minimum guaranteed supply from renewables.

Renewable power paired with significant storage capacity will soon be cost-competitive with new coal, with steep learning curves being observed in renewable and storage costs. According to the draft NEP, capital expenditure for 5 hours of storage (adjusted upwards for depth of discharge) is expected to drop from 9.3 Cr/MW in 2022 to 5.24 Cr/MW in 2030. Table 13.4 depicts the Levelised Cost of Storage (standalone, not paired with RE) estimates as per NEP assumptions.

Table 13.4 Levelised cost of storage

Storage (5 hours)	*Year of commencement*		
(Rs./kwh)	2028	2029	2030
LCOS	5.66	5.35	5.05

The choice between coal and renewables for meeting the peak load while minimising the cost of generation requires multiple considerations. The year of capacity addition, size of additional capacity required, and demand in non-solar hours have implications on the choice of alternatives. RTC auctions with oversized RE have proved to be more economical than coal power and can be used to meet some of the incremental demand before large-scale energy storage becomes viable. However, in a scenario with strong electricity demand growth from 2022 onwards, limits to scaling with oversized RE will likely emerge.

Coal plants have a long gestation period of 5+ years once permits are granted, with cost overruns (as compared to initial estimates) being the norm. Additionally, the cost of coal power is inflationary in nature due to the increase in coal price and logistics. On the other hand, renewables and storage have a much shorter deployment period of 1.5 and 0.5 years, respectively, and have a deflationary cost trend. However, there is still some uncertainty around the cost estimates of lithium-ion batteries due to factors such as the availability of raw materials, increased deployment, and technological breakthroughs. The reversal of lithium-ion cost declines observed in the last year and uncertainty about its trajectory in the short term has led to recent calls for further coal capacity expansion in India. However, it is increasingly probable that by the time any new coal capacity commences operation, it will be economically unviable compared to the same generation from a combination of RE + battery storage.

New coal plants are not compatible with the target of limiting temperature increase to 1.5°C (Ganti and Brecha, 2019). Development finance institutions such as the Asian Development Bank and Climate Investment Fund are developing pilots for retiring coal plants. New research by LUT University suggests that by transitioning to renewables by 2050, India can reduce its electricity costs by 40%. The study estimates the cost of renewables to fall further by 50–60% by 2050 and the cost of coal power to increase by 70% (Gulagi et al., 2022). The rapidly evolving economics of electricity generation has tipped in favour of renewables already, and will soon favour battery storage as well. This, in combination with the imperative to bring down global fossil fuel emissions by 2050, will make it likely that any new coal power plant will not be permitted to complete its useful economic life of 25 years or more.

Benefits of Retiring/Repurposing Older Coal Plants

Excess coal-fired power generation capacity is the main reason why fleet capacity utilisation factors are low. This has also meant that younger, more efficient units are, in some cases, being sub-optimally utilised. At the same time, distribution utilities are saddled with fixed cost payments with contracted plants, even if they are not always utilised due to merit order placement. The surplus capacity in the system means that in the short-to-medium term, there is, in most cases, no shortage of peaking power availability.

This combination of factors allows for an opportunity for states to selectively retire a few of their oldest/least efficient/most expensive power plants, replacing their generation with cheaper new renewable capacity or even renewables with storage capacity, lowering the average cost of generation. This will also allow for rationalisation of coal linkages to replace supplies from distant mines with mines closer to the operating fleet, generating additional savings. Retiring older plants will reduce the investment needed for pollution control technologies to meet air pollution standards.

Climate risk horizons analysis for Maharashtra shows that there is up to 4.02 GW of potential retirements in the state that can be made at a significant financial benefit, as demonstrated in the table 13.5.

Table 13.5 Maharashtra: potential savings from retiring 4,020 MW coal plants over 20 years of age

Savings summary	
Avoided retrofits by phasing out plants older than 20 years	Rs. 2,063 Cr
Coal supply rationalisation to reduce freight charges	Rs. 627–967 Cr per annum
Replace lost generation from plants 20 years and older with renewable energy	Rs. 1,656 Cr per annum

Data inputs

Pit head coal plant levelised cost of electricity (LCOE)		
Particulars	Value	Source
Capex	Rs. 10.28 Cr/ MW (2027)	NEP
O&M	Rs. 20.93 lakhs/MW (2024)	CERC, inflation adjusted
Coal GCV	3,250 kcal/kg	Jindal and Shrimali
Coal price (Rs./MT)	Rs. 3000	Jindal and Shrimali, inflation adjusted
SHR	2390 kcal/kwh	CERC, adjusted for flexible operation as per CEA study on flexible operation
Auxiliary consumption	8.5%	NEP
Plant life	25 years	
Cost of debt	12%	
Cost of equity	15.5%	
Debt:equity ratio	70:30	

Levelised cost of storage (LCOS) 5 hours		
Particulars	Value	Source
Capex (adjusted for depth of discharge)	Rs. 5.24 Cr/ MW (2030)	NEP
Opex	1% of Capex	NEP
Project life	15 years	NEP
Cost of debt	9%	
Cost of equity	15.5%	
Debt:equity ratio	75:25	

Source: Fernandes, Ashish, and Harshit Sharma. "Maharashtra's Energy Transition: A 75,000 Cr. Savings Opportunity." Accessed January 7, 2023. https://climateriskhorizons.com/research/Maharashtra-Enery-Transmission.pdf.

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Appendix 13B

Collaborations Among Indian Firms as a Business Strategy to Foray into Green Hydrogen

Vibhuti Garg

India has laid out ambitious plans for renewable energy. Further, the Central Government announced the Energy Conservation Bill 2022 (*The Energy Conservation (Amendment) Bill, 2022*, n.d.), which empowers the government to lay down different consumption thresholds for various non-fossil sources and consumer categories. In addition, the government approved the green hydrogen mission with the target of development of green hydrogen production capacity of at least 5 MMT (million metric tonne) per annum with an associated renewable energy capacity addition of about 125 GW in the country (PIB, 2023).

PSUs Taking the Lead in Building Partnerships

It becomes imperative that Public Sector Undertakings start joining hands with renewable energy companies to decarbonise their operations, particularly for the production of green hydrogen in India. The development of a green hydrogen ecosystem is highly capital-intensive. Conventional debt will not be available to fund these forays. A large part of the capital will need to come from the promoter’s balance sheet. Thus, for one particular company to diversify, across the green hydrogen value chain carries many risks and requires huge capital. Hence, collaborations are necessary to successfully develop green hydrogen/green ammonia in India.

Collaborations can help companies to continue with their primary business but at the same time decarbonise and shift towards clean energy. The partnerships can happen in the form of joint ventures (JVs), the creation of Special Purpose Vehicles (SPVs), etc., to provide firm power.

Build Strength Across the Value Chain

One such example is Indian Oil Corporation (IOC) and NTPC signing an agreement in July 2022 to form a JV company to meet the power requirement of upcoming projects of IOC refineries with round-the-clock renewable energy to the tune of 650 MW by December 2024 (*Indian Oil, L&T, ReNew Power in JV For Green Hydrogen*, n.d.).

IOC is further showing its commitment towards a cleaner goal by signing a Memorandum of Understanding (MoU) in October 2020 through its Research and Development Centre (R&D) with the Indian Institute of Science (IISc) (*Indian Institute of Science*, n.d.). The partnership aims to develop biomass gasification-based hydrogen generation technology for producing fuel cell-grade hydrogen at an affordable price. Under this MoU, IISc and IOC will work jointly to optimise biomass gasification and hydrogen purification processes.

IOC is going big on green hydrogen. The company signed a pact in February 2021 with Greenstat Norway to set up a Centre of Excellence on Hydrogen (COE-H) (www.ETEnergyworld.com, n.d.). The COE-H will facilitate the transfer and sharing of technology, know-how, and experience through the green hydrogen value chain and other relevant technologies, including hydrogen storage and fuel cells.

Larsen & Toubro (L&T) and ReNew Power have also signed a tripartite agreement with IOC to supply green hydrogen at an industrial scale (*Indian Oil, L&T, ReNew Power in JV For Green Hydrogen*, n.d.). The tripartite venture brings together the strong credentials of L&T in designing, executing, and delivering EPC projects, IOC's expertise in petroleum refining along with its presence across the energy spectrum, and ReNew Power's prowess in offering and developing utility-scale renewable energy solutions.

Leveraging Individual Strengths

In June 2022, Oil and Natural Gas Corporation Limited (ONGC) signed an MoU with Greenko ZeroC Private Limited to jointly pursue opportunities in renewables, green hydrogen, green ammonia, and other derivatives of green hydrogen ("ONGC Inks MoU with Greenko to Manufacture Green Hydrogen," 2022).

State-owned GAIL (India) Ltd is also building India's largest green hydrogen-making plant to supplement its natural gas business with carbon-free fuel. GAIL can also collaborate with other renewable energy companies to produce green power (*India's Largest Green Hydrogen Plant to Be Built by GAIL*, 2021). Such synergies will drive more efficiency and cost optimisation in achieving climate goals. Given there is a demand from such PSUs, more investments will go into renewable energy deployment as off-taker risks get minimised.

If such collaborations and partnerships are successful, many more PSUs will likely follow, given that the government is setting out their individual net-zero targets or consumption targets for certain sectors.

Private Companies Too Have Joined the Bandwagon

Further, such partnerships are not only restricted to PSUs, and even private companies are playing to their strengths and joining hands with each other. For example, Larsen & Toubro, India's leading engineering conglomerate, and ReNew Power, India's leading renewable energy company, announced a partnership agreement in December 2021 to tap the emerging green hydrogen business in India. Under this agreement, L&T and ReNew will jointly develop, own, execute, and operate green hydrogen projects in India (*L&T and ReNew Announce Partnership to Focus on the Green Hydrogen Business in India*, n.d.).

Adani has signed an MoU with Ballard Power Systems for fuel cell manufacturing in India ("Adani Group, Ballard Power Systems Sign MoU for Hydrogen Fuel Cell JV," 2022).

Greenko Group also joined hands with John Cockerill, a Belgian manufacturer of alkaline electrolysers. Greenko and John Cockerill aim to jointly develop market initiatives for green hydrogen electrolysers in India and innovate technologies to manufacture carbon-negative fuels.

If we look at the global trends, green hydrogen development is a part of industrial clusters. In industrial clusters, several different entities will be operating, each with diverse expertise, including green hydrogen producers, logistics providers, and end-users. Thus, collaboration is important among all these entities within a cluster. In India, too, this template is being followed. Mangalore is becoming the hotspot for green hydrogen projects in the country.

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14 Evaluation of Energy and Environmental Efficiency of the Indian Thermal Power Plants

A State-Level Analysis

Sabuj Kumar Mandal

Introduction

In India, thermal power plants produce almost 60% of the total CO_2 emissions. The majority of the thermal power in India is generated from non-renewable sources such as coal, lignite, diesel, and natural gas. Coal- and lignite-based thermal power generation has been the backbone of power generation because of their abundant supply. Coal-based thermal power plants (TPPs) in India are less efficient than the power plants in other developed countries. This is due to the quality of fuel used for power generation. Even though the Indian coal-based fuel for TPPs has low calorific value and high ash content in comparison to that of gas-based fuels, it is highly unlikely for India to make a shift to gas since accessibility and affordability are key factors. The carbon intensity of the Indian power sector is higher than the global average. Along with that, India's coal-based electricity generation has rebounded strongly by 13% in 2021 after a decline of 3.7% in coal generation in 2020 (IEA, 2022).

Since the thermal power sector is very important for the functioning of the country, it is crucial to analyse energy use (in)efficiencies that exist in this sector and to understand how to alleviate them. The 12th five-year plan (2012–2017) has recognised peak electricity demand and deficit and has encouraged private sector investments to make the country self-sufficient in terms of electricity and to reduce energy imports. Therefore, to achieve such energy sufficiency and reduce emissions it is crucial to estimate and understand the energy use efficiency levels of the TPPs located across several Indian states. It is of significant interest to understand the behavioural dynamics of the power sector, which can possibly answer important questions about the country's electricity needs and about how CO_2 emissions can be reduced in this sector. Achieving a higher energy use efficiency of the power plants will not only reduce emission to a large extent and make them sustainable, it will also make them competitive globally.

This study makes an attempt to estimate energy use efficiency of the Indian thermal power plants adopting a Data Envelopment Analysis framework. State-level data on electricity generation and fuel utilisation is used for the period 2018–2019 and 2019–2020. The empirical results show that for the years 2018–2019 and 2019–2020, an overall input reduction of 13% and 15%, respectively, is feasible to generate electricity with the given inputs and technology indicating that a significant amount of emission reduction is possible just by improving the energy use efficiency of the power plants.

This chapter is organised as follows. A brief literature review is presented in "Literature Review." An overview of the thermal and renewable energy sectors is presented in Thermal Power and Renewable Energy Sectors. The data and methodology used are

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discussed in Energy Efficiency Estimation for the Indian TPPs. The results and discussion of the analysis are presented in the latter part of the section. Conclusions along with direction for future research are presented in the last section.

Literature Review

Some of the notable studies that have focused on estimating the energy efficiency of the thermal power sector include Chai et al. (2020). This study used a slacks-based measure-data envelopment analysis (SBM-DEA) for a few listed companies in China to find their technical efficiency and their relationship with the industry. The results show that the sustainability factor of green energy, even though commendable, lacks in efficiency, unlike the thermal power sector where efficiency levels are higher. In the Indian context, Singh (1991) has found technical efficiencies in the thermal power sector and attempted to find the relationship between the plant size and its technical efficiency. The chapter finds a positive relationship between a thermal power plant's size and its efficiency level. A non-parametric DEA model used by Chitkara (1999) to estimate operational inefficiencies of Indian power plants highlight measures required to improve efficiencies of the power plants. It includes improving technical knowledge, better use of the production inputs, and initiating a performance-based benchmark to rank the plants that are doing better. Shanmugam and Kulshreshtha (2005) explore the technical efficiency levels of coal-based TPPs in India, using the stochastic frontier production function methodology for the period 1994–2002. They found that the efficiency values are widely different across different plants and are time invariant. Thakur et al. (2006) use the DEA method for 26 Indian state-owned energy utilities to find comparative efficiency values. They found that several of these units, especially large-sized units, are not functioning at their optimal level and suggested scaling the units down. Mukherjee (2008) has estimated and compared the energy efficiency values for the Indian manufacturing sector across states and assessed the impact of power sector reforms on energy efficiency. Ghosh (2010) helps in identifying power plants that contribute more to the overall emission using net electricity generation and CO_2 generation for the years 2004–2008. By employing the (Charnes, Cooper and Rhodes) CCR (Banker, Charnes and Cooper) BCC models of DEA, Shrivastava et al. (2012) estimated the relative technical efficiency values for 60 coal-based thermal power plants. The chapter discusses the efficiency levels of plants based on their production size and on the basis of their ownership. They also highlight that the betterment of thermal plants by increasing their efficiency levels can financially help the states to channel their capital to build or improve capacity. Bajpai and Singh (2014) employ the DEA approach and construct different models to find the efficiency indices for 25 coal-based power plants from various locations in India. The results identify power plants that are comparatively efficient and give suggestions about improving their operational and environmental performances. Sahoo et al. (2018) found the effects of normalisation on energy efficiencies as a result of the PAT scheme using DEA along with cross-sectional analysis. Here they found that coal quality and fuel mix were responsible for the variability in energy efficiency.

Thermal Power and Renewable Energy Sectors

State-Wise Overview

The total All India Installed Electricity Generating Capacity as on 31 March 2021 is 382151.22 MW comprising of thermal *234728.22 MW*, Hydro 46209.22 MW, Nuclear

6780.00 MW, and 94433.79 MW from renewable energy sources (CEA, 2021). Around 61% of the total electricity comes from the thermal power sector. Average Plant Load Factor (PLF), a measure of a power plant's capacity utilisation, for thermal power plants is 54.51%, which indicates sub-optimal use of energy generating resources. A plant with a higher PLF will increase the total output produced and reduce the cost per unit of electricity generated.

Table 14.1 depicts a sector-level distribution of TPPs across states. We observe that most (61%) TPPs are situated in the West followed by the South. Gujarat, Chhattisgarh, and Maharashtra have the highest number (26 plants each) of TPPs followed by Tamil Nadu and Andhra Pradesh. While the West and South together accounts for 43.63% of the total population with a total installed capacity of 62.42%, the North and East combined accounts for 53.18% of population with a total installed capacity of 36.49%.

Table 14.1 Thermal power plants distributed across states

No. of stations

Region	*State*	*Total*	*State*	*Centre*	*Private*	*Installed capacity(MW)*	*Population (million)*
East	West Bengal	19	9	4	6	14277	98.125
	Bihar	6	0	6	0	7050	123.083
	Jharkhand	8	1	4	3	4460	38.471
	Orissa	9	1	4	4	9800	44.033
Total		**42**	**11**	**18**	**13**	**35587**	303.712
North	Haryana	6	3	2	1	5761.59	29.483
	Uttar Pradesh	21	4	8	9	25222.14	230.907
	Delhi	4	3	0	1	2208.4	20.571
	Punjab	5	2	0	3	5680	30.339
	Jammu &Kashmir	1	1	0	0	175	13.408
	Rajasthan	9	7	0	2	10843.13	79.281
Total		**46**	**20**	**10**	**16**	**49890.26**	403.989
West	Madhya Pradesh	11	4	0	7	21950	84.516
	Gujarat	26	12	2	12	23643.41	69.788
	Maharashtra	26	8	2	16	28173.08	124.437
	Chhattisgarh	26	3	4	19	23688	29.493
	Goa	1	0	0	1	48	1.559
Total		**90**	**27**	**8**	**55**	**97502.49**	309.793
South	Tamil Nadu	24	9	6	9	14398.881	76.402
	Andhra Pradesh	23	4	1	18	16525.344	52.787
	Telangana	7	6	1	0	7572.5	37.725
	Karnataka	9	4	1	4	9505.2	66.845
	Kerala	4	2	1	1	693.54	35.489
	Pondicherry	1	1	0	0	32.5	1.571
Total		**68**	**26**	**10**	**32**	**48727.965**	270.819
North East	Assam	7	3	2	2	1394.855	35.043
	Tripura	5	2	3	0	1099.6	4.071
	Manipur	1	1	0	0	36	3.165
Total		**13**	**6**	**5**	**2**	**2530.455**	42.279
National total		**259**	**90**	**51**	**118**	**234238.17**	1330.592

Source: Compiled by the authors.

This means that the demand for electricity is higher for the northern and eastern regions. The North and East have a higher number of central governments based TPPs, while the South and West has more State and Private sector TPPs. The North East region has 5% of the total TPPs for a distributed population of 3.17% having a total capacity of 1%.

Specific emission is a measure with which the performance of a thermal power plant is assessed. The region-wise specific emission data show that the TPPs in the North and South (followed by the West) regions are operating with lower emission rates than plants in the East and the North East. These higher emission rates could be due to the age of these plants or the usage of low-efficiency systems.

CO_2 and Energy Intensity in Electricity Generation

The CO_2 intensity of electricity generation is the amount of CO_2 emitted when producing one unit of electricity (kg CO_2/kWh). The intensity values can be used to compare state performances, and suggest areas of focus to reduce CO_2 emissions. Energy intensity calculates the amount of energy required to produce one unit of output i.e., electricity. While a low energy intensity value should be associated with lower emission intensity, it depends on the quality of the fuel and the efficiency of utilisation. The traditional measure of energy efficiency is the inverse of energy intensity. In this study, we first estimate and compare CO_2 and energy intensity values across states and find the relationship between them. We also check if states with a higher percentage of renewable energy have lower CO_2 intensities in comparison to states using fossil fuels in TPPs.

We use Indian state-level data for 20 states that use both thermal and renewable sources of energy (see Table 14.2). The selection of thermal power states is based on the amount of electricity produced and the type of fossil fuels used. In addition, there are states that have their own share of electricity produced based on renewable energy sources (RES) i.e., states that have both thermal and renewable energy-based power. The main data sources used here are the CEA's General Review reports and CO_2 data (taken from the CEA's CO_2 baseline database) for the years 2018–2019 and 2019–2020.

The CO_2 emission intensity of a state is calculated as the ratio of absolute CO_2 emissions (kgCO_2) of the state and its gross electricity production (kWh). The CO_2 intensity here does not only account for coal and lignite usage but also for other forms like gas and diesel oil. Energy intensity is the ratio of the total energy used in British Thermal Unit(BTU) and the amount of electricity produced (kWh) by each of the states. The fossil fuel values are all converted in BTU units.

Across 20 states, the average value for the year 2018–2019 and 2019–2020 is 1.57 and 1.50, respectively. States with CO_2 intensity values higher than the average for both years are Uttar Pradesh, Chhattisgarh, Madhya Pradesh, Tamil Nadu, Jharkhand, Odisha, West Bengal, Assam, and Tripura. Assam and Tripura seem to emit much higher levels of CO_2 as compared to the amount of electricity they produce. Uttarakhand and Delhi emit comparatively lower amounts of CO_2 during the electricity production process.

The average energy intensity value is 59772.43 for 2018–2019 and 67025.52 for 2019–2020. That is, for 2018–2019, around 59772.43 BTU of energy is used on average by 20 states to derive one KWh of electricity. Energy is estimated from several types of fuels including coal/lignite, furnace oil, light diesel, LSHS/HHS, gas, HSD, and naptha. Karnataka has the highest energy consuming coal-based power plants that use higher amounts of gas for electricity generation, hence having higher energy intensity values for both years. All the other states have values that are significantly lower than

Table 14.2 State-wise CO_2 intensity and energy intensity estimation

States region	2018-19 CO_2 intensity	CO_2 intensity ranks	Energy intensity	Energy intensity ranks	RES %	TPP %	2019-20 CO_2 intensity	CO_2 intensity ranks	Energy intensity	Energy intensity-ranks	RES %	TPP %
Delhi	0.4359	19	5492.26	I8	3.1923	96.8077	0.2734	20	5219.426	19	4.5044	95.4956
Haryana	0.9413	15	9726. I8	15	2.6404	97.3596	0.7821	16	8831.16	16	3.5582	96.4418
Punjab	0.5854	17	9447.85	16	6.5279	93.4721	0.5774	17	8531.11	17	8.4674	91.5326
Raj a=than	0.8615	16	11194.79	14	17.7739	82.2261	0.8703	15	11532	15	21.1048	78.8952
Uttar Pradesh	1.702	8	12309.14	12	8.2774	91.7226	1.7164	8	12341.53	14	7.5526	92.4474
Uttarakhand	0.2466	20	4615.37	19	34.735	65.265	0.2832	19	5480.427	I8	29.7427	70.2573
Chhattisgarh	1.5948	9	13949.87	6	1.375	98.625	1.5516	9	13967.74	5	1.5543	98.4457
Gujarat	1.0277	13	13424.43	8	15.2751	84.7249	0.9653	13	12906.65	13	17.2306	82.7694
Madhya Pradesh	1.809	7	17273.51	2	11.2635	88.7365	1.8276	5	18003.23	2	12.2305	87.7695
Maharashtra	0.9709	14	13102.01	11	12.1357	87.8643	0.9567	14	13493.18	9	11.7315	88.2685
Andhra Pradesh	1.0915	12	13181.13	10	22.5897	77.4103	1.0629	12	13636.69	8	21.622	78.378
Telangana	1.4659	10	9205.02	17	19.1578	80.8422	1.3915	10	13343.77	11	18.3238	81.6762
Karnataka	1.1295	11	971148.89	1	48.73	51.27	1.0651	11	1114231	1	57.1483	42.8517
Kerala	0.4921	18	3807.57	20	99.4458	0.5542	0.5227	I8	3306.701	20	98.4293	1.5707
Tamil Nadu	1.8134	6	12024.7	13	29.857	70.143	1.7953	6	13679.83	7	34.6853	65.3147
Jharkhand	1.9277	5	13389.73	9	0.1567	99.8433	1.792	7	13421.7	10	0.1706	99.8294
Odisha	2.3918	3	15644.25	5	4.0381	95.9619	2.0413	3	15606.14	4	4.0003	95.9997
West Bengal	1.9396	4	13736.93	7	3.971	96.029	1.9729	4	13764.52	6	4.1691	95.8309
Assam	3.997	2	15966.7	4	1.9059	98.0941	4.9122	1	12929.14	12	1.8002	98.1998
Tripura	4.9044	1	16808.22	3	6.8163	93.1837	3.7168	2	16284.73	3	3.6555	96.3445
State average	1.5664		59772.43		17.4932	82.5068	1.5038		67025.52		18.0841	81.9159

Source: Data taken from CEA and computed by the author.
Note: CO_2 intensity is the ratio of absolute emission and gross electricity production; energy intensity is the ratio of total energy used and total electricity produced.

the average. Apart from Karnataka, states like Chhattisgarh, Madhya Pradesh, Odisha, Assam, and Tripura have higher energy intensities. Figure 14.1 shows the share of coal production by Indian states. By comparing this percentage with the intensity values we estimated in the table, we can see that almost all the states with higher coal production shares have higher levels of CO_2 and energy intensities. Chhattisgarh has the largest amount of raw coal followed by Odisha and they rank 3rd and 9th, respectively, with respect to their CO_2 intensities. Their energy intensities are also higher in comparison to other states.

We observe that Karnataka has the highest energy intensity among all the states for both time periods and Kerala, which almost fully uses RES for power generation, has the lowest energy intensity. For both time periods, when we look at intensities we find that lower energy intensities need not have or lead to lower CO_2 intensities. TPPs in Karnataka have used higher amounts of energy but have only emitted 1.12 tonnes of CO_2 for the generation of 1 MWh (for 2018–2019) of electricity, while Telangana has used lower energy levels to emit more CO_2 during power generation. States like Tamil Nadu, Uttar Pradesh, and Jharkhand have comparatively lower energy intensities with higher CO_2 intensities. On the other hand, Assam and Tripura have higher levels of energy and CO_2 intensities i.e., they use higher levels of energy and also emit increased levels of CO_2.

In the table, we try to compare the CO_2 intensity and energy intensity rankings among the states. Even though Karnataka (in both time periods) ranks 11th in CO_2 intensity, it tops first in the energy intensity rankings. This could be due to the high calorific value of the fuel used for electricity generation. Karnataka, followed by Maharashtra, use significantly higher levels of gas, which has high calorific value, as compared to other Indian

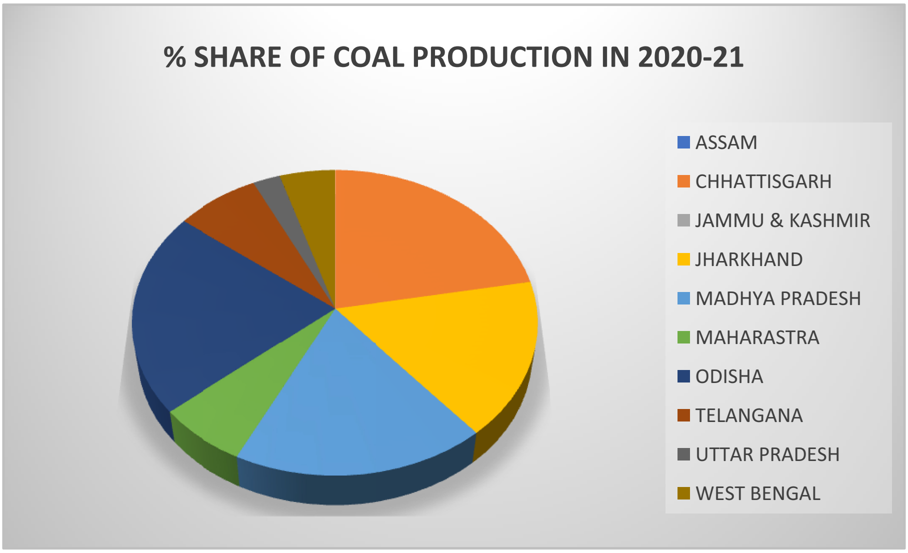

Figure 14.1 Share of raw coal production among Indian states.

Source: Provisional Coal Statistics, 2020–2021 report.

states for power production. States like Tripura, Assam, Odisha, and West Bengal have higher CO_2 intensity corresponding to higher levels of energy intensity. On the other hand, states like Kerala, Uttarakhand, Delhi, and Punjab rank lower both in terms of CO_2 intensity and energy intensity. (It should be noted that states with higher intensities are ranked higher).

From the table, we can also see if states with higher shares of RES are less CO_2 intensive or not. Kerala has started disabling its TPPs and is moving towards a more sustainable and cleaner source of energy for electricity generation. The state has a very low CO_2 emission intensity followed by Uttarakhand which has the lowest emission intensity among all states. States like Tamil Nadu and Karnataka have also started generating RES power and have relatively lower CO_2 intensities. Chhattisgarh, Jharkhand, and Assam have electricity produced majorly by TPPs and have higher than average CO_2 emission rates. Several states in 2019–2020 have comparatively higher shares of power generation through RES than the previous year.

The significance of renewable energy-based electricity is increasing, not only from sustainability concerns but also from India's energy security objectives. The Indian government's financial allocation to RES is expected to increase as is private sector participation. In addition, to meet the economy's growing power needs, India also needs to modernise existing technologies of power generation. While Kerala has transitioned quickly to RES based power, major production states have to adopt a strategy that can lower emission rates without compromising the gross annual electricity generation that is required for the effective functioning of the state.

Energy Efficiency Estimation for the Indian TPPs

Variables and Data

The study attempts to estimate efficiency values for a single output i.e., electricity generated and three inputs i.e., energy, labour, and capital using state-level TPP data for two time periods, 2018–2019 and 2019–2020. For variables like electricity generation, energy, and labour, data is obtained from the CEA's All India Electricity Statistics: General Review Reports. Electricity generation refers to the gross electricity generated (in GWh) by the TPPs of the Indian states in a year. The energy variable, based on the fuel type, has been extracted from the database and then converted to British Thermal Units (BTU) before aggregating to a single input value. This is the total energy used for the production of electricity by the respective states. Labour input, here, refers to the total number of regular and non-regular workers in the state power corporations/undertakings. Because of the unavailability of data on the labour force involved exclusively in thermal power generation, the "total manpower – regular and non-regular" employed by the state power corporations/undertakings is considered as the closest proxy. Capital refers to the net capital stock which is calculated according to the method suggested by Garofalo (Garofalo & Yamarik, 2002), where the national capital stock value is apportioned to respective Indian states in proportion to their State Domestic Product (SDP). The capital stock for electricity, gas, and water supply given at the Indian level is considered for apportion. Therefore, the SDP from the RBI's website and the capital stock value obtained from the National Accounts Statistics is used to calculate the capital stock values for the states.

Methodology

The traditional measure of energy efficiency, which is calculated as the inverse of energy intensity, is inadequate as it does not disclose important behavioural components of the firms/plants that could have caused an increase or decrease in efficiency levels. A better way of approaching this limitation is by considering a measure with a production theoretic framework. The DEA is, therefore, a non-parametric, linear programming technique used to measure the performance of decision-making units (DMU). The Banker Charnes & Cooper (BCC) (Banker et al., 1984) DEA model is used to estimate the input-oriented technical efficiency of the TPPs of the Indian states. The DEA approach is widely used because of its maximisation/minimisation conditions that engage in resource allocation, reduction of cost, and output emissions issues of the DMUs. It is structured to estimate efficiency values for units with multiple inputs and outputs.

Suppose j represents a DMU, i.e., an Indian state, that produces a single output y_j using a vector of m inputs given as $x=(x_1, x_2, x_3)$, the input-based efficiency of j is given as the ratio of optimal input bundle of j to the actual input bundle of j, holding other input values constant.

The input-output bundle is represented as (x_0, y_0) and the model is explained through the following equations.

$$\theta^* = \min\theta \tag{1}$$

Subject to the following constraints,

$$\sum_{j=1}^{n} x_{ej}\lambda_j\ \theta x_{e0}\ \text{(e represents energy input)} \tag{2}$$

$$\sum_{j=1}^{n} x_{ij}\lambda_j \leq x_{i0}\ \text{(i represents inputs like labour, capital, and energy)} \tag{3}$$

$$\sum_{j=1}^{n} y_j\lambda_j \geq y_0 \tag{4}$$

$$\lambda_j \geq 0 \tag{5}$$

where θ is the measure of energy efficiency and the optimal value of θ gives a proportionate reduction in inputs while producing a given output level. x_{ij} represents the input values where i includes labour, capital and energy. The output of a state is the electricity generated for a given year, represented as y_j. $\lambda_j \geq 0$where λ is a scalar. The states here operate with the notion to reduce energy input level to the maximum extent possible (equation 2) with other input levels not increasing (equation 3) and without any reduction in the output level produced (equation 4) so far by them.

One important to note here that, we assume the production technology to exhibit constant returns to scale since we are using state-level data by aggregating inputs and outputs of all the power plants in a state.

Results and Discussion

Table 14.3 presents the input-specific energy-specific efficiency values estimated by the above discussed model. For the year 2018–2019, the overall energy efficiency value is 0.7955 or 79.55%, implying that a reduction of energy input by 20.45% is possible even when using the given technology, level of other inputs and electricity production. Likewise, the energy efficiency value for the year 2019–2020 is 0.7224 or 72.24%, implying that a reduction in the energy input by 27.76% is feasible with current parameters. The energy efficiency levels vary across states. While states like Delhi, Punjab, Haryana, Uttarakhand, Chhattisgarh, and Kerala operate their TPPs with higher level of energy use efficiency, states like Karnataka, Odisha, and Assam, Tripura could produce their respective electricity levels by reducing their energy inputs significantly. In 2019–2020, the energy efficiency values of states like Haryana, MP, Telangana, Karnataka, TN, Jharkhand, and WB have come down, while the levels have improved for states like Gujarat, AP, Odisha, and Assam. States such as Delhi, Punjab, Rajasthan, UP, Uttarakhand, Gujarat, Chhattisgarh, Maharashtra, Kerala, and Tripura have continued to have 100% energy efficiency. Considering both the years, Karnataka, Odisha, and Assam are the worst performers based on this efficiency measure. These low-efficiency states may look into the high-performing states and learn from their management practices followed while producing electricity. They can work on implementing low coal pathways to improve their energy use efficiency. Some of the plans include shutting down thermal power plants that have very low energy efficiency; switching to better fuels or revamping the technology and plant tools for better energy efficient power generation.

Table 14.3 State-wise energy efficiency values of TPPs

States/region	*Efficiency for 2019–2020*	*Efficiency for 2018–2019*
Delhi	0.8450	1
Haryana	0.8664	0.8963
Punjab	1	1
Rajasthan	0.8450	0.8721
Uttar Pradesh	0.8581	0.8663
Uttarakhand	0.9523	1
Chhattisgarh	1	1
Gujarat	0.8659	0.8281
Madhya Pradesh	0.5829	0.6636
Maharashtra	0.7249	0.7610
Andhra Pradesh	0.7638	0.7349
Telangana	0.6051	0.9530
Karnataka	0.1524	0.1565
Kerala	1	1
Tamil Nadu	0.5305	0.6671
Jharkhand	0.7982	0.8790
Odisha	0.5730	0.5384
West Bengal	0.7263	0.7962
Assam	0.4032	0.2974
Tripura	0.3574	1
Average efficiency	**0.7224**	**0.7955**

Source: Values computed by the authors.

There might be several factors for inter-state variation in energy use efficiency. The important factors may include average age of the plants of a state, imported versus indigenous coal used and PLF. A comparison of the average age of TPPs and their efficiency indicates that Assam, Odisha, Tamil Nadu, and West Bengal have some of the oldest plants. Thus, in Assam, for example, revamping technology and upgrading plant tools can improve its efficiency levels. Almost all the states with higher PLF percentages under central, state, or private sectors have higher efficiency scores. The PLF percentage of Chhattisgarh under the central sector is impressively high in comparison to multiple other states.

Based on the 2020 Coal statistical report, Gujarat imports around 554.7 lakh tonnes of coal, which is around 34.4% of the coal imported by the country. Andhra Pradesh imports around 21.7% of the total imported coal. Plants from both these states perform well and their efficiency levels are higher. Greater import shares reflect the increased demand and consumption of energy from these TPPs. These plants have more time to move to low-carbon units.

Concluding Remarks and Limitations of the study

Since coal is an abundant resource in India and it is easily accessible, the Indian power sector is likely to remain dependent on coal in the near future. Therefore, achieving higher fuel use efficiency of its TPPs is the need of the hour to meet India's ever-growing energy demand in a sustainable way and to ensure a low-carbon economy. In this backdrop, this study provided an overview of the performance of the thermal power sector of India with an emphasis on its energy and carbon dioxide intensity. Specifically, it attempted to measure and compare the energy use efficiency of TPPs across states using the DEA method for 2018–2019 and 2019–2020.

We also explored if the performance of these power plants could be improved with respect to energy use efficiency thereby reducing CO_2 emissions. Our results show that all the states are not functioning at their full efficiency levels. For the year 2018–2019, the average energy efficiency of the states is 79.55% and it is 72.24% in the year 2019–2020, implying that a reduction of energy input by over 20% is possible even at the current technology and input quality. Therefore, a significant amount of emission reduction is possible just by improving the energy use efficiency of the power plants. The overall energy efficiency levels have also declined. Based on our analysis, we find that Karnataka, Odisha, and Assam demonstrated the lowest efficiency levels for both time periods. The states that produce electricity with higher level RES are found to be more energy efficient compared to others. Some of the highest coal-producing states are found to be less energy efficient in electricity production.

Our efficiency analysis suffers from a major limitation. The DEA method for efficiency analysis is best suited when the data is available at the plant level. But this study has aggregated plant level data to get state-level values. This means that the heterogeneity of fuel use and efficiency across different plants is not captured accurately. Therefore, some of the poorly performing states may be home to power plants with better performance, but this information is lost because of aggregation. This study could be further extended by looking at plant level efficiency trends for a longer period of time for the thermal power sector. More accurate labour and capital data for both state-wise and plant-wise levels can help to reveal exactly which plant requires attention, therefore helping in improving its efficiency. Nevertheless, this study is able to highlight which state requires immediate intervention, modernisation, and measures of efficiency for carbon-sensitive electricity generation in TPPs.

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15 Energy Storage and Its Potential Role in Electricity Transition

Shubham Thakare and Rishikesh Sreehari

Introduction

India's net-zero target for 2070 underpins a massive integration of renewables especially utility-scale solar and wind into its electricity mix. India's current pace of solar capacity addition suggests its dominance in the future power grid. In order to balance electricity demand reliably, it is a must to inject firm power, and moreover, powered through zero-carbon sources. Power demand in India peaks in the evening, requiring balancing sources to be at disposal when the sun doesn't shine to meet the sudden surge. To meet this, Indian policymakers have been pushing measures to ensure energy storage systems (ESSs) to make this swift transition. ESSs have a fast response time and serve vibrant grid applications ranging from energy time shift, and frequency response to grid support. With the evolving status of each technology, it is important to understand the role of each of these technologies in the near to long term.

The second section discusses energy storage technologies and the applications served along with other parameters. The third section provides a comparison framework for various ESS based on their essential characteristics. The fourth section throws light on a few of the policies supported by the central government, and the last section enlightens the role of ESS in meeting India's medium and long-term targets for decarbonising the power sector.

Energy Storage: Technologies and Applications

The global ESS capacity, at the end of 2021, stood at 177 GW of which 90% represents pumped hydro storage (PHS) (International Energy Agency, 2022). Battery energy storage systems (BESS) stood at just 7% of the total installations with the US and China leading the Li-ion-based BESS capacity. The ambit of ESS has shifted focus from the existing PHS to emerging technologies including electrochemical and chemical storage in the last few years. With the increasing penetration of renewables, the net load shape is changing swiftly and requires rapid ramping. As BESS has instant response time and meet high power requirements, the massive increase in its scale is unprecedented. Further, PHS has a history of long gestation periods owing to socio-economic disputes, adding uncertainty to its expected future role in balancing grids. Within the coming decade, as technologies evolve, a diverse set of technologies could serve various applications, as we shall discuss in the chapter. Historically, ESS deployments can be observed as early as in the nineteenth century starting with the invention of the first fuel cell (Mitali et al., 2022). Over the years, new technologies have emerged with novel methods to improve energy density and other operational characteristics to meet current needs.

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ESS can be classified using characteristics such as applications served, storage duration, operating efficiency, response time, and so on. In this section, ESSs are categorised based on the form of energy stored, as depicted in Figure 15.1. For each type of ESS, we proceed to discuss recent developments of these technologies in the Indian context and provide a few case studies depicting their scale of implementation.

Mechanical Energy Storage

In mechanical energy storage (MES) systems, energy is stored mechanically and is converted into electrical energy as and when required. During hours of low demand, electrical energy from the grid is converted and stored mechanically in the form of potential energy, kinetic energy, pressurised gas, or compressed spring based on the type of technology (Nadeem et al., 2019). At peak hours, this stored energy is converted back into electrical energy and fed into the grid. Widely used MES systems are pumped hydro storage (PHS), compressed air energy storage (CAES), and flywheel energy storage. It is widely used for purposes with long duration of energy discharge and has comparatively longer lifetime.

Pumped Hydro Energy Storage

In pumped hydro storage systems (PHES), electrical energy is stored in the form of potential energy by pumping water from the lower reservoir to a higher reservoir. During hours of high demand, water flows from the upper to the lower reservoir, thereby producing electricity. PHES is a very widely implemented technology, but has socio-economic issues, huge capital investments, long gestation period, and issues related to natural conservation (Nadeem et al., 2019). PHES operates within an efficiency range of 76–85%

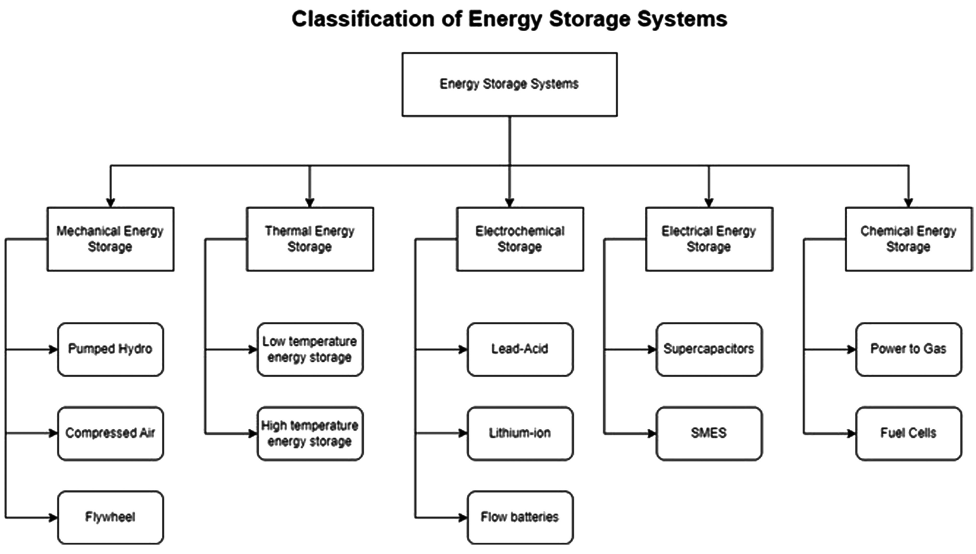

Figure 15.1 Classification of energy storage systems based on the form of energy stored.

Source: Compiled from https://www.sciencedirect.com/science/article/abs/pii/S0306261916308728 and https://ieeexplore.ieee.org/document/8580457.

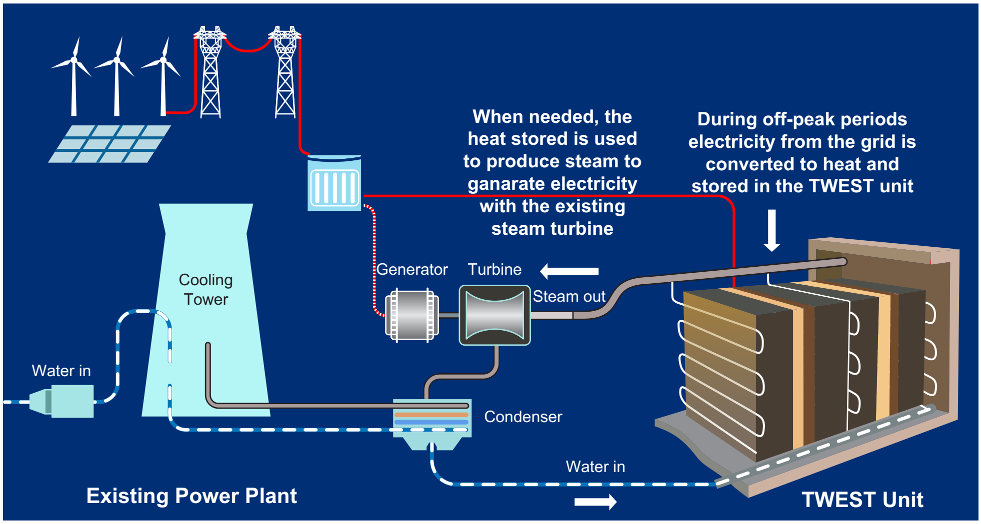

Figure 15.2 Repurposing thermal power plant illustration.

Source: E2S Power.

supporting energy to a power ratio of 8~10 and has a lifespan of at least 50 years, with unlimited life cycles of operation (Nadeem et al., 2019).

Globally, PHES comprises about 96% of the total installed energy storage capacity. India's realised PHS potential is assessed to be around 90.5 GW from a total of 80 feasible projects (Singh Bawa & Upadhyay, 2022). As per the Central Electricity Authority (CEA), India's PHS capacity stands at 4.74 GW with 1.8 GW of storage under construction (Central Electricity Authority, 2022). But many of these installations are either under maintenance or in pumping mode as these are primarily used for irrigation, with energy storage as secondary (NITI Ayog, 2019).

Compressed Air Energy Storage

Compressed air energy storage (CAES) is the only other storage technology apart from PHES that can be used for bulk storage. With surplus electricity in the grid, the energy is used to compress air and store it in underground caverns, vessels, or above ground pipes. During peak demand, the air is released, heated, and expanded in a turbine-generator setup to produce electricity (Aneke & Wang, 2016). Like PHES, CAES is a long-duration storage, however natural CAES plants require a cavern, thus restricting its installation to specific sites only. CAES systems have an estimated efficiency of around 70% with an approximate lifespan of 40 years (T.Kousksou, 2014). Currently the global capacity of CAES is around 406 MW with just 11 operational commercial-scale projects, none of which are in India.

Flywheel Energy Storage

In flywheel energy storage (FES) systems, electrical energy is stored as kinetic energy in a rotating mass. While storing energy, the motor utilises electrical energy to accelerate a rotating mass that is connected via a shaft. The rotation of the shaft transfers the angular momentum and energy is stored in the rotating mass. During discharge, the rotating mass transfers its kinetic energy back to the motor-generator unit and electricity is produced (Aneke & Wang, 2016). FES systems have high power density, faster response times in the range of milliseconds, and have a cycle life of approximately 1 million cycles (IRENA, 2017). Due to the friction losses within the system, FES is mainly used for short-term applications such as frequency response.

2.2 Thermal Energy Storage

Thermal energy storage (TES) systems are energy storage systems that are designed to store energy in the form of heat by cooling, condensing, melting, heating, or vaporising. In TES, phase change materials are stored at high or low temperatures within an insulated shell to prevent energy losses. Energy stored is extracted at temperatures based on the application. TES can be used for water heating, electricity generation, and storage. Based on the temperature at which the energy is stored, TES can be classified into low-temperature energy storage (LTES) and high-temperature energy storage (HTES). Most commonly used TES systems are sensible heat storage where energy is stored as an increase or decrease of temperature in a material, latent heat storage systems where energy is stored in a material that undergoes phase change and thermochemical storage where thermal energy is stored as chemical energy.

2.2.1Repurposing of Existing Thermal Plants

Thermal power plant repurposing is a strategy to reuse existing facilities by producing or storing energy by alternative methods. In terms of power generation, existing sites can be retrofitted by solar PV, solar thermal, wind, or biomass assets for power generation and through battery, thermal, or pumped hydro for energy storage applications (Energy Sector Management Assistance Program, 2021). The most fundamental repurposing applicable is replacing existing turbo generators in thermal power plants by synchronous condenser (SynCON) as well as replacing fuel for generating superheated steam. Some ways of repurposing include replacing the fuel with renewable sources for generating superheated steam, converting existing turbo generators into synchronous condenser (SynCON) for providing ancillary services or using the thermal plant as a thermal energy storage facility. A novel technology developed by E2S Power allows the transformation of existing thermal power plants into energy storage systems using renewable energy. The self-contained system uses electrical energy from renewable sources and converts it into heat using direct radiative heating, stores the heat in advanced storage materials, and then returns the stored energy in the form of superheated steam. E2S and India Power have collaborated to pilot a thermal storage repurposing in existing as well as near retiring assets (E2S Power, 2022). Based on economic lifetime, 25.2 GW of coal-based thermal power plants are due for retirement during 2022–2027 (Central Electricity Authority, 2018). Thus, by repurposing technologies similar to the ones developed by E2S, India has a great potential in terms of repurposing its existing thermal fleet.

Electrochemical Storage

Electrochemical energy storage systems (EcES) are the emerging energy storage systems despite being one of the oldest. EcES can be mainly classified into battery energy storage systems (BESS) where energy is stored between the electrodes and flow battery energy storage systems where energy is stored at cathodes and anodes through an electrolyte. Commonly used EcES are discussed in the following sections.

Lead–Acid Batteries

Lead–acid batteries are one of the oldest energy storage technologies that is being used widely. It consists of a lead dioxide cathode and a lead anode immersed in an electrolytic medium made of sulphuric acid (Mitali et al., 2022). Due to its low cost and moderate efficiency, lead–acid batteries have a good cost to performance ratio and can be used in a wide range of applications (IRENA, 2017; T.Kousksou, 2014). They are mainly used in application such as starter batteries in automobiles, power backup systems, traction batteries, and off-grid deployment of solar home systems (IRENA, 2017). But these batteries have a relatively shorter cycle life, low depth of discharge, and poor performance for grid applications (T.Kousksou, 2014). New developments in advanced lead–acid batteries are currently in the R&D phase. Lead–acid batteries are completely recyclable, however exposes damage with partial cycling, hence research on renewable integration is still ongoing. In India, lead–acid batteries are limited to behind the metre applications and hence grid-scale applications are distant.

Lithium-Ion Batteries

Lithium-ion batteries control 90% of the global grid-scale energy storage market and it possesses higher energy density compared to its peers. Owing to its high round trip efficiency, high depth of discharge, and low self-degradation, it is widely used in consumer electronics and EV segment. Li-ion BESS cycle life is temperature dependent and thus requires battery management systems and cooling. This increases capital costs by ~15% (National Renewable Energy Laboratory, 2021). Based on the chemistry and applications, there are a wide range of lithium-ion batteries available, but lithium iron phosphate (having higher energy density) is used in applications such as energy time shift, whereas lithium titanate (LTO) (having high power density) is used in applications for high instantaneous power discharge (Paridwal, 2021). India's first grid-scale lithium-ion based battery energy storage system was commissioned in 2019 in Rohini, Delhi, by Tata Power, having a capacity of 10 MW. The system can deliver up to 10 MWh of energy and will provide grid level services benefitting 2 million consumers served by Tata Power (Fluence, 2019).

Flow Batteries

Also known as redox flow batteries, the energy is stored in electrolytes instead of the electrodes. The electrodes are placed in separate chambers separated by a porous membrane that only allows the flow of ions and electrolytes stored and pumped into the chamber for reaction to take place, thereby producing electricity (T.Kousksou, 2014). Commercially available flow batteries are vanadium redox batteries, zinc–iron batteries, and zinc–bromine batteries. Since electrolytes are stored outside the system, their energy capacity is easily scalable. Flow batteries have a longer lifespan, require less maintenance, and possess lower discharge rate so that it can be used for storing energy for longer periods (T.Kousksou, 2014). There are multiple commercial grid-connected flow batteries globally, but in India it is limited to research organisations (NITI Ayog, 2019). In India, flow battery installations include a 30 kW vanadium redox battery at Bangalore in 2015 and a 50 kW vanadium redox flow battery at Bharat Heavy Electricals Limited (BHEL), Hyderabad, in 2018 (E22, 2018; Richardson, 2015). Researchers at IIT Madras are developing a redox flow battery that is cost effective by replacing existing membranes with cheaper alternatives (Quantum, 2022).

Electrical Energy Storage

In electrical energy storage (EES) systems, energy is directly stored in an electric field, without converting into other forms of energy. EES can be further classified into electrostatic energy storage systems and magnetic energy storage systems. Examples of electrostatic energy storage systems include capacitors and supercapacitors, whereas superconducting magnetic energy storage (SMES) is a magnetic energy storage system. Capacitors store energy in between its electric plates and are being widely used in utility-scale power control applications (Mitali et al., 2022). Capacitors are able to deliver high bursts of energy for a short period of time but have very low energy density (Mukrimin Sevket Guney & Yalcin Tepe, 2017). Supercapacitors solve this drawback of capacitors and have high energy density due to its larger surface area, resulting in higher energy density. SMES systems store electrical energy in a magnetic field and provide response in the order of milliseconds. Despite their technological advantages, very few SMES systems are commercially available due to higher costs (T.Kousksou, 2014).

Chemical Energy Storage

As the name indicates, in chemical energy storage systems, energy is stored in the form of chemical energy. Hydrogen energy storage is the most popular chemical energy storage due to the advantages of hydrogen as a fuel. Using electrolysers (power-to-gas) off peak electricity is used to electrolyse water and produce hydrogen (NITI Ayog, 2019). This hydrogen is stored and used later either to produce electricity in a fuel cell or to produce methane (Central Electricity Authority, 2022). One shortcoming of using hydrogen for energy storage is the low overall efficiency of around 30% (Blakers et al., 2021). To promote hydrogen storage and production, India has announced a National Hydrogen Energy Mission (NHM) for boosting the use of hydrogen as an energy source and making India a green hydrogen hub (Ministry of Power, 2022a, 2022b). Green hydrogen pilots that are coming up in India include a 100 kW Anion Exchange Membrane (AEM) based green hydrogen plant in Assam (Economic Times, 2022) and a green hydrogen fuelling station in Ladakh set up by NTPC (Economic Times, 2022).

Comparison of Energy Storage Technologies

In this section, we compare the ESS technologies discussed using some key parameters. As the technologies discussed have emerged, especially over the last decade, it is important to address the status quo and current developments. These characteristics are compared based on quantitative and qualitative parameters including their capital investments, maturity, and other operational parameters. These characteristics were chosen considering the ideal requirements for an energy storage technology like high efficiency, fast response time, long lifetime, less capital costs, etc. Based on specific characteristics, Table 15.1 also recommends appropriate applications for each of the technologies.

Table 15.1 Comparison metrics of energy storage technologies and associated applications

Characteristics/technologies	*PHS*	*CAES*	*FES*	*TES*	*Lead–acid*	*Li-ion*	*Flow*	*Super capacitors*
High round trip efficiency								
Fast response time								
Long lifetime								
Mature technology								
Low capital cost								
High energy density								
High power rating								
Indigenous capability in India								
Less space required								
Short construction period								
Applications	Bulk power management	Bulk power management	Grid support, UPS	Grid support	Grid support, UPS	Grid support, UPS	Grid support	Grid support, UPS

Initiatives by the Government to Boost Energy Storage Implementation

The focus on high RE integration has put an impetus on intermittency and balancing the electricity supply and demand. As per the estimates by Central Electricity Authority (CEA), India would need 27 GW of battery storage by 2030 with four hours of storage and 10 GW of pumped hydro storage (Central Electricity Authority, 2022). To scale up the capacity and tackle high upfront investments, strong policy support is required from the Government of India (GOI). Some of the initiatives by GOI for supporting ESS and suggestions to further bolster them are discussed below.

Policy Support

Untapped Potential and Impetus for PHS

As mentioned earlier, PHS represents the lion's share in global energy storage installation (~96%) with a mature technology that is operational for decades. Proposals for another 8.9 GW are still awaiting approval as per CEA. PHS has a record of a long gestation period and low recovery from the existing pricing mechanisms. Thus, the Government of India has proposed ways to fast track the progress on PHS. Firstly, in 2019, the Ministry of Power (MoP) proposed an amendment to the electricity rule to provide peak power price of supply (Buckley & Shah, 2019). Adoption of this differential pricing regime would thus improve bankability of PHS projects and invite more private sector participation. Secondly, in mid-2022, with the introduction of *Hydro Purchase Obligation* (HPO) (including PHS), it is deemed to increase compliance of energy procured through hydro sources to load centres (Ministry of Power, 2022c). This comprises ~3% of the total *Renewable Purchase Obligation* (RPO) by 2030. To further the pace of implementation, the government could further focus on identifying brownfield expansion plans in existing reservoirs to boost adoption of PHS.

Indigenisation of Energy Storage Supply Chain

In 2021, the Cabinet panel chaired by Hon'ble Prime Minister approved the *Production-Linked Incentive* (PLI) scheme for manufacturing of Advanced Chemistry Cell (ACC)-based electrochemical battery storage for an outlay of 18,000 crore Rs. (Ministry of Heavy Industries, 2021). Although the impetus has been primarily for the creation of a value chain for EVs, stationary storage applications-based technologies are covered under the scheme. As per the status quo, three companies have signed agreements to manufacture battery capacities to the tune of ~95 GWh (Ministry of Heavy Industries, 2022). Increasing the ambit of ACC beyond the scope of supporting the manufacturing of components and including the balance of plant and advanced power electronics could support this transition. Further, investments in R&D in emerging technologies in energy storage could boost the adoption of ESS.

Battery Storage Scrappage Policy

In 2022, the Ministry of Environment, Forest and Climate Change (MoEFCC) published the *Battery Waste Management Rules* to ensure sound disposal of generated battery waste (MOEF&CC, 2022). Based on the concept of Extended Producer Responsibility (EPR), where the producer is responsible for collection and recycling of materials from the battery packs, it mandates creation of a centralised online portal where EPR certificate exchange between producers and recyclers/refurbishers shall ensure fulfilment of the obligations of producers. The policy would be effective in material recovery and will create a supply chain of rare minerals for battery manufacturing and spur new investments.

Market and Tariff Rationalisation

Round-the-Clock (RTC) Power Supporting High RE Integration

In February 2020, MoP floated the draft guidelines for implementation of RTC tenders focusing on firm power supply (Ministry of New and Renewable Energy, 2020). It implies bundling of dispatchable power with RE source, given that RE contributes to 51% of the annual energy served with a 90% availability. The provision to use energy storage was introduced, thus providing impetus to integrate high RE. Solar Energy Corporation of India (SECI) awarded the first RTC tender at 2.9 Rs./kWh for a 400 MW capacity (Saurenergy, 2020). However, higher battery costs are slowing the pace of RTC tenders. Moreover, with the increased scale of implementation, DISCOMs would be more inclined to purchase RTC power. There are two major reasons to support this. Firstly, the peak power requirement is currently met by procuring power from exchange at a higher variable cost or curtailed; energy storage could come to the rescue. Secondly, the obligation to supply power from RE in fixed quantum ensures that firm power is supplied at cheap cost. To ensure low tariffs discovered in RTC auctions, the government can increase the ambit of technologies eligible and provide fiscal support. This shall increase competitiveness and maturity in new RE and storage projects.

Market-Based Procurement of Ancillary Services and Energy Storage Systems

In 2021, Central Electricity Regulatory Commission (CERC) notified the *ancillary service regulation* regarding inclusion of energy storage for the purpose of providing reserves (Central Electricity Regulatory Commission, 2022). This enables a market-based mechanism to procure secondary and tertiary ancillary services in order to maintain grid frequency to 50 Hz. This shall be traded in the day ahead as well as the real-time market at a uniform clearing price. The purpose of inducing this mechanism will ensure enough reserves spread across the country and not limited to any particular load centre.

Going forward, it would be much more encouraging to see multiple revenue streams defined as part of the regulation, like the type of response, voltage support, black start capabilities, etc. This shall ensure that energy storage systems will have a large role to play in the power markets. Further, response time is subject to fast-acting resources like BESS being deployed within seconds; the regulations could put tighter gate closure in order to increase its viability.

Outlook for Long-Duration Energy Storage (LDES)

Indian power system observes a daily variability in electricity demand unlike seasonal variability in American or European power grids where heating is predominant. Although PHS can dispatch energy for a long duration (8–10 hours), a significant rise in RE share in the total electricity (60–70%) would require balancing beyond BESS and PHS. Long-duration storage would thus provide power for days to several weeks, although the scope of implementation remains beyond this decade, given the current state of technological progress.

Currently, there are no government policies directly supporting LDES, although significant activities associated with the *national hydrogen mission* are currently invested in the R&D stage (Ministry of Power, 2022a). Through the Department of Science and Technology (DST) support, advanced R&D activities in manufacturing of materials for hydrogen storage are currently supported (The Energy and Resources Institute, 2022). Further, activities under the ambit of O&G companies to identify Rock caverns for gas and hydrogen storage, which is expected to firm up beyond 2040 to support the net-zero ambitions.

Outlook of Energy Storage in India's Power Sector Decarbonisation Journey

India's current grid-scale energy storage capacity stands at 4.7 GW of which almost ~96% is PHS with 70% currently working in the pumping mode. Balance capacity is anticipated to resume after addressing operational issues related to reservoir development and technical issues. Currently 1.6 GW of PHS is under construction and anticipated for likely benefits within the next 3 years (Central Electricity Authority, 2022). In order to meet near-term RE targets, CEA through its integrated resource planning exercise has assessed the capacity of energy storage requirements by 2031–2032. As per the study, PHS capacity of about 7 GW would be required by 2026–2027 which is a 70% increase over the current installed capacity (Central Electricity Authority, 2022). The storage capacity requirement increases to 70 GW (19 PHS and 51 GW BESS (5 hours storage)) by 2031–2032. This represents a 14-fold increase over the current ESS capacity. The quantum of storage requirements itself speaks for the need of readiness in the Indian market to integrate a substantial amount of renewables.

By 2030, as per the estimates by National Renewable Energy Laboratory (NREL) (Chernyakhovskiy et al., 2021), India might require ~4-hour battery energy storage with ~68 GW BESS along with pumped hydro in line with CEA mandates. In 2050, the growth of pumped hydro capacity might plateau, but BESS would gain substantial growth with 240 GW capacity and 6 hours or more. The Energy and Resources Institute's (TERI) estimate shows that 120 GWh BESS by 2030 would be enough to avoid the renewable curtailment (Spencer et al., 2020). Thus, a massive transition will require firming up market mechanisms for providing these services and stacking financial value to increase its viability. In the near term, there would be a diminishing role of coal in providing reserves, where ESS would ensure stability to the grid. Further there is a role of ESS in providing ramping flexibility, as the solar generation goes down in the evening. The role of ESS in providing peak requirement and total energy requirement is limited till 2030 due to the continuing role of coal in the electricity mix. Thus, in the near term, predominant applications served would be to support power system flexibility (2–3 hours duration) and frequency response to manage operating reserves at the grid level.

India's long-term ambition includes net-zero emissions by 2070. However, it is well realised that the Indian power sector might achieve zero emissions well in advance, as suggested by the International Energy Agency (IEA) net-zero outlook (International Energy Agency, 2021). This suggests a near to complete phase out of all coal plants that used to serve the base load. In this scenario, the storage will not only meet demand in the absence of renewables, but also will support the base load for longer durations. As per the study by CEEW, 5,630 GW of solar integration and 1,792 GW of wind integration are required in the Indian power sector by 2070 to meet its net-zero target, this suggests a substantial amount of storage to integrate renewables (Chaturvedi & Malyan, 2021). Thus, with the rapid rise of renewables coming into the generation mix by 2070, a wide range of energy storage technologies are required to support a wide range of applications. In the long term, it would span across a complete spectrum of the grid ecosystem. This ranges from short term (frequency response, voltage support), medium term (ramping, load following), and long term (energy shift, transmission deferral, seasonal storage). As the grid evolves beyond 2030 with high penetration of renewables, new technologies would emerge, and thus, it is pertinent to invest in an R&D ecosystem for indigenous manufacturing and ensure India's long-term vision to net zero. To provide resource adequacy, system stability and renewables integration would require a holistic approach towards ESS capacity addition in the coming years.

Conclusion

The evidence is clear – ESS will be the backbone of the Indian power sector in the coming decades as India inches closer to achieve its net-zero target. In the sections above, we delved into ESS technologies and their underpinning role towards a deep decarbonisation of the Indian power sector through various applications. We also discussed various policies supporting implementation of ESS, and further support required. The role of ESS in the future power grid from the current coal-dominated grid towards India's net-zero future was explored. Moving forward, the push to high energy storage penetration in the Indian market will need stepping up policy and financial support from centre as well as state governments. This could be encouraged through obligations on capacity investments and incentives. As supply chain disruption continues, reliance on particular technology is risk adhering, hence exploring the vibrancy of ESS technologies and new investments based on changing RE penetration is required. As the geopolitical situation unwinds and supply chain for critical minerals becomes rigid, India needs to firm up its position by investing in the near term and also assess viable ESS pathways for a medium- to long-term carbon neutral future.

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16 International Experiences

The Cases of *Iberdrola*, Enel, and NextEra Energy

Shubh Majumdarr, Abhinav Jindal, Shantanu Srivastava and Vibhuti Garg

Introduction

> A transition to clean energy is about making an investment in our future.
>
> ~ Gloria Reuben

Fossil fuels have powered the world economies and transformed the industries, transport, and agriculture sectors for the past 150 years. Considered the basic infrastructure of economic growth, it has contributed to about 70% of global emissions through energy generation (Kell, 2019). Thus, in order to reduce and limit the rise of global mean temperature under 2°C in line with the *Paris Agreement 2015*, the worldwide production and projection of CO_2 emissions need to be brought down in line with UNEP's *Production Gap Report 2021* (SEI, IISD, ODI, E3G, 2021).

The migration to renewable energy sources from systems primarily dependent on fossil fuels, i.e., energy transition of unprecedented scope, depth, and speed, can be an effective solution for the future (IEA, 2017). It might also be instrumental in avoiding irreversible climate change, such as rising sea levels, which might hamper food security and migration (Flavelle, 2019). However, the economic and social cost associated with the energy transition is at the centre stage of the debate. Critical studies by Karpinska and Śmiech (2021) state that energy transition may increase the depth and breadth of energy poverty, and transition capital needs could lead to a crowding-out effect, negatively impacting economic growth (Dupont et al., 2021). However, the positives outweigh the negatives, and studies by Garcia-Casals et al. (2019) and Ram et al. (2022) highlight positive spillovers of the energy transition with higher job creation and significant global welfare such as reduction of GHG emissions, health improvement, and education spending. It will further protect the economies from price volatility, leading to affordable energy supplies and enabling energy security (Zahedi & David Wittenstein, 2022).

Technological advances have led to an unprecedented decline in renewable energy production costs (Liu, 2018) and the emergence of new opportunities via digitalisation and smart technologies. A societal push via corporate and investor actions has pushed global energy transformation irrevocably towards renewables and sustainability (IRENA, 2018). Further, the regulatory changes such as European Union's "Emission Trading Scheme" and carbon pricing have incentivised decarbonisation, making renewables competitive (Bayer & Aklin, 2020). The formation of the "RE100 coalition" and the "Renewable Energy Buyers Alliance," with mega-corporates committing to 100% power from renewable sources (S&P Global, 2020), has spearheaded the transition in the power generation sector, with a significant rise in solar and wind electricity generation worldwide. Thus,

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since 2012, renewables have beaten conventional power generation capacity (IRENA, 2019), and IEA's forecast further states that RE power capacity will increase by 50% between 2019 and 2024 (S&P Global, 2020).

Despite these developments, the transition is not happening as fast as required. Tollefson (2022) predicts a further 1% increase in worldwide carbon emissions in 2022, and the window of opportunity to make meaningful change is closing fast (World Economic Forum, 2019). Thus, renewables need to be scaled up by at least six times to reach the decarbonisation and climate mitigation goals (IEA, 2017). According to McKinsey & Company, a leading consulting company, achieving 50–60% decarbonisation may be possible with little to no additional investment beyond that required by rational economic behaviour (Finkelstein et al., 2020). Emissions, on the contrary, need to be brought down with a coordinated effort from the government, consumers, and industries that contributed 28% of global greenhouse gas emissions in 2014 (de Pee et al., 2018).

Parallel to the emission targets, forecast models, and research, there is a need to discuss the learning from the ins and outs of the transition process and challenges. There is limited information on specific experiences, whether successful or not, of firms as they embark on a transition pathway. This may be attributed to the significant delays, major uncertainties, and high investment associated with energy transition (Pruyt et al., 2011), making industries rarely lead it from the front. Yet, due to its rare and extended nature, the studies of historical energy transition lessons and experiences of companies and sectors can be used for future reference (Fouquet, 2010, 2016). It would further help to identify internal (Verbong & Geels, 2007) and external factors (Horbach & Rammer, 2018), which can play an instrumental role in transition outcomes. There are lessons to be drawn for the power sector in India on the specific experiences of other firms as they move to a sustainable energy mix. In what follows, we discuss the transition experiences of three European and American conglomerates from the power sector. We start with discussing lessons that Indian firms can draw from Enel's unique creating shared value model. This is followed by tracing the decarbonisation pathway for NextEra Energy, a Florida-based energy conglomerate. It does not rely on carbon-capture systems or offsets, and with clearly articulated interim targets, it can serve as a template for Indian firms to chart their path in a manner which enables the ability to tap into financial markets for transition finance. Finally, we take a detailed look at *Iberdrola*, which stands out as a very recent successful energy transition experience. Set in 2017, *Iberdrola* tackles the dilemma and challenges of operating or decommissioning coal plants, a situation that all Indian utilities must also face up to.

Enel's Strategy of Sustainability and Innovation: Creating Shared Value (CSV) Model

Enel, an Italian multinational energy conglomerate, is the largest private renewable energy operator and private-sector electricity distribution company globally, with 53 GW of capacity under management and more than 75 million end-users connected to its grids.[1] The company is a global champion in sustainable development efforts with a business model starkly different from most of its peers.

A cornerstone of Enel's sustainable growth strategy is its creating shared value (CSV) model. Enel Green Power (EGP), the group's renewable energy arm, initially championed the model in response to a business need to expand its business into emerging economies.

EGP wanted to move beyond the typical "compensation attitude" of doing business and instead create real value in the markets where it operated. Enel gradually spread the CSV model across the wider group in 2015.

The model focuses on creating value for the business and the community in which it operates and is embedded across the Enel group and its value chain. Enel adopts a proactive approach to anticipate needs and conflicts between the business and the communities. As per Enel, the CSV model helps enhance a company's competitiveness while advancing the economic and social conditions in the communities in which it operates, differing from the conventional definition of corporate social responsibility (CSR) initiatives.

The CSV model also aligns with Enel's sustainability or Environmental Social and Governance (ESG) strategy. A sustainability materiality assessment helps Enel identify the most important/material ESG issues for the company, which are then crosschecked with the issues identified as per CSV. This helps verify the degree of alignment or misalignment between external expectations and internal priorities.

At its core, the CSV is a systematic framework for collaborating with stakeholders. For instance, for a power generation project, the framework starts with understanding the local context where the plant will come up, identifying relevant stakeholders and mapping the potential positive and negative impacts of Enel's activities on them. This is followed by defining a detailed CSV plan in line with the priority issues identified and monitoring and reporting on the implementation progress subsequently. Enel executes the model across the life cycle of an asset right from the business development, construction, and operation stage to the asset decommissioning stage.

Projects executed under the model have included initiatives to create job opportunities and develop health care, education, and local infrastructures.

The CSV model offers several opportunities to tackle climate change. The main interventions are through the propagation of renewable energy, improving energy efficiency and decarbonising existing thermal assets. A major societal issue today relates to little access to electricity in several parts of developing economies. For instance, in Alto Loa, Chile, Enel operates a wind power initiative and works to train local communities to manage this site and create a tourist route to highlight the natural and cultural heritage of the area, exploiting its tourism potential. In the United States, the company works with local scientists to plant flowers and grasses around solar plants, creating habitats for bees and other pollinator insects, benefitting the natural ecosystem.[2] In South Africa, Enel trains local young people as service technicians to match the skill demand at renewable energy plants.[3]

Enel also leverages the CSV model to decommission thermal plans and repurpose those sites into new development opportunities for local communities. In 2015, the company launched the Futur-e project, the world's first large-scale redevelopment of an industrial area, which has now been extended to several projects where the company is managing end-of-life thermal assets.[4] For instance, its Spanish subsidiary Endesa has developed a plan that, among other measures, seeks to install 700 MW of renewable energy projects in the area. In doing so, it plans to train the local workforce in renewable technologies and invite interested parties globally to submit additional redevelopment plans for the area.[5]

The uniqueness of the CSV model is that it facilitates an open engagement between Enel and local communities on an ongoing basis. Stakeholders are engaged starting from the design phase to ensure all their claims and grievances are listened to and understood. Unlike conventional CSR initiatives that organisations deem as cost centres, the CSV model creates value for the company in several ways. Firstly, it helps in brand building, enhances reputation, and improves global recognition. This helps foster trust by highlighting the value Enel has created for local communities in past projects.

Further, as sustainable value is maximised, it attracts ESG-aligned investors and makes it easier to capitalise on sustainable finance instruments. Enel is a pioneer in the issuance of sustainable finance. The company issued the world's first sustainability-linked bond in 2019, which is today one of the fastest-growing segments of the global sustainable finance markets. Today, 55% of the company's finance is through sustainable sources, which Enel plans to scale up to 70% by 2030.

Lastly, it provides an added revenue line where clients can participate in new or existing CSV programmes, which helps them improve their sustainability performance. Enel does this through the "premium offer," wherein it offers its current and potential clean energy power purchase agreement (PPA) clients an opportunity to leverage their commitment to sustainability through partnering in CSV projects. Clients can partner in existing or new tailored CSV projects. Enel classifies each project as per its ESG credentials and alignment with United Nations Sustainable Development Goals (UN SDGs), which helps the client identify projects which align most with their sustainability targets.

For Indian utilities transitioning to clean energy, the CSV model can help scale up renewable capacities, both utility-scale and distributed, in a sustainable manner and help decommission thermal assets. For this, shared value creation must be embedded in the company's business strategy. A starting point is to convince internal and external stakeholders of the benefits of a corporate entity creating shared value for local communities. Internal

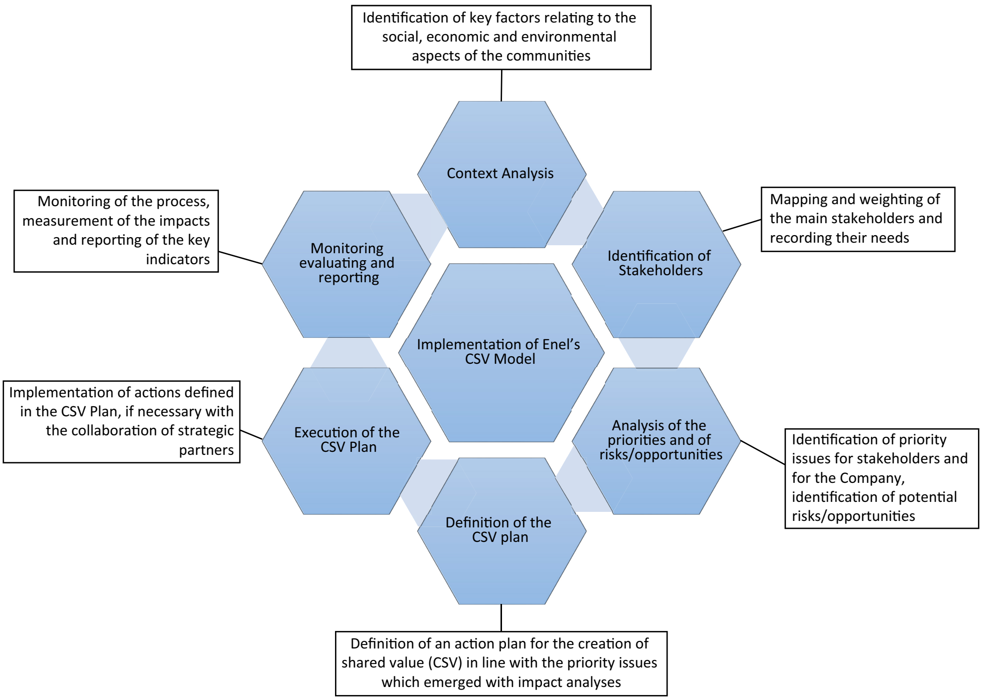

Figure 16.1 Implementation of Enel's CSV model.

Source: Enel Americas.

stakeholders need to see community engagement as a value-creation activity and not as a cost centre. Following that, a stakeholder engagement plan needs to be devised. The CSV model relies upon an open engagement with local communities on a day-to-day basis. Lastly, measurement and reporting of CSV initiatives are imperative to ensure they do not become a checklist exercise. For instance, Enel has developed a digital management platform to monitor shared value and sustainability integration into projects across its value chain.

How NextEra Energy Is Ditching Carbon: Lessons for Indian Firms

NextEra Energy, with a market capitalisation of more than US$150 billion, is a leading clean energy company headquartered in Juno Beach, Florida. It owns the Florida Power & Light (FPL) Company, the United States of America's (US) largest electric utility that sells more power than any other utility, providing clean, affordable, reliable electricity. With its affiliated entities, NextEra Energy is the world's largest solar and wind energy generator and a world leader in battery storage.

The company has made remarkable progress, with its CO_2 emissions rate declining faster than the national average due to clean energy investments and actions. The company has avoided more than 175 million tonnes of CO_2 emissions since 2001 by building the cleanest and most efficient generation fleet. The company improved its CO_2 emissions rate from 37% better in 2005 to 51% better than the US electric power sector average in 2021. Over the period, total generation capacity increased by 72% to meet growing customer demand.

Further, over the last 20 years, FPL has eliminated its use of foreign oil and shuttered all of its coal plants in Florida while saving its customers more than US$12 billion in avoided fuel costs. The company's strategy to reduce CO_2 emissions and avoid fuel costs is through various measures, including the deployment of natural gas, wind, and nuclear power plants till 2010. From 2010, the company also added a lot of solar-based capacity in addition to wind, nuclear, and natural gas. In addition, since 2020, the company has been building storage capacity to balance intermittent renewable power.

The company has reduced the use of oil to generate electricity from 41 million barrels in 2001 to only 100,000 barrels of low-sulphur diesel, a fuel used as an emergency backup, in 2021. Further, the company has been reducing its portfolio of high-emission assets, including natural gas. It divested 3,828 MW of natural gas plants in 2016 and retired and demolished 250 MW of coal plants in 2017 and 636 MW of coal and 2,530 MW of natural gas and oil plants in 2018. Further, in 2020, NextEra Energy retired 615 MW of nuclear and 330 MW of coal plants, converted 924 MW of coal plants to natural gas, and cut its CO_2-emission rate by 40%. By 2021, the company had completely phased out all its coal plants.

There are learnings from NextEra Energy's transition experience that can help Indian industries to deploy technologies and phase out fossil fuels, strategies adopted to develop projects and manage their costs to decarbonise their operations.

Commitment to Real-Zero Emission by 2045

NextEra Energy is committed to moving past net zero all the way to Real Zero, leveraging low-cost renewables to drive energy affordability for customers. It has set decarbonisation targets of 36% by 2025, 52% by 2030, 62% by 2035, 83% by 2040, and 100% by no later than 2045. Figure 16.1 shows its plan to achieve Real Zero.

Giving customers additional opportunities to invest in solar through the SolarTogether™ programme, the largest community solar programme in the US, is another innovative method used by NextEra Energy to promote clean energy. Launched in 2020, the SolarTogether™ programme initially aimed to allow customers to offset their energy capacity with power from 20 universal solar energy centres, totalling nearly 1,500 MW of capacity.

FPL is executing a pilot programme to assess how combustion turbines operate with a hydrogen fuel mix. Through this, FPL wants to learn how to effectively use hydrogen fuel production and battery energy storage facility on site with combustion turbine units. This can provide valuable insights to Indian public sector units (PSUs) to convert their thermal sites to produce hydrogen and battery energy storage facilities.

NextEra Energy's transition can provide valuable insights for other companies to follow. Its plans to eliminate greenhouse gas emissions by 2045 without relying on carbon-capture systems or offsets mark one of the biggest bets yet to make hydrogen a central piece of the energy landscape. Moreover, clearly articulated interim decarbonisation targets set on a five-yearly basis will massively support NextEra's ability to tap global sustainable finance markets, a point that Indian utilities, such as NTPC and Tata Power, should note.

Indian companies have been slow to announce net-zero plans. In contrast, NextEra committed to Scope 1 and Scope 2 emissions by building renewable energy assets and outlined plans to achieve Real Zero for facilities and buildings outside FPL's service territory through direct clean, renewable energy procurement or virtual power purchase agreements (VPPAs). Further, the company is expanding capabilities through investments in software platforms, including NextEra 360™, for better reporting on Scope 3 emissions and working with supply chain partners and customers on solutions to reduce emissions throughout the entire value chain.

Economic studies indicate that reaching NextEra Energy's Real Zero goal could create 150,000 jobs and add US$15 billion to Florida's annual gross domestic product (GDP) through 2045.

Huge Investment Requirements

NextEra Energy is betting on battery storage, green hydrogen, etc., to achieve Real Zero. However, this requires huge investments not only for the development of clean energy

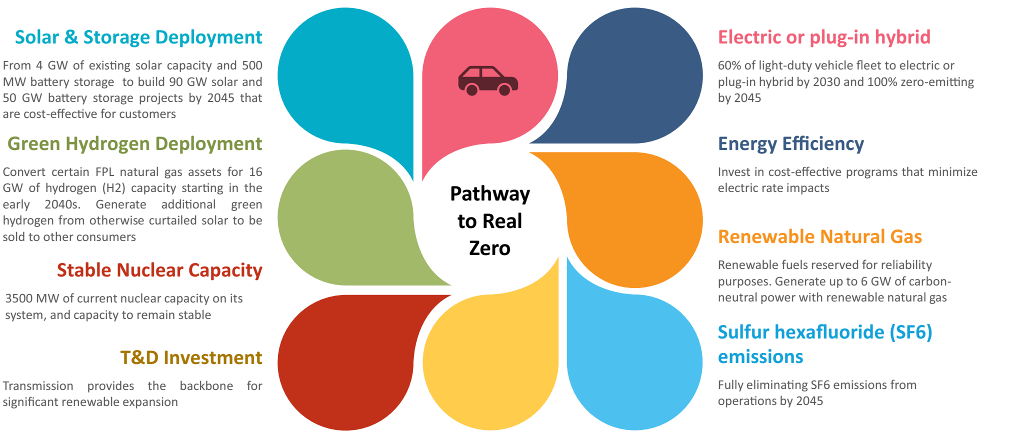

Figure 16.2 NextEra Energy's path to Real Zero.

Source: IEEFA Analysis.

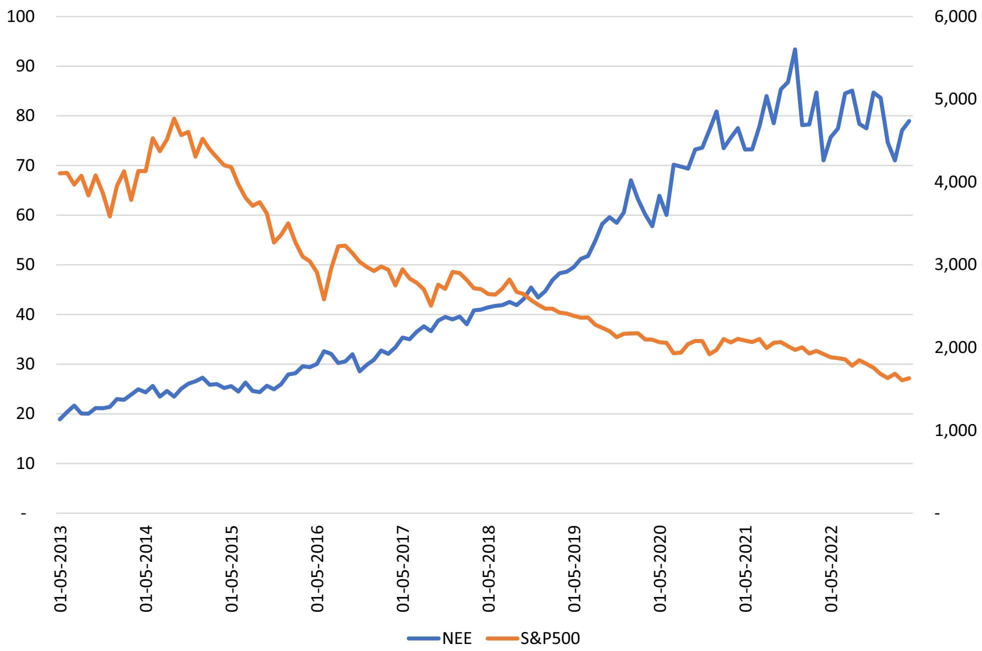

Figure 16.3 NextEra Energy and US Market equity market performance over last one decade.
Source: Yahoo Finance.

alternatives but expensive upgrades needed for NextEra's natural gas pipelines and turbines if they are to use pure hydrogen.

A constructive regulatory environment and lowering operating costs have helped attract investments to grow clean energy capacity and keep costs low for customers while improving reliability. From 2012 to 2021, the company deployed approximately US$51 billion in smart capital investments in Florida to keep enhancing its customer value proposition. Also, it has cut its operating costs and gone from almost 10% worse than the industry average in 1988 to become 65% better than the industry average by 2020.

NextEra Energy's investment plan to invest US$85–95 billion over 4 years through 2025 across solar, wind, and storage assets supports its core strategy of expansion in the renewable energy segment. In addition, the recently announced Inflation Reduction Act of 2022 in the US will likely accelerate its plans.

Indian companies can also pay for the transition by lowering operating costs and making operations more efficient. Further, they can pass these reduced costs on to the consumers by lowering tariffs on the renewable energy produced.

How Investors Are Valuing the Transition

NextEra Energy (+375%) has materially outperformed the US equity market (+175%) over the last decade as it has ramped up its investments in zero emissions generation and associated grid infrastructure.

Diversification and decarbonisation have provided financial gains to the company shareholders. This trend will strengthen as awareness and demand for sustainable development increase in the coming years. It is time Indian companies shift away from fossil fuels, build a clean energy portfolio, and build capacities across the value chain.

Iberdrola's History and Transition Till Date (2001–2016)

Iberdrola traces its roots back to the early days of the European Union's power industry liberalisation in 1992, when two private legacy Spanish utilities, *Hidroeléctrica Española* and *Iberduero*, were merged into a single corporation (*Iberdrola*, 2012). The parent companies, established in 1907 and 1944, respectively, played a fundamental role in Spain's nation-building and shared a rich history of innovation and accomplishments.

Iberdrola inherited 40% of the home country's generating capacity from its inception with a blend of hydroelectric, nuclear, oil, and coal-fired power-generation plants (International Directory of Company Histories, n.d.). Spain's accession to the European Community in 1986 triggered a substantially larger wave of outward investment, and *Iberdrola* followed by expanding to international markets with a series of acquisitions in Latin America (Maxwell & Chislett, 2004). The company acquired the Argentinian thermal power plant acquisition in 1992, followed by Bolivian power distribution centres in 1995. It further strengthened its portfolio with the addition of Chilean electricity generation utilities in 1996 and came out on top in Mexico in 1999 with a contract for a combined-cycle facility. Its global presence significantly increased further with the acquisition of hydroelectric and distribution plants in Brazil. During this phase, the company also purchased assets in Chilean sanitation, Brazilian telecommunications, and gas distribution in Brazil, Argentina, and Colombia, which intended to transform the company into a true multi-service operator.

In 2001 with new leadership at the helm, the company manoeuvred towards renewable sources by implementing the "Strategic Internationalization Plan," focusing primarily on electricity generation and supply via renewable energies and gas (Costa, 2019; S. Galán, 2020). The firm further reinforced its commitment by redesigning the original blue logo with a tri-element logo of "green leaf," "blue droplet," and "orange droplet," representing renewable and clean energies (*Iberdrola*, n.d.-b).

The company significantly trimmed its assets via disinvestments in the non-core sectors in domestic and foreign markets through *Petroceltic* and *Medgaz* (Enerdata, 2013), *Sagunto* and *BBG* regasification plants (Chakraborty, 2021), and *Euskaltel* Telecom (Meads et al., 2012). It pursued international expansion again by acquiring Great Britain and US-based *Scottish Power* and *Energy East* in 2006 and 2008, respectively (ScottishPower, 2008). In line with its vision, these acquisitions transformed *Iberdrola* into a globally diversified company and the world's largest wind energy producer, with 62,613 MW of installed power capacity in 20 different countries, including Brazil and Mexico (Kolk et al., 2014). The acquisitions continued with the Brazilian distributor *Elektro* in January 2011 (Chediak & Saitto, 2011).

The Spanish ministry mandated a 100% meter replacement under 15 kW under *STAR PROJECT* during the same period. The firm made an opportunity out of the obligation by further automating the MV distribution network, which would, along with smart meters, be incremental for active management and future integration of electric vehicle charging (CapitalMadrid, 2014; ZivAutomation, 2018). In 2015, the firm further expanded in the United States by purchasing *UIL Holdings Corporation*, which was

Table 16.1 *Iberdrola*'s decommissioned thermal plants

Plant name	*Technology used*	*Power (MW)*	*Closing year*
Escombreras	Fuel oil	300	2001
Castellón	Fuel oil	1	2008
Aceca 2	Fuel oil	314	2009
Santurce	Fuel oil	1	2009
Escombreras	Fuel oil	574	2010
Cockenzie	Carbon	1.2	2012
Pasajes	Carbon	217	2012
Lada 3	Carbon	150	2012
Aceca 1	Fuel oil	314	2012
Longannet	Carbon	2.4	2016

Source: Compiled by authors from *Iberdrola*.com.

merged with *Iberdrola* USA to form *Avangrid* (*Iberdrola*, n.d.-a), *followed* by an 8.1% stake in *Siemens Gamesa Renewable Energy* in 2016 (Evwind, 2016) The company had contributed to battling the effects of climate change by investing 120 billion euros in renewable energy, smart grids, and power storage over the previous years.

It is also working to phase out its coal-fired electricity production worldwide. The company has phased out 7,500 MW of thermal energy capacity worldwide since 2001 (*Iberdrola*, 2017). These include *Castellón* and *Escombreras*. The *Cockenzie* and *Longannet*, with a cumulative capacity of 3,600 MW, were further decommissioned in 2012 and 2016 (Energynews, 2017) Table 6.1. The table presents the thermal coal plants decommissioned by *Iberdrola* over the years. We now turn our attention to *Iberdrola*'s remaining coal-fired power plants.

Remnant Coal: *Iberdrola*'s Blemish

The last two coal-fired plants in *Iberdrola*'s portfolio are located in *Lada* and *Velilla* of northern Spain. The *Lada* thermal plant began early operations in 1949 with Group 1 and expanded with Groups II, III, and IV. The only current operational Group IV was inaugurated in the 1980s and had a capacity of 358 MW (Enerdata, 2017). The *Velilla* thermal plant, on the contrary, started operations in 1964 with a 148 MW capacity power unit. It expanded with a 350 MW power unit in 1984 to a combined capacity of 516 MW. Both plants consumed indigenous coal, which gradually declined since the early 2000s and has been mainly operational upon imported coal (LaNuevaEspana, 2012; Newbery, 2017).

In the last decade, the firm has made upwards of €100 million investments in desulphurisation plants to upgrade and reduce particulate emissions of the facilities by approximately 70%, significantly improving the plant's operations and reducing its consumption (*Iberdrola*, 2011).

Financial Performance of *Iberdrola*

Iberdrola's financial performance has been a cause of concern. The firm's revenue and gross profit have contracted (see Table 6.2), and the burden of rising debt had forced the

Table 16.2 *Iberdrola*'s financial parameters

Sr. No.	*Financial attributes (in billions)*	*2014*	*2015*	*2016*
1	Revenue	39.94	34.87	31.83
2	Gross profit	16.2	14.25	14.32
3	Cash (millions)	476.2	272.1	192.1
4	Total long-term debt (annual)	33.53	32.59	33.08

Source: Compiled by authors from Ycharts.com.

management to rectify its long-running growth strategy. The firm's rising debt, further plagued by the recession-hit home market, led to the sale of multiple company assets, like *NuGeneration Ltd.* (Williams & Amiel, 2013) and *Bahía Bizkaia Electricidad* (Enerdata, 2014). It also led to cutting down on promised investments and an effort to improve efficiency (Power Engineering International, 2013; Rucinski, 2012).

The Political Economy of *Iberdrola*'s Energy Transition

Iberdrola's political economy, in the context of encouraging an energy transition, has been mixed, at best. As a part of the EU, Spain has played a significant role in developing European Union's policies and established itself as a leader in implementing liberalisation measures (Guide to Business in Spain, 2022) but has also balanced its domestic interest on the sidelines.

As a signatory of the *Paris Agreement 2015*, the European Union has officially committed to limiting global warming to under 2°C. It must rapidly decarbonise its power sector to achieve its goal, as coal-fired power plants contributed 18% of EU emissions (ClimateAnalytics, 2017). Thus, in early 2017, the European Union adopted the "Best Available Technique," which requires a high upgradation cost for coal-fired power plants but assures a high level of environmental and human health protection (OECD, 2018). According to the Best Available Techniques (BAT) policy, all EU coal-fired power plants must meet the new stringent standards issued by 2021 (ClimateAnalytics, 2017).

The Spanish laws, on the other hand, continue the *Transitional National Plan* exemption, enabling coal power plants to emit elevated amounts of toxic pollutants such as

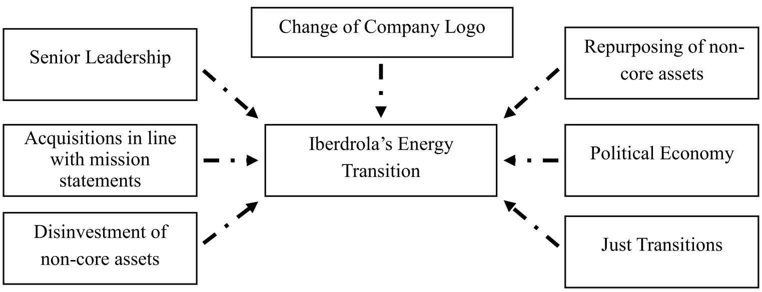

Figure 16.4 Key takeaways for *Iberdrola*'s successful energy transition.

Source: Compiled by authors from various sources.

SO_2 and NO_x (IIDMA, 2017). However, from 2020, the utilities were forced to minimise their SO_2 and NO_x emissions. According to the British daily, *The Guardian*, although most Spanish coal power plants burn imported coal, the political clout carried by the Spanish vocal lobby cannot be ignored (Vaughan, 2017).

Repurposing of Remnant Coal-Fired Power Plants

After *Iberdrola* announced the closure of the *Lada* and *Velilla*'s coal-fired plants, it faced opposition from the Spanish government. The government presented a royal decree and veto draft, giving ministers the final authority regarding coal-plant closures in case the plant's closure threatens energy security or if the plant is profitable or its closure would lead to higher electricity prices in Spain (Energiewende, 2017; Robert, 2017).

However, despite the initial conflicting views, the Spanish government granted *Iberdrola*'s decommission request, with an additional investment of €35 million for decommissioning over the next 4 years. Thus, with the extended time period, the financials improved and 170 workers from both plants were retained and relocated to other facilities (*Iberdrola*, 2017). The company also included plans to construct 550 MW solar and wind power facilities to replace coal-fired ones. The capacity would be shared between four wind farms in *Lada* with a combined total of 130 MW and 420 MW of additional wind and solar power in *Velilla* (Rack, 2019).

In the latter part of 2021, the *Velilla* thermal power plant's cooling tower was demolished through a controlled explosion, and 35% of the dismantling was completed (*Iberdrola*, 2021).

Key Takeaways

The *Iberdrola* case demonstrates that, since energy transitions are long-term commitments, the firm's senior leadership plays a crucial role in implementing strategies. Changing the firm's logo as a symbol expresses its underlying ideology and value system (Dandridge et al., 1980) to internal and external stakeholders. The company's acquisition, disinvestment, and repurposing in line with the strategic plan further help manage the firm's financials. The firm's embracing energy transition also needed to embrace Just Transition for their impacted workers and navigating the political environment for smooth execution. Indian firms have a lot to learn from *Iberdrola*'s deft navigation of its transition pathway.

Notes

1 Enel. Enel Annual Report FY 2021.
2 Enel. Agrivoltaics: A New Land Use Model in the Shadows of Solar Arrays. April 2019.
3 Enel Green Power. South Africa.
4 Enel. The Futur-e Project. 2016.
5 Montel. Endesa plans 700 MW of green power at Spain coal plant site. June 2020.

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Part 4

Investors and Shareholders: an Introduction

Mritiunjoy Mohanty and Runa Sarkar

As its name suggests, this section navigates the role of and benefits for investors and shareholders in financing India's shift towards a more sustainable energy mix through debt and equity, keeping squarely, the requirements of Just Transition in mind. There is little doubt that the buildup of electricity systems will be a capital-intensive activity. A common refrain from the previous sections has been the need for adequate finance, appropriate financial mechanisms, and methods to identify which projects to fund and develop a timeframe for financial flows. It also has to be kept in mind that it is not just the repurposing or renewable energy projects that require attention, but the entire social ecosystem around the change, which implies that financial flows and instruments must not be limited to merely project finance.

Towards this objective, Chapters 17 and 18 take a deep dive into the financial landscape of India to first determine the quantum of financial flows required for an energy transition which is along the lines of India's Nationally Determined Contributions (NDC) targets. The pathway needed to achieve the NDC targets is very steep, with a requirement of almost 40 GW of average annual cumulative additions of wind and solar between now and FY30. However, the battery and other storage technologies required for higher integration of renewable energy (RE) do not yet have established business models, limiting their uptake. In light of these targets, *Singh and Kumar*, in Chapter 17, analyse the financing required, the current finance at play, and how the country could mobilise the required financing using both short and long-term measures.

Singh and Kumar recognise that being an asset of the infrastructure class, most of the capital expense for setting up the RE, particularly solar and wind projects, is financed by debt. Hence, the current lending exposure of the banking system versus the financing requirements until 2030 is quite high and alternative options such as fledgling infrastructure debt funds and other similar platforms of scale to support the banking systems are limited. Beyond domestic capital, external commercial borrowings are limited because of associated tenure issues, current high rates of interest, and the lack of private debt players to take over the construction risk. International green bond issuances have worked well to refinance loans for renewable energy projects, but the rising interest rate domestically and in the USA have dampened refinancing through green bonds in 2022 and in the near future.

Thus, it is clear that India needs to harness diverse instruments and structures to supplement existing banking system by refinancing loans and allowing banks to make loans to new projects and take the construction risk or co-lend with them. These could include partial guarantee for banks and non-banks to extend credit for new technology and

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small-scale applications and developing guarantees for bonds so that companies with less than AA ratings can also benefit from them. Extant mechanisms and platforms/institutional structures for debt funding the 2030 RE targets are discussed Beyond the guarantee structures, institutional structures for debt funding the 2030 targets such as alternate investment funds, infrastructure debt funds, and investment trust funds are touched upon. Further, the limitations of funding agencies to identify which projects to fund in the absence of a universally accepted sustainable finance taxonomy and without clear policy direction are discussed. Appendix 17A *(Ørsted's Farm-Down Model: Lessons for Indian Firms)* by *Shantanu Srivastava* presents an innovative financing model employed by Ørsted as an exemplar.

In Chapter 18, *Sikka*, *Khanna* and *Purkayastha* look at financing transition technologies from the perspective of financial institutions. They discuss the current definition of transition finance and emerging regulations in the field. They trace the emergence of the concept of transition finance to the EU Taxonomy's "transition activities" and present multiple interpretations of "transition activities" and "transition finance" by different regulators and international organisations. This is followed by an exploration of the challenges of financing transition technologies. These include the lack of enabling environment, high cost of capital, and lack of innovative financial instruments. The chapter suggests that to ensure higher capital flows to transition finance, engagement with multiple interpretations is a must. This in turn entails developing transparent policy and regulatory frameworks defining transition activities and sharing clear guidelines on transition pathways for different sectors at the national level. De-risking mechanisms such as blended finance structures need to be put in place so as to satisfy the risk and return profile requirements of a typical financier. Appropriate carbon-pricing mechanisms also need to be established for channelling capital to transition technologies. In a box (*Deutsche Bank TLC Framework for Investor Friendly Policies*) *Abhinav Jindal* presents a policy design framework to reduce regulatory risks and increase investments in RE.

The role of domestic institutional capital in funding India's energy transition forms the content of Chapter 19. *Srivastava* starts by laying out the domestic institutional investor landscape as of date, while emphasising their suitability for the capital-intensive requirements of the energy transition. Globally, institutional investors have helped several low-carbon technologies scale up worldwide through debt and equity investments. However, from an Indian perspective, while foreign institutional investors have played an important role in providing capital for renewable energy producers, domestic institutional investors have largely sat on the fence. This is despite India being home to a large number of institutional investors, both private and public, including pension funds, insurance companies, and banks. Mutual funds are excluded from these discussions as they do not fit the definition of long-term patient capital. The insurance and pension sectors have the largest share of investor capital among domestic institutional investors and have played a major role in helping grow the domestic capital markets. They have been anchor investors and capital providers for central- and state-level debt securities, which have been used to fund several developmental needs. Public sector units (PSUs) have also relied on these investors for raising bonds and debentures, often raising debt at ratings at par or, at times, better than sovereign. The steady and timely inflow of funds for insurers and pension funds in India has helped them consistently provide for the nation's development needs.

However, domestic institutional investors' funding in India's domestic renewable energy sector has been sparse compared to the global scenario. Chapter 19 explores reasons for this, concluding that their primary hurdle has been the lack of options for them to invest under the current regulatory environment. It also suggests solutions to scaling up domestic institutional investors (DII) investments including regulatory reform. It prioritises the introduction of these reforms and identifies the appropriate agency to implement it. Given the politically sensitive nature of these issues, there must be a strong resolve to undertake reforms for channelling capital from these investors. Additionally, sectoral regulators will need to take cognisance of the climate risks plaguing these sectors and work towards incorporating Environmental Social and Governance (ESG) principles. Further, the chapter also suggests how corporate entities need to revisit their business models so as to attract transition finance from DIIs. In Appendix 19A *(Financial Ecosystem for Scaling Up Renewable Energy) Jaju and Dey* suggest creative financing mechanisms for encouraging investments in RE. *Shantanu Srivastava* demonstrates changing business models in RE deployment in Appendix 19B (*India's Energy Sector: Redefining Business Models and Adopting New Clean Energy Technologies*).

What is clear from the first three chapters is that the government needs to signal clear support by initiating a supportive policy environment for green transition finance to flow. The steps would mean endorsing clear transition pathways, establishing greater certainty in future demand for financeable projects, establishing a green taxonomy, and addressing risks through various instruments and structures.

In this light, Chapter 20, by *Kumar* and *Tandon*, seeks to suggest ways through which Just Transition can be embedded and mainstreamed into the discourse of development finance. Recalibration of public and private finance will be central to achieving a Just Transition to ensure resilience of financial and non-financial entities on one hand while safeguarding the well-being of workers, communities, and consumers on the other. Transitional sectors such as electricity and agriculture constitutionally lie in the concurrent and state lists making the role of the States critical in steering and managing "Just Transition." In fact, the centre and states will need to evolve a comprehensive framework for coordinated action and demarcate their common and differentiated responsibilities. Managing the fiscal space to finance India's energy transition will require massive efforts to attract different sources of capital, at the level of both the centre and the state. Pricing carbon appropriately, the loss of revenues in one sector and raising of subsidies for another will need deft fiscal management and an understanding of some inevitable trade-offs that will emerge. This will further impact the fiscal space available to states and the centre, thus necessitating systematic planning. Appendix 20A (*Decarbonisation Goals: Benchmarking NTPC and Tata Power with Enel*) by *Saurabh Trivedi* suggests operationalising decarbonisation goals using a sustainability linked finance framework.

Just Transition must form a part of disclosure mechanisms and accepted taxonomy and be integrated into funding requirements for energy transition-related projects. Sovereign issuances should include Just Transition objectives and it should feature prominently in collaborative agreements at all levels.

Building on the previous chapter's recommendations, *Swarnakar* and *Shukla* explore the ways in which the concerns and demands of just energy transition can be integrated into the international climate finance mechanisms in the last chapter of this section. After discussing the notion of common but differentiated responsibility and the distributive, procedural, and restorative dimensions of climate justice, the authors warn that when cast into the language of donor and recipient, the climate finance discourse often delinks the process from its basic premise of distributive justice. The finance from the developed countries is not a donation or a loan, but what is owed to the developing countries for the developed world's relentless use of natural resources to feed an economic system that has benefited few at the cost of many. In this context, the chapter discusses the possibilities and requirements for integrating the concerns of Just Transition in India within the broader agenda of international climate finance.

As a by-product of larger climate crises, the energy transition and its impacts should be strongly integrated into the international climate negotiations as well as financing frameworks. For this to happen, the underlying justice principles and implications of both international climate finance and Just Transition, need to be revisited, clearly defined, and strongly institutionalised through inclusive and research-driven processes.

The unique requirements, dependence, and vulnerabilities of the Indian coal-producing regions and fossil fuel-based power sector need a carefully tailored, multilayered, and justice-driven response, at the sub-regional, regional, national, and international levels.

17 Financing India's 2030 NDC Targets and Beyond

Vaibhav Pratap Singh and Neha Kumar

Introduction

Indian Parliament in August 2022 approved the updated Nationally Determined Contribution (NDC) targets (PIB, 2022).[1] The updated targets are (i) reducing the emission intensity of the Gross Domestic Product (GDP) by 45% from the base 2005 levels and (ii) increasing the share of non-fossil installed generation capacity to 50% of the total energy mix by 2030. A major share of the proposed emissions' intensity reduction is expected to accrue from greening the electricity systems, which in 2018 contributed to over 40% of the country's annual emissions. Other measures include energy and process efficiency improvements in the industrial sector, contributing another 20% to the total emissions (India, 2021).[2]

As per the Central Electricity Authority's (CEA) optimal generation mix, which maps India's electricity system's least-cost pathway-based deployment till 2030, India would have 817 GW generation capacity by 203 (Central Electricity Authority, 2020)[3]. The expected capacity mix comprises 420 GW of installed renewable generation capacity with a share of 280 GW of solar and another 140 GW from the wind. The new additions to other technologies like biomass and waste to energy, excluding large hydro, take the total to 450 GW of renewables by 2030, also quoted as the target of renewable energy (RE) at some of the avenues by the Ministry of New and Renewable Energy (MNRE). The same report places the required addition of around 27 GW of battery storage for 4 hours, i.e., about 108 GWh of battery support by 2030. As of 30 September 2022, India had an installed wind and solar capacity of 107 GW, with 67 GW of solar and 40 GW of wind and almost no battery storage systems (Ministry of Power, 2022).[4]

Thus, the pathway needed to achieve these targets is very steep, with a requirement of almost 40 GW of average cumulative additions of wind and solar between now and FY30. However, the average addition to the renewable capacity ranges 9–15 GW between 2017 and 2022 (Shah, Sharma, Nair, & Garg, 2022).[5] However, the battery and other storage technologies required for higher integration of RE do not yet have established business models limiting their uptake. India is moving away from simple solar and wind projects to hybrid tenders with or without storage. In the first half of the year FY23, of the total 6.7 GW procured, 36% was under hybrid project models (Shah, Bibhudatta, & Nair, 2022).[6]

In light of these targets, this chapter analyses the financing required, the current finance at play, and how the country could mobilise the required financing using both short- and long-term measures.

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Finance Requirements

The buildup of the electricity systems will be a capital-intensive activity. The capital expenditure (CAPEX) for the buildup of the generation, transmission, and distribution between 2020 and 2030, as per CEEW-CEFs estimate, will cost US$ 523 billion (Singh & Sidhu, Investment Sizing India's 2070 Net-Zero Target, 2021).[7] The report shows that most of these investments, worth US$ 382 billion, would be required in generation capacity alone. A report from the Parliamentary Standing Committee estimates that the investments required for the renewables capacity target of 450 GW alone at Rs. 1.5 lakh crore to 2 lakh crore (US$ 18–24 billion) annually (Singh & Sidhu, Investment Sizing India's 2070 Net-Zero Target, 2021).[8] The financing flows towards renewables, according to the same report, over the last few years are Rs. 75,000 crore (US$ 9.1 billion) per annum – far below the average capital required to set up the capacities required for the target of 450 GW by 2030.

The Parliamentary Committee report also indicates that India fell far short of the 2022 rooftop solar target of 40 GW. One of the identified reasons beyond the policy inconsistency and others is the reluctance of the banks and non-bank finance companies (NBFC) to extend credit to small-scale borrowers, and even the performance of dedicated debt schemes has not been up to the mark.[9]

Finance at Play

Being an asset of the infrastructure class, most of the capital expense for setting up the RE, particularly solar and wind projects, is financed by debt. Given the long-term nature of finance, debt financing is usually left to patient capital such as pension funds.

A project's debt level is to the tune of 75% to 80%. Thus, the country would need almost US$ 150–160 billion of debt to be raised for setting up these projects until 2030 of the US$ 200 billion required for setting up the solar and wind capacity alone.[10]

According to RBI data, the exposure of all scheduled commercial banks for the entire power sector on 25 March 2022 stood at Rs. 6.1 lakh crore (US$ 75 billion). Power Finance Corporation (PFC), Rural Energy Corporation (REC), and the Indian Renewable Energy Development Authority's (IREDA) total exposure, which is largely towards the power sector, summed up to Rs. 3.1 lakh crore (US$ 39 billion), Rs. 3.8 lakh crore (US$ 47 billion) and Rs. 33,931 crore (US$ 4 billion), respectively, as on 31 March 2022.[11] Cumulatively, a total of US$ 165 billion is the exposure of the country's major banks and NBFCs.

It is thus evident that the current lending exposure of the banking system versus the financing requirements until 2030, pegged at US$ 523 billion for the entire power sector, is pretty high and highlights the RE's financing challenge. Banks and NBFCs take most of the construction and initial operational risks. Most of them have reached their internal exposure limits to the power sector or other concentration limits, e.g., group exposure limits, etc.

As we advance, the banks and NBFCs will find it challenging to meet the financing requirements of the sector. Also, India does not have many alternative options like the fledgling Infrastructure Debt Funds (IDF) and other similar platforms of scale to support the banking systems in the country for the RE buildup.

An independent study found that electricity production, energy-intensive manufacturing (chemicals, petroleum, primary metals, and cement), mining and quarrying

Table 17.1 Breakup of the cumulative green, social, sustainability (GSS) bond issuances by Indian players

Particulars	*Green*	*Sustainability*	*Social*	*Total*
Size of market (USD)	18.3 billion	0.6 billion	0.5 billion	19.5 billion
Number of issuers	72	1	2	75
Number of currencies	3	1	2	3

Source: India Sustainable Debt, State of the Market (2021).

(including coal), and gas refineries, which comprise 60% of emissions, account collectively for around 12% of all domestic currency bank lending and 40% of bank lending to large corporates (Bhattacharya, Kumar, & Lonikar, 2022). Beyond domestic capital, external commercial borrowings (ECBs) are one of the routes to finance the RE CAPEX. But the associated tenure issues, current high rates of interest rate, the world over, and other constraints like the lack of private debt players to take over the construction risk under this route is an issue. However, the recent ECB issuance data, visible from the RBI monthly ECB exposure publication, showcases an improved investor sentiment towards this route.

International green bond issuances are the other debt capital stream that has worked well for RE developers. In FY22, Indian RE developers raised almost US$ 5.1 billion worth of green bonds, practically equivalent to all the combined historical issuances in the years before (Garg, 2021). This route, in the past, has allowed a lot of refinancing of existing bank loans and allowed a freeing up of the bank capital, which is deployable back to new greenfield RE projects. By June 2022, the cumulative volume was US$ 25 billion since 2015 (Bhattacharya, Kumar, & Lonikar, 2022).[12] Climate Bonds Initiative database had a total of US$ 25 billion cumulative green, social, sustainability (GSS) debt issuances.

Accessible finance leads to a constant lowering of the costs of winning bids at utility-scale renewable energy auctions in India. Refinancing loans for these projects has resulted in green `bond issuance from developers and financial institutions. The raising of interest rate domestically and by the US Federal Reserve over the current fiscal year has dampened the refinancing of green bonds in 2022.

Green Bonds as the Prominent Tool for Refinancing RE Worldwide

Global Landscape

Globally, the rise of sustainable finance, and the successful uptake of green bonds in particular, has made them a prominent tool for mobilising and directing capital towards climate investment opportunities and driving policy action on climate change. The market stands at over US$ 2 trillion of global issuance till date. The year 2021 saw 80% growth on 2020 – all from just a few billion in 2013. In 2022, the global issuance of green, social, sustainability, and sustainability-linked (GSSS or sustainable) bonds was down 13% from a year earlier and down 10% from the second quarter of 2023, according to the report by Moody's Investor Service. This downward trend is aligned with the slowdown of the broader market which is down nearly 27%, according to the report, but notably thematic bonds have gone down by a more modest 17%. The fundamental drivers of long-term growth in sustainable bonds remain in place and the issuance would pick up when market conditions become more favourable.

Indian GSS Debt Papers

Indian GSS debt issuance increased more than sixfold to reach US$ 7.5 billion in 2021 following a pandemic-induced decline in issuance in 2020 (Shah, Sharma, Nair, & Garg, 2022).[13] Three-quarters (75%) of the cumulative-labelled bond volume in India originates from the private sector. Non-financial corporates comprise the largest issuer type by volume (US$ 12.6 billion) and the number of deals (40 of 77). That is followed by government-backed entities (US$ 4 billion) and financial corporates (US$ 2 billion).

USD is the preferred currency for raising GSS debt in the Indian market. 87% of the cumulative amount issued, and 37 of the 75 deals, are USD denominated. The two recent GSS local currency deals suggest that issuers will continue to consider local currency for raising future GSS debt. The only other currency used so far is the EUR. One EUR-denominated deal was completed in 2021: a Climate Bonds Certified 7-year, EUR 300 million green bond from Power Finance Corporation Ltd with proceeds earmarked for solar and wind energy projects.

The domestic corporate bond market which totals around Rs. 39.5 lakh crore (US$ 487 billion) has seen only two issuances over the last couple of years from Indian RE developers.[14] The issuances were small and were securitised against cash flows from the project portfolio, summing up to 350–555 MW against an issue size Rs. 1,237 crore (US$ 151 million) and Rs. 1,440 crore (US$ 175 million).[15,16] Also, these bonds have a tenor of 3 years versus the loans of 16 years that each refinanced.

It is safe therefore to assume that only two sources of debt capital, i.e., domestic banks and foreign bonds, for refinancing existing loans are accessible or are working from the debt funding perspective.

Presently, the domestic bond markets and the foreign institutional debt beyond the bond markets, e.g., foreign banks, are not accessible to RE developers. The fiscal tightening by regulators worldwide is leading to higher interest rates, and Indian RE developers have not used the international green bond markets to raise capital in the current fiscal year. Thus, solutions would have to be worked around if the scale of India's RE ambition is to be met; otherwise, access to capital could prove to be a massive bottleneck if things continue the way they are.

Equity

A look at the balance sheets of the major renewable energy players operating in utility-scale projects and with some scale reveals that most major players have a concrete runway and strong ownership of sovereign wealth and pension funds for equity. Also, the profile of the RE projects, marked by 25 years of power purchase agreements with sovereign counterparties like Solar Energy Corporation of India (SECI), low operating costs, and returns in the low double digits, is well pretty suited for such investments (Dutt, Arjun; 2021).[17]

Another report by the CEEW-CEF, which maps over 160 solar and wind projects, found that most of the solar projects in 2021 are investment grade, while none were in 2012. And almost 60% of solar projects rated in 2021 had a rating of A and above. The trend showcases that the sector is maturing, as are the contract structures, and indicates a low probability of default by the RE projects in the country.

Solutions

India needs to harness diverse instruments and structures to supplement existing banking system by refinancing loans and allowing banks to make loans to new projects and take the construction risk or co-lend with them. We discuss several approaches including structures and instruments that, if deployed under platforms, could allow a greater flow of capital to projects in line with the requirements of the RE targets.

Instruments

Partial Guarantee for Banks and Non-banks to Extend Credit for New Technology and Small-Scale Applications

Using partial, first-loss guarantees or a combination of guarantees at the portfolio level can help banks and non-banks extend credit for small-scale solar deployments. Such a facility could also help derisk technology-related lending risk, e.g., for the battery energy storage at both the grid and distributed scale. Once a track record of operations and credit history for such projects is created, financial institutions like banks and non-banks could optimally price risk and extend credit to such projects.

Credit Guarantee Fund Trust for Micro and Small Enterprises (CGTMSE) by the Small Industrial Development Bank of India (SIDBI) and the Government of India (GoI) *is one such example of a guarantee structure unlocking capital for the non-collateralised lending* by banks and non-banks to small and medium enterprises in India. In FY22, guarantees worth Rs. 56,172 crore against over 7 lakh successful applications were sanctioned. A similar approach could be used for unlocking project debt for small, new-tech RE projects in India.

Figure 17.1 showcases one structure for the facility to work a bilateral loss-sharing facility between the trust and lenders. Under the structure, a facility manager extends the guarantee to the lending institutions per the trust rules and trustee guidance.

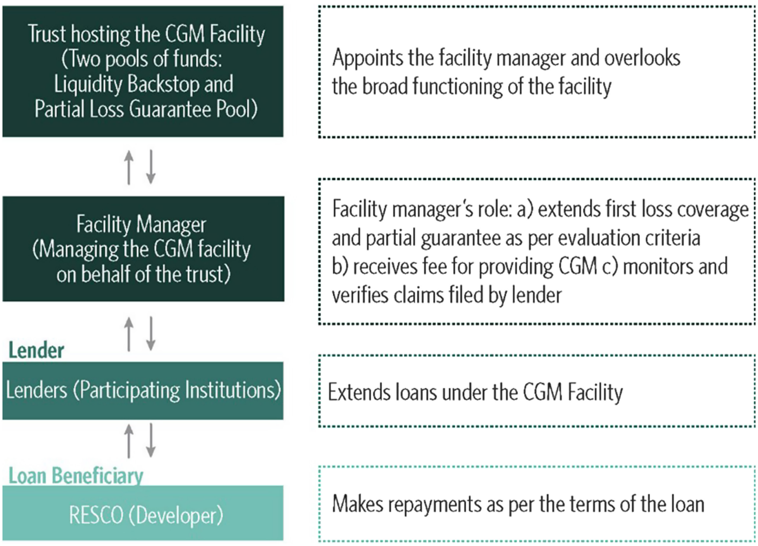

Figure 17.1 A potential structure for the partial guarantee facility (CGM Facility).

Source: Singh et al. (2018).

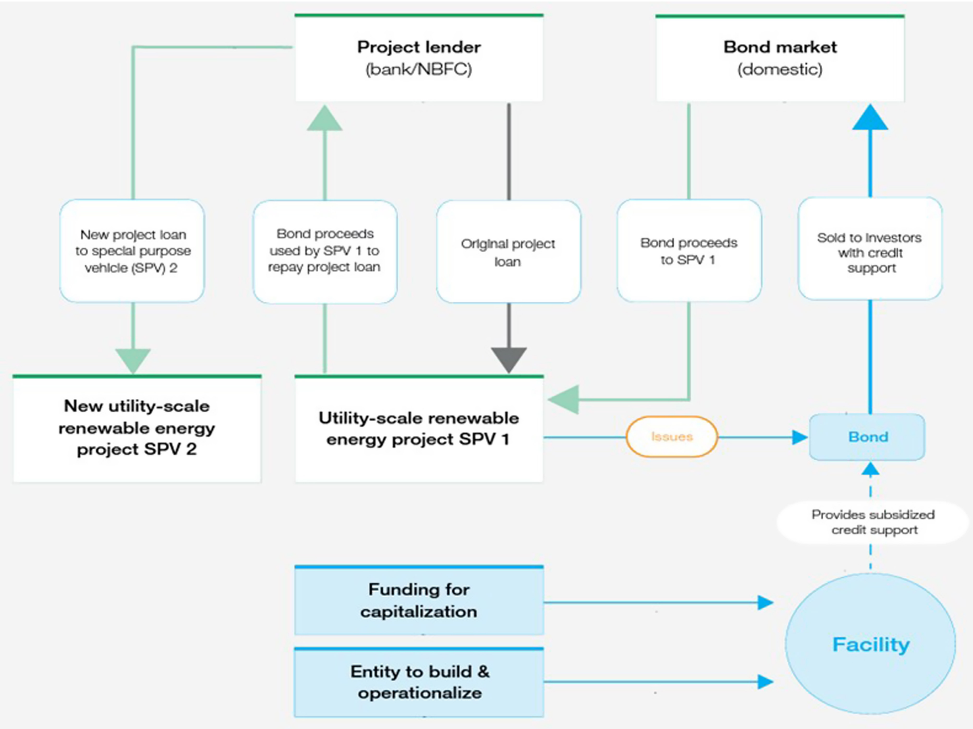

Figure 17.2 A potential structure for subsidised credit enhancement solution.
Source: CEEW-WEF Community Paper.

Guarantees – For Bonds

Indian corporate bond market is largely confined to bonds with ratings of AA and above.[18] The domestic market can be a refinancing option for the project loans and allow financial institutions like NBFCs to offload the assets and make new loans to the projects. The guarantees could provide a small nudge as most of the existing utility-scale projects are rated investment grade. The available credit guarantee products are usually not viable, given their costs and lack of depth (CPI, 2019). In this case, a limited-period subsidised credit enhancement could help open the bond market for RE developers in the country. The structure could use public money to subsidise the costs per a CEEW-WEF Community Paper. The paper shows a capital of US$ 10 million would be sufficient to raise bonds worth US$ 150–190 million. Once a track record is established, this may allow existing bond market players accustomed to RE-backed securities by the developers and the NBFCs.

Platforms/Institutional Structures for Debt Funding the 2030 RE Targets

Beyond the guarantee structures, the platforms like Alternate Investment Funds (AIF), Infrastructure Debt Funds (IDFs), and Investment Trust (InvIT) could play a role in extending credit and refinancing portfolios of the RE assets. The following text discusses each of these structures' main features and advantages.

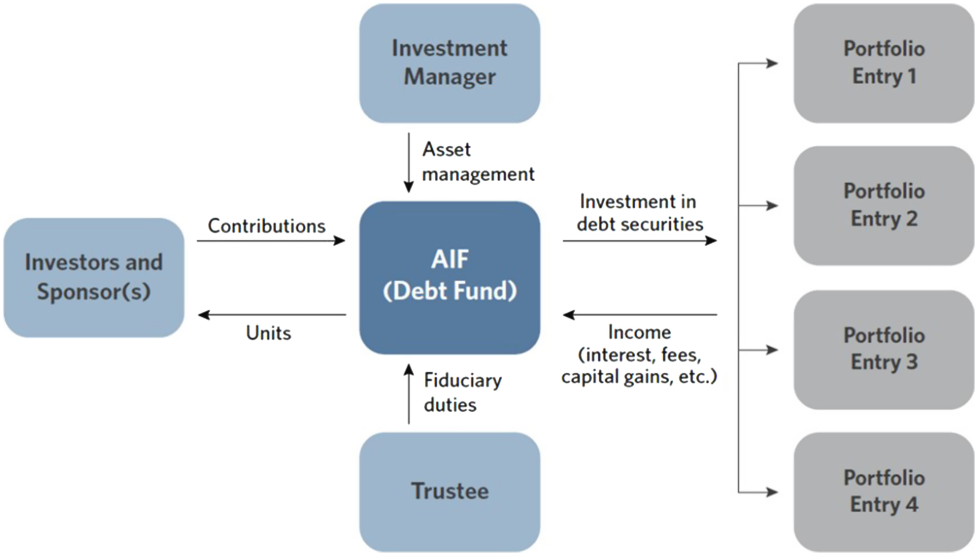

Figure 17.3 Workings of a debt AIF purchasing debt securities backed by portfolios of the non-banks.

Source: CPI (2019).

Alternate Investment Fund – An AIF, as defined by Securities and Exchange Board of India (SEBI), is a fund that collects money from investors for investing under its investment policy. India has over 1,000 AIFs listed with the SEBI.[19] Listed as a debt fund, an AIF which invests in both listed and non-listed debt securities could be of great use in the medium to the short term for financing RE (Singh, Purkayastha, & Shrimali, 2019).[20] The non-banks could use such a fund to offload their portfolios securitised as bonds, whose units the AIF subscribes to, and thus lenders make fresh lending to the new RE projects. AIF structures could provide early-stage venture capital for new and emerging businesses in the green energy space and help fund new companies and ideas in the RE space. According to announcements by IREDA, the NBFC is looking at the AIF route to deleverage the book and extend credit to parties who have reached exposure limits – simultaneously bringing in more investors to participate as investors in the fund (Das, 2022).[21]

Infrastructure Debt Fund (IDF) – India, in 2011, set out to develop its infrastructure debt fund market. An IDF in India may be listed as a Non-bank Finance Company or a mutual fund (RBI, 2022).[22] It is possible to fund the infrastructure and refinance existing bank loans, co-fund the infrastructure of the bank, or take equity positions under the mutual fund route and even take the construction risk. One of the benefits of the IDF listed under the NBFC route is the possibility of long-term fixed loans, which could be well suited for RE projects with a fixed tariff under the power purchase agreements (PPA).

However, one of the concerns is the excess liquidity of the banking system through enormous cash deposits at their end could outcompete the majority of the IDF loans and probably point to a lack of growth in the investment portfolios in the RE space in the

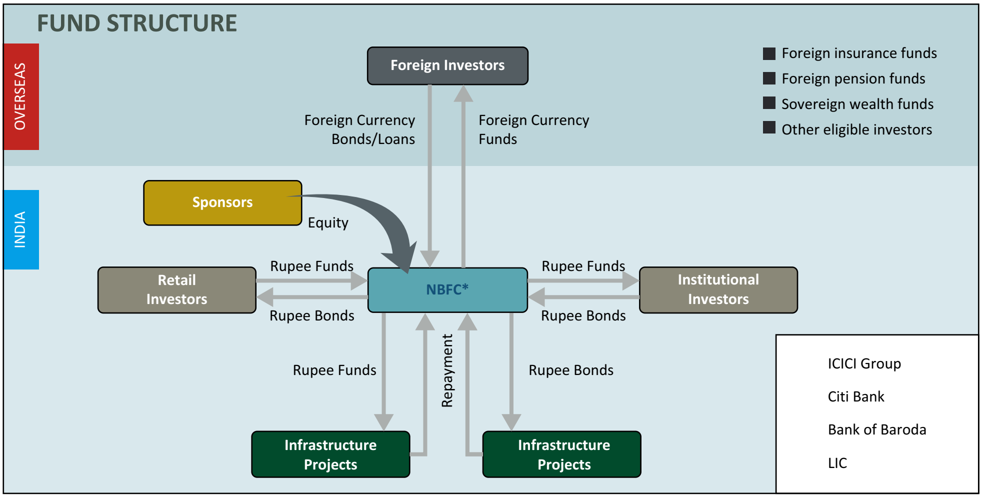

Figure 17.4 A typical IDF structure with foreign and domestic investors.

Source: IJGlobal (2013).

recent past. Also, the preference of RE developers to continue with banking and other channels is likely to continue in the future. But given the constraints of the banking system to extend the amount of credit the RE sector may require, the IDFs can provide recycling for established routes like utility-scale projects.[23] With some innovations wherein the cost of foreign capital is bought down, the IDFs could be easily used to refinance the RE infrastructure in the country (Lambert, 2014).[24]

NIIF Infrastructure Debt Limited, launched in 2014, is listed and has been helping the RE financing space. The financing platform combines NBFC Infra Debt Fund and an NBFC Infra Finance Company. The IDF supports two RE companies apart from investing in other suitable investment opportunities. The debt platform is expected to raise enough resources to extend debt support of Rs. 1 lakh crore to projects by 2025.[25]

Infrastructure Investment Trust (InvIT)

Under an InvIt structure, the renewable energy developer spins off the operative assets from the balance sheet to a special purpose vehicle/trust to develop, finance, and implement the new projects. In a typical InvIT structure, the entity/sponsor transfers the operative/semi-finished assets into a new company/trust. InvIT invests in the project either directly or through Special Purpose Vehicles (SPVs) (50% holding at the SPV level). The trustee holds the investment on behalf of the trust, which lists units through share/unit issues. The unit holders claim a minimum of 90% of the distributable cash flow. Sponsors must maintain over 25% ownership of the trust with a minimum lock-in period of 3 years.

As RE projects mature, the InvIT could provide a way to move the projects off the balance sheets and allow the developers to take on new projects while the investors

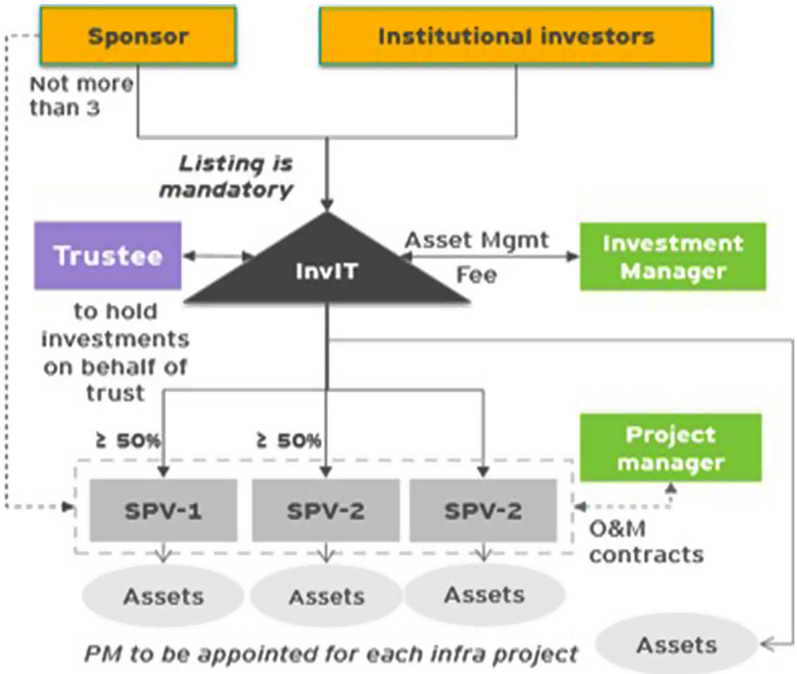

Figure 17.5 Typical InvIT framework.

Source: Kaushik Aruna (2018).

looking at stable returns may look at subscribing to the units of an InvIT. India has 15 InvITs under different infrastructure sectors. In early 2022, Virescent Renewable Energy Trust, an InvIT focused on RE with an operational portfolio of over 500 MW of RE, raised bonds worth Rs. 650 crore to fund the expansion and buying of more operational assets.[26]

Beyond using public capital to showcase solutions and solving short-term issues using guarantees, we would need the platforms hosting the structures like the AIFs, IDFs, and InvIT over the medium to long term.

These instruments and structures are new, and Indian debt markets are yet to adopt these instruments for wide-scale usage for RE financing and refinancing. A few examples exist, as cited above. There is considerable scope for growth if the government would consider the blending of public capital, which could help create a track record and create additionality by attracting more private capital in future. The role of multilateral institutions and philanthropies will be critical for some initial pilots of the platforms discussed earlier as soon as policymakers work to remove the barriers to widespread adoption.

Beyond these solutions, India would need a greening of the financing institutions in the long term. Such greening is essential to ensure a consistent and regular flow of finance for mitigation-related activities like setting more RE under the target.

Financing Credible Net-Zero Transition

As per estimates by CEEW-CEF, the transition to net zero until 2070 could cost US$ 10.1 trillion, of which almost US$ 1.6 trillion will have to flow into industrial decarbonisation between now and 2070, i.e., an average flow of US$ 32 billion annually over the next 50 years. India is also aiming to mobilise resources to have around 5 million tonnes of green hydrogen production annually for decarbonisation domestically and abroad by 2030.[27] Also, many technologies to be adopted for net zero are at the developmental stages and would require substantial R&D investments and the initial scale-up.

We explained the sources of finance, instruments, and structures that can augment the flow of finance to decarbonise the Indian economy. The scale and the pace required for this also depend on a clear classification of the activities that align with decarbonisation targets and pathways. It is a crucial step to understanding what activities the funders can fund and be in line with the long-term developmental trajectory requirements. International standard-setting bodies such as the Climate Bonds Initiative have set out a framework that aligns with the Intergovernmental Panel on Climate Change (IPCC) trajectory for net zero by 2050. It classifies activities into near zero, the pathway to zero, interim, and stranded, as depicted Figure 17.6:

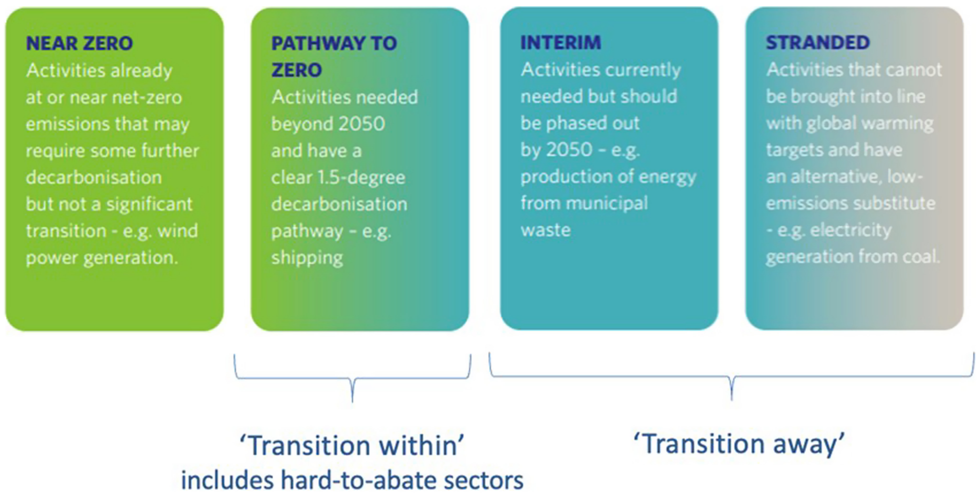

Figure 17.6 Classification of activities and their alignment to net zero by 2050 and beyond.

Source: Climate Bonds Initiative.

The activities within each category need to be supported by clear criteria (See Appendix 17A) so that alignment to IPCC net zero by 2050 and the national targets are remain credible. This allows for setting the right ambition, being inclusive (beyond pure-play green) and charting out a clear action plan to achieve a reasonable transition to net zero. This will also necessitate that the various financing instruments such as green bonds, sustainable bonds, sustainability-linked bonds (mostly used by issuers in hard-to-abate sectors), etc., are also true to label and are backed by targets and plans that can be validated and verified to be credible. There is an immense scope to grow this market in India. Globally, this has already reached nearly US$ 3 trillion.

Role of Sustainable Finance Taxonomy in Financing the Decarbonisation in Line with the NDC Targets and Beyond

As a founder member of the International Platform for Sustainable Finance (IPSF), India has argued for standardised and interoperable taxonomies. It has also constituted a Sustainable Finance Task Force anchored by the Ministry of Finance. The task force's report on the "Taxonomy of sustainable activities" is due for a release and can streamline many interrelated aspects of creating a robust, sustainable finance market, and ecosystem.

Research by the Climate Bonds Initiative reveals specific features necessary for a powerful taxonomy, as articulated by domestic and international investors. Most international investors profess a preference for existing internationally adopted frameworks, and all investors consider the development of national taxonomies as a positive signal to the market and a signal of leadership. But, they like to see interoperability and alignment to international frameworks as it saves them the opportunity cost. Domestic Investors noted that regulators like Securities and Exchange Board of India (SEBI), RBI, and Pension Fund Regulatory and Development Authority (PFRDA) could use the taxonomy to guide capital. Whilst acknowledging that such themes could be harder to quantify, they also welcomed the inclusion of social considerations and Sustainable Development Goals (SDGs) in India's taxonomy.

Both international and domestic investors emphasised the need and opportunity to finance transition in hard-to-abate sectors and indicated that this would be a more inclusive choice for the taxonomy to consider. Another feature of importance is issuer integrity. There are some pure-play issuers whose green bonds are easy to buy, for example, in the renewable space. However, many larger entities will have a renewable business issuing green bonds while at the same time being involved in controversial activities, e.g., coal or a controversial dam. Investors are becoming discerning about these organisational exposures. Even if a portfolio is meant to be focused on green bonds, the issuer needs to meet the strictest essential and valuation characteristics (the bonds' maths need to add up). Thus, most portfolios had some exclusion rules, e.g., no coal or violators of UN Global Compact norms. Investors were willing to engage and be slightly more lenient with green bond issuers coming from emerging markets concerning the application of standards (e.g., level of commitment to net-zero/1.5-degree alignment). However, this is temporary and always comes with a heavy appetite for engagement with the issuer. The same is for the quality of post-issuance reporting.

It is evident that there is a shortage of dedicated Asia/Emerging Market (EM) green bond or sustainable debt portfolios. The most significant portion of assets that could potentially invest in Indian green bonds was vanilla EM or Asian debt portfolios that would normally buy vanilla Indian sovereign debt, but if a green bond opportunity became available, they would definitely consider it. All investors are developing green/transition/ESG portfolios and, in many cases, with a geographical focus on EM, further growing the market.

For industries such as steel, which are pretty hard to abate, the technology for their decarbonisation is only at the pilot stage or quite expensive. It will benefit significantly from the availability of such transitionary steps for the building infrastructure, such as energy efficiency within existing capacity or financing infrastructure like green steel-based capacities that are expensive. Without clear definitions and metrics, not only the risk of greenwashing would persist, but it will also blunt the actions that financial firms and regulators, and real economy actors can take to identify and manage transition risks on the one hand and ramp up investment and lending to meet the 2030 targets.

The Reserve Bank of India's paper published in July 2022 takes cognisance of climate-related financial risks (broadly classified into physical and transition risks)[28] and focuses on actions that regulated entities can undertake to tackle them, such as integrating it into their scenarios analysis and stress testing, as well as disclosures. These developments will influence the trajectory of the sustainable finance market and have implications for issuance and trading volumes.

Many central banks are now expanding risk disclosure requirements to encompass the physical and/or low-carbon transition risk of climate change. Disclosure is intended to redress potential mispricing of financial assets by improving information about the risk–return ratio. While risk disclosure highlights areas where financial institutions should ideally reduce their exposure, sustainable finance taxonomies highlight areas where they should preferentially direct capital. Both these aspects will be critical and will determine the volumes of capital flow to fund the transition.

Conclusions

This chapter provides an overview of the requirements for financing India's 2030 transition and discusses both the existing state of play and the deployment of innovative structures and instruments for the same. Structures like the AIF, IDF, InvIT, and others to finance the RE capacity deployment, banks, and bonds will be required for the country to finance or refinance and meet the 2030 NDC targets. These innovative structures, with the support of regulators and platforms ready to host them, would be essential to increase the flow of finance towards RE in the country. The pilots would need some policy impetus and a blending with public capital for an initial uptake and a wider adoption.

For a faster and more inclusive transition, there is a need to green the capital markets ecosystem by expanding labelling to include all financial instruments from equities to short-term borrowing across all sectors. Taxonomies that can be used by global and local investors seamlessly and with minimum transaction costs will facilitate the recognition and wider uptake of different green financial instruments.

Finally, the government needs to signal clear support by initiating a supportive policy environment for green transition and finance to flow. The steps would mean endorsing clear transition pathways, establishing the certainty of future demand for financeable projects, establishing the green taxonomy, and addressing risks through various instruments and structures outlined as solutions in this chapter.

Notes

1 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1847812
2 https://unfccc.int/documents/268470
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Appendix 17A

A Typology of Available Use of Proceeds (UoP) Bonds

In the thematic debt space, a plethora of instruments exists that could be used to fund the decarbonisation of the hard-to-abate sector. Specifically, there are Use of Proceeds (UoP) bonds, which are defined by the allocation of proceeds to specific environmentally or socially beneficial projects, assets, activities, or expenditures. This category includes the following labels

- Green Bonds – Proceeds allocated to climate and/or environmentally beneficial projects.
- Social Bonds – Proceeds allocated to socially beneficial projects.
- Sustainability Bonds – A hybrid of green and social bonds, proceeds are allocated to a mix of environmentally and socially beneficial projects.
- Blue Bonds – In the main a subset of green bonds, but with proceeds allocated to ocean-based projects.
- Climate Resilience Bonds – A subset of green bonds, with proceeds allocated explicitly to climate-related projects.
- Transition Bonds – In the main a subset of green bonds, often with proceeds allocated to decarbonising assets or projects.

- Pandemic Bonds – In the main, a subset of social bonds, with proceeds allocated to addressing pandemic-related social issues, such as healthcare or employment. But maybe allocated to projects with both social and environmental.
- Sustainability-Linked Bonds (SLBs) – Proceeds of SLBs are usually not allocated to specific projects, assets, or activities but used for general purposes. The sustainability angle comes from the issuing entity making forward commitments to the future delivery of sustainability outcomes, often in the form of the company level – key performance indicators (KPIs). In some cases, the cost of capital is linked to achieving those KPIs.
- Hybrid: Sustainability-linked green bonds (SLGBs) – A hybrid that ties the use of the proceeds model of a green bond with the performance-based structure of an SLB. The first SLGB was issued by the Japanese construction company Takamatsu in March 2021. There are expectations that this structure will gain traction rapidly over the coming years.

Appendix 17B

Ørsted's Farm-Down Model: Lessons for Indian Firms

Shantanu Srivastava

Ørsted, a Danish state-owned utility, transitioned from being one of the most coal-intensive utilities in Europe to a global leader in offshore wind energy. Ørsted's commitment to energy transition through long-term strategy realignment helped it change its business model fundamentally and, in the process, generate immense wealth for its shareholders. Since listing in 2017, the company's share price has increased by an impressive 150% till November 2022.[29]

An important aspect of Ørsted's transition was its capital management plan. The capital-intensive nature of renewable energy (RE) assets requires large financial capital outlays during project construction. Ørsted was able to scale up its RE capacity rapidly and aggressively bid for large projects due to its ability to deploy equity in under-construction projects when required. This was possible because of its unique asset rotation strategy known as the "farm-down model."

The model involves selling a part stake in the project (usually 50%) after the project's Final Investment Decision (FID) at a valuation close to the project's Net Present Value (NPV). A majority of the value creation in an offshore wind farm happens during the development (site selection, obtaining approvals, and licences) and construction phases, as the project de-risks while moving from development to construction to operations. After the FID, post the development phase, Ørsted brought in an equity partner, usually long-term patient capital from pension funds, and realised up to half of the project's value upfront while also earning a premium on the sale. It then recycled this capital into pipeline capacity. Thus, the company could keep bidding for new farms and expanding its pipeline of projects.

In 2010, Pension Danmark acquired a 30% stake in one offshore wind farm from Ørsted,[30] which was the first farm-down deal for the Danish company.

Consequently, it used this model extensively in the future to spread risks, secure co-financing for projects, and provide cash flows to invest in new projects.

An important factor underpinning the success of the farm-down model was the stable subsidy regime for the offshore wind business in jurisdictions such as Denmark, the United Kingdom, and Germany, where Ørsted operated. A large proportion of cash flows were fixed in nature due to these subsidy schemes for several years in the future. This cash flow visibility was desirable for financial yield investors such as pensions, who are long-term patient investors requiring stability and diversification of investments to minimise portfolio risk. India's long-term power purchase agreements (PPAs), signed between RE generators and state distribution companies (DISCOMs), offer similar long-term cash flow visibility.

The farm-down model is different compared to the traditional asset rotation strategies where the project manager typically exits after the stake sale. Ørsted's fully integrated model helps it continue earning operations and maintenance (O&M) revenues from the project even after the stake sale. This is possible because most of the farm-down partners are financial yield investors, having limited or no experience or even interest in operating offshore wind farms.

Several Indian companies, such as ReNew Power,[31] Adani Green Energy,[32] and Acme Solar,[33] have successfully recycled capital in operational projects in the past, helping them deploy capital into pipeline projects. Nevertheless, deals involving project-level equity or debt investments have been sparse, in an accelerating RE capacity addition trajectory. This is partly because state-level PPAs carry business risks due to past instances of state DISCOMs wanting to renegotiate existing PPAs.[34] Another issue hampering such deals is the rising inventory of unsigned power sales agreements (PSAs) with sovereign-backed entities, such as the Solar Energy Corporation of India (SECI).[35] These instances increase the risk premium attached to individual projects, which might make them unattractive as per the risk appetite of several long-term patient investors.

A slew of financial investors, like pension funds, sovereign wealth funds, and strategic investors such as oil and gas majors, are eyeing the Indian market for potential opportunities to park their capital or diversify their business. Indian RE assets make a compelling case for pension funds looking for long-term annuity-like returns. Strategic investors like oil and gas companies are looking for joint ventures or strategic partnerships with local RE developers in their quest to achieve their net-zero targets. Weeding out issues related to the sanctity of PPAs and marketing de-risked operational projects to global institutional investors will help Indian corporates recycle scarce capital for pipeline projects while also securing more funds to bid for new projects in the super-competitive RE market in the country.

Indian public sector undertakings (PSUs) such as National Thermal Power Corporation (NTPC) which have highly ambitious RE targets and equally strong balance sheets can also utilise the farm-down model. For such entities, farm down can help realise value upfront while also earning a premium on the sale as projects de-risk after operationalisation, helping increase the overall return profile of the project.

18 Transition Finance

Aanandita Sikka, Neha Khanna and Dhruba Purkayastha

Introduction

The Paris Agreement set an ambitious target of keeping the global temperature at "well below 2 degrees, preferably 1.5 degrees Celsius," above pre-industrial levels. To achieve the 1.5-degree Celsius goal, global emissions must decline by about 45% from 2010 levels by 2030 and reach net zero by 2050 (IPCC, Summary for Policymakers. Global warming of 1.5 degree, 2018). Emission reduction at this scale would require a massive transformation of the economy. In line with the Paris Agreement, countries have committed to Nationally Determined Contributions (NDCs) and several countries have committed to a net-zero target. To achieve these targets, climate finance needs have increased significantly. It is estimated that realigning economies to meet net zero would require $50 trillion in incremental investment (Oliver Wayman, 2020).

To transition to net zero, countries will need to shift to cleaner technologies by scaling up zero or near-zero emission technologies like renewable energy, while simultaneously reducing emissions through decarbonising hard-to-abate sectors, that is, high-emitting sectors for which complete decarbonisation is technically or economically not feasible given the current circumstances, and/or creating carbon sinks. In terms of finance, while investments in clean energy have increased significantly in the past few years, investments in hard-to-abate sectors have not kept pace. Climate Policy Initiative's report titled "Global Landscape of Climate Finance" estimates that total investment in energy supply is $334 billion which represents 58% of total mitigation finance. Out of this, $324 billion (about 98% of the total investment in energy supply) was invested in renewable energy. Compared to this, only $7 billion annually on an average is channelled to other industries for mitigation efforts. This investment is minuscule considering decarbonising industry to levels compatible with the Paris Agreement would need investment of about $280 billion to $448 billion annually (Barbara Buchner, 2021).

It is essential to address the large financing gap for the hard-to-abate sectors if economies are to reach net zero. Conceptually, transition finance aims to address this financing gap. While the concept has gained immense popularity till date, there is no consensus on the definition of transition finance. However, by most definitions, transition finance focuses on decarbonising hard-to-abate sectors (such as steel) with some definitions including enabling technologies that support emission reduction in other sectors, such as battery storage as well. The variations in transition finance definitions and frameworks are discussed later in the chapter.

Decarbonising hard-to-abate sectors would require financing new, unconventional, and innovative technologies. This can be challenging for the financial sector as most

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financial institutions (FIs) are technology agnostic, and decisions on financing are based on appetite for risk and expectations of return. Therefore, financing new technologies is fraught with challenges, some of which are listed below.

1. The cost of capital for financing transition technologies is high because new technologies are risky to finance (also see discussion in chapter 9).
2. There is a lack of financial instruments that are suited to finance transition technologies.
3. The enabling environment including facilitative policy and regulatory frameworks for transition activities and transition finance is largely absent.

This chapter attempts to think through the concept of transition finance and discusses the current definition and emerging regulations in the field with a focus on financial institutions. The chapter is divided into three major sections. The first section attempts to build conceptual clarity around transition finance, while presenting multiple frameworks and definitions that are in place across the world. The second section looks at the challenges of financing transition technologies for financial institutions (FI) and the final section proposes solutions to scale transition finance.

Transition Finance: Definition and Momentum

Transition finance has lent itself to multiple definitions put forth by different entities varying in scope (country level, entity level, activity/asset level) and sectors covered within its scope. The motivation for investing in transition activities, however, remains more or less the same. At the macro level, transition finance is about reducing as much emissions as possible; at the entity level, transition finance is to address climate (transition) risk impinging the specific entity. The Basel Committee on Banking Supervision defines transition risk as the societal changes arising from a transition to a low-carbon economy. These risks can arise through changes in public sector policies; innovation and changes in the affordability of existing technologies; or investor and consumer sentiment towards a greener environment (Basel Committee on Banking Supervision, 2021). This section traces the origins of the concept and multiple definitions and interpretations of transition finance, which has emerged as a separate area of finance owing to the complex nature of transition risks.

The term "transition" is loosely used to describe transformation to a low-carbon economy, usually aligned to the targets set by the Paris Agreement. For mitigation, this would mean reducing overall emissions by promoting clean energy, clean transport, energy efficiency; decarbonising industries; and creating carbon sinks. Therefore, "financing transition" would include any investment that serves to reduce emissions.

In contrast, "transition finance" by most definitions, is an approach designed to address a more specific issue of financing decarbonisation in the hard-to-abate sectors. It derives its genesis from "transition activities" mentioned in European Union (EU) Taxonomy for Sustainable Activities' Article 10(2) (2020). As per the EU Taxonomy, three kinds of activities can be labelled sustainable. These are as follows:

1. Low-carbon activities: Those that have low or near-zero Greenhouse Gas (GHG) emissions such as renewable energy. Investments for these activities are usually covered under green finance.

2. Transition activities: Those that promote adoption of technologies that have GHG emissions "substantially lower than sector or industry average" for sectors which are hard to abate and cannot be aligned to the Paris Agreement, thereby reducing emissions and "do not lead to a lock-in of carbon intensive assets."
3. Enabling activities: Those that reduce emissions in other sectors.

This means both transition and enabling activities are "incompatible with climate neutrality by 2050" and would have some GHG emissions. However, these activities provide an opportunity for emission reduction in some capacity, and therefore, are categorised as "sustainable."

It is important to note that the EU Taxonomy draws a few boundaries for categorising transition activities. These activities should ideally have no low-carbon alternatives and should be important for future development. Transition activities should also contribute to mitigation efforts through the deployment of "best-in-class technologies" which emit less than the sector or industry average.

Japan's Ministry of Economy, Trade and Industry (METI) (2021) suggests that countries cannot transition to low-carbon technologies for all sectors at one go. This can be due to limited access to particular technologies, cost implications, resource base, and development trajectory. It recommends a phased progress to net zero with a transition phase. In the transition phase, all sectors maximise efforts to decarbonise as much as possible through process efficiencies, fuel switching, etc. This is to reduce emissions until breakthrough technologies such as carbon capture become technologically and economically viable to drive economies to a carbon-neutral state.

Several countries like Singapore and Canada are in the process of developing regulations for sustainable finance. Initial reports suggest that both countries may include transition finance in some manner.

Demystifying Financing Transition vs Green Finance vs Transition Finance

Transition activities or technologies can decrease emissions and help align economies to Paris Agreement. However, transition technologies are not "green," meaning that they are not zero emission technologies. Therefore, these activities are usually not financed through green finance instruments such as green bonds. Table 18.1 provides greater conceptual clarity on the difference between financing transition, green finance, and transition finance.

Apart from government agencies, several international organisations and FIs have put forth their definitions and frameworks. Climate Bond Initiative (CBI) defines transition finance as the investment required to reduce *GHG emissions to levels* "commensurate with meeting the goals of the Paris Agreement" (Anna Creed, 2020). This implies that both "transition activities" and "enabling activities" can be financed under CBI's framework. OECD limits the scope to hard-to-abate sectors and argues to concentrate financing of "economic activities that are emissions-intensive, do not currently have a viable green substitute (technologically, economically or both), but are important for socio-economic

Table 18.1 Green finance vs transition finance

	Financing transition	*Green finance*	*Transition finance*
Definition	Financing any activity that reduces emission	Financing technologies that are zero emissions or near emissions and thus, already aligned to the Paris Agreement	Reducing emissions for sectors that are hard-to-abate sectors or sectors that are important for emission reduction in other sectors (enabling activities) In most cases, these are activities that cannot be aligned with the Paris Agreement and have no other alternatives
Examples	All mitigation activity – renewable energy, energy efficiency, carbon capture, forests, etc.	Solar energy, wind energy	Steel, cement, aviation

Source: Authors own.

development" (OECD, 2022). Moving towards an entity-specific approach, International Capital Market Association (ICMA) defines transition finance as "investments that effectively address climate-related risks and contribute to alignment with the goals of the Paris Agreement" (ICMA, 2020).

Despite the lack of consensus on the definition or a framework, many stakeholders including FIs as well as multilateral organisations are discussing their role in the transition finance space. Some of these organisations have drafted their own transition activities' frameworks and have designed instruments for promoting transition finance. For example, London Stock Exchange (Transition Bond Segment, 2022) has launched a transition bonds segment to finance "decarbonization beyond traditionally green industry sectors." Several banks such as Standard Chartered Bank (2021) and DBS Bank Limited (2022) (see box) have released frameworks for transition financing.

Deutsche Bank TLC Framework for Investor-Friendly Policies

Abhinav Jindal

Investors expect a set of transparent, comprehensive, consistent, and long-lived policies for scale deployment of green technologies in addition to the minimisation of regulatory risk. The TLC-DB Framework by Deutsche Bank for the evaluation of regulatory policies may serve as a good template for selecting appropriate policies.

In 2009, a study by the Deutsche Bank Group developed the TLC-DB framework for selecting an optimal mix of public policies in terms of targets which reduce regulatory risks and increase investments of capital for renewable energy (RE).[1] This has been widely recognised as an effective policy design framework that has helped in the fast adoption of RE across many countries, including China and Germany (CT, 2011). Further, this framework has also proved useful in formulating policies which lead to increased investments in RE.

Table 18.2 provides the key features of this framework.

Table 18.2 Key features of TLC-DB framework

Sl. No.	*Metric*	*Description*
1.	Transparency	Understanding policies, targets, and execution
2.	Longevity	Create a conducive and stable policy ecosystem
3.	Certainty	Reasonable rate of return for investors

Source: DB (2009).

In the Indian context, considering system flexibility needs and interdependencies between RE, green hydrogen, and battery storage so as to provide round-the-clock power and energy supply, a policy framework like TLC-DB is likely to prove highly beneficial for scale adoption of emerging green technologies for its power system. Increased transparency and certainty in policies would stimulate developers' interest which, with stable policies, would help establish an enabling environment for the required deployment of green technologies like green hydrogen and battery storage.

Forthcoming policies such as renewable portfolio standards (RPS) or battery procurement standards (BPS), etc., can be evaluated in terms of investor/developer's response for each of the metrics specified in the TLC-DB framework.

Note

1 Paying for Renewable Energy: TLC at the Right Price Achieving Scale through Efficient Policy Design." Deutsche Bank Group.

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DB. (2009). "Paying for Renewable Energy: TLC at the Right Price Achieving Scale through Efficient Policy Design." Deutsche Bank Group.

Most frameworks are consistent on several basic principles when it comes to transition finance. For example, like EU Taxonomy, most frameworks discussed above agree that transition finance should not hamper the development and deployment of low-carbon alternatives. However, there is consensus to be built on several aspects. The variations in the definitions of transition activities or transition finance proposed in different frameworks require attention. These details are crucial in deciding what technologies would be scaled up and what activities will be phased down. Consequently, it would have cost implications for companies undergoing transition and for economies as a whole.

Guiding Principles for a Transition Finance Framework for Financial Institutions

Three broad considerations should underpin a transition finance framework for FIs. These are as follows:

1 **Best-in-class technology:** Transition finance frameworks recommend investing in "best in class technologies." Climate technologies are rapidly emerging, so what is considered "best in class technology" can change. For FIs, consistency in the choice of technology is important because investment decisions and cost of capital are based on track record of similar projects financed in the past. Therefore, it is challenging to finance "best-in-class technology" if recommended technologies change rapidly. This conceptual inconsistency because of technology development is an ongoing process and finance requires stability and successful track records.

2 **Alignment with Paris Agreement:**

There are concerns that not all activities can be aligned with Paris Agreement, i.e., achieve net zero by 2050. For some sectors, there are very few scalable technologies for abatement and for others, the technologies are available, but currently they are not economically viable. This means that the effort and capital required to decarbonise different sectors would vary significantly. It is because of this that some frameworks recommend using sector-specific science-based targets (such as the ones proposed by Science-Based Target Initiative, SBTi) as the benchmark for transition technologies in place of Paris Agreement alignment. However, none of these frameworks are commensurable with regional- or country-level targets.

3 **Flexibility and concerns about transition washing:**

Several frameworks argue for flexibility in deciding what transition looks like for each country and what technology options would be viable for transition considering national emission reduction targets, economic circumstances, and resource base to name a few.

While it is important to incorporate flexibility in frameworks so that countries and entities can decide their transition pathway, too much flexibility can be a slippery slope. At least in theory, stricter transition frameworks would enable reaching Paris Agreement targets in a more certain manner and avoid spillover beyond 2050. However, stricter frameworks may ignore country-level or industry constraints on making the required transition. On the other hand, less stringent choices that allow too much flexibility might pave the way for the possibility of transition washing (Shrimali, 2022).

Importance of a Transition Pathway and a Roadmap

IPCC suggests multiple pathways to 1.5-degree and 2-degree alignments. Different pathways mean different emission reduction trajectories which would directly impact timelines for scaling cleaner technologies and phasing down the high-emitting ones. These trajectories can therefore be a deciding factor if activities on borderline such as supercritical thermal power, gasification of coal, or use of natural gas would be included under the "transition activities" label.

Therefore, countries need to move beyond the net-zero targets and think about decarbonisation pathways to bring clarity to the sector. These pathways can also be a starting point for a transition finance framework, as it identifies which set of technologies and activities have to be financed and the order in which the financial flows are to be made.

Financial Institutions and Transition Finance

FIs have kept pace with market discussions on the need to decarbonise high-emitting sectors. Companies and FIs have issued dedicated financial instruments such as transition bonds to finance transition technologies. However, the issuance of transition finance instruments has been slow globally. The first half of 2022 witnessed the issuance of 23 transition bonds worth $2.1 billion. Compared to this, green bonds issuance was 100 times larger and was worth $218 billion for the same period (Climate Bonds Initiative, 2022).

There is consensus that decarbonising hard-to-abate sectors is important for reducing overall emissions, for which investments would need to move beyond green finance. However, the definitions and frameworks for transition finance continue to be ambiguous in a poor enabling environment. Additionally, the high cost of capital and lack of financial instruments hinder finance for transition technologies.

This section concentrates on some of these challenges and risks faced by FIs in financing transition technologies. These are divided into three categories – enabling environment, cost of capital, and financial instruments.

1 **Enabling environment:**

Globally, there is no agreed definition for transition finance, and stakeholders are yet to reach conceptual clarity on several issues. Most developing countries including India are yet to develop a decarbonisation pathway, meaning that there is a lack of clarity on what are the preferred transition technologies.

The lack of a clear definition and transition finance framework and the absence of regulatory or policy incentives for transition finance mean that financiers hesitate to fund transition technologies.

2 **Cost of capital:**

Large-scale deployment and adoption of new and innovative technologies are important to meet international targets. Some of these technologies are also in early deployment stages, meaning there is significant technology and performance risk involved with financing these. Others are not yet competitive with their GHG-emitting counterparts.

In most cases, the track record for commercial deployment of these technologies is thin. Therefore, assessing the risk and the creditworthiness of technologies is difficult. This either limits the capital flows to such projects or that capital is priced at a very high rate.

3 **Financial instruments:**

For commercial finance instruments, it is challenging to satisfy the risk and return appetite for any technology that is new, capital-intensive, and eliciting long-term finance.

Green finance instruments that are designed keeping in mind the urgency for climate action, concentrate on a few already established sectors such as solar energy and energy efficiency and a few other near-zero emitting technologies. Transition technologies are usually excluded from these instruments because most transition technologies emit some amount of GHG.

Therefore, for transition technologies, financial instruments need to be suitably designed with optimal share of financing from commercial financiers of varying risk appetites, and impact capital providers, keeping in mind the development stage of technology and the nature of investment required, simultaneously drawing up a committing, credible framework for impact reporting.

Enabling Transition Finance

Finance is technology agnostic and does not differentiate between decarbonising technologies, as long as these technologies satisfy the risk and return appetite of the financier. The challenge is that transition technologies are inherently risky, and the cost of financing is high. Additionally, there is a lack of consensus on the definition of transition finance. Thus, currently capital is either too expensive, short-dated, or not flowing sufficiently for transition activities (Oliver Wayman, 2020).

To ensure an increase in capital flows towards transition activities, diverse out-of-the-box solutions, requiring cooperation of – and coordination among – multiple stakeholders need to be implemented. It would include creating an enabling environment that supports decision-making for FIs and encouraging capital allocation through aligning risk–return profiles and designing dedicated instruments.

Enabling Environment

Appropriate regulatory and policy measures can help create an enabling environment and instil confidence in financiers. This framework can include details about country's transition pathway, a clear definition on "transition technology" and "transition finance" and a few incentive mechanisms to attract capital to transition technologies. These could include:

- **Designing transition pathways and defining transition activity**: Transition pathways would guide on volume, scale, and timeline of emission reduction at the country level. Therefore, it provides guidance on the timeline for scaling clean technologies and phasing down of carbon-intensive technologies. Based on these pathways, the countries can define "transition activities" best suited to their local context.
- **Benchmarking emission reduction targets**: Once the definition of transition activities is clear, the next step is to set sector-wise benchmark targets for emission reduction. These targets could be set by aligning all sectors to a common target of 1.5 degrees, which could mean a common target of reducing emissions by 45% by 2050 or this could mean deciding permissible emission levels for each sector keeping in mind the remaining carbon budget. These benchmarking targets could be set using scientific targets proposed by international organisations like SBTi or Transition Pathway Initiative (TPI).
- **Performance reporting and monitoring:** A comprehensive set of guidelines for entities to access transition finance is important. This could include drafting transition plans at the entity level and following robust reporting standards.

Aligning incentives: A transition finance framework with a clear definition of transition activities, sector-wise targets, and robust reporting standards enable decision-making for FIs. However, this might not be enough to encourage the flow of capital to these activities, and therefore, it is essential to align incentives for the financial sector through regulation and policy. This could be in the form of fiscal concessions or subsidies. Incentives can be provided through regulations, for example by incorporating a "risk subsidy" derived on the basis of the cost of carbon (Dhruba Purkayastha, 2021).

Supporting Capital Allocation

Capital flows to transition activities can be encouraged by improving risk–return profiles and designing dedicated instruments.

Table 18.3 Ways to increase capital flow to transition activities

Function	*Action category*	*Potential steps*	*Potential decision-making body*
Enabling environment *(Policy & regulatory landscape that supports decision-making for FIs)*	Guidelines	1. Country-level transition pathways 2. Transition finance framework or Taxonomy	Policymakers (Ministry of Environment, Forest and Climate Change, MoEFCC) Policymakers (Ministry of Finance, MoF)
	Standards	Benchmarking emission reduction targets. This could be through: • Alignment with Paris Agreement (1.5 degree or 2 degree) • Carbon budget • Science-based standards (ex: SBTi)	Standard-setting bodies and FIs
	Performance reporting and monitoring	Guidelines for entities to disclose: • Transition plans • GHG reduction targets	Securities and Exchange Board of India (SEBI)
	Aligning incentives	Providing a "risk subsidy"	Policymaker/regulator depending on the kind of intervention
Supporting capital allocation *(Mechanisms that allow channelling of capital)*	Aligning risk–return profiles	Accounting for carbon in risk assessment framework through **carbon ratings**	Regulator (Reserve Bank of India, RBI), Credit rating agencies, FIs
		De-risking measures (Insurance, Guarantees, etc.)	FIs, public funds, Multilateral Development Banks (MBDs)
		Special structures: **blended finance**	MDBs, FIs, public funds, philanthropic entities
	Dedicated instruments to raise finances	Transition bonds/ sustainability-linked bonds	FIs

Source: Authors' own.

- **Improving risk–return profiles**
  - **Risk assessment framework:** Banks assess the risk of an investment based on entity's past performance, internal models, and economic outlook. Risk assessments determine the rate of interest, thereby affecting the cost of capital. Incorporating climate risk in internal risk assessment models of FIs can correct inefficiencies in the financial system that currently favour carbon-intensive technologies compared to newer technologies that have lower emissions.
  - Climate risk can be measured through a "carbon rating framework" which captures "carbon per unit of financing." Incorporating a carbon rating within conventional risk assessment can reduce the cost of capital for transition technologies.
  - **Blended finance:** Blended finance is the use of development capital (public or philanthropic) to catalyse private capital which would otherwise not be available

(Shrimali, 2022). In most blended finance structures, public or philanthropic capital takes a first-loss position or settles for lower returns. This improves the technology's risk–return profiles and thus the project's bankability.
- ○ Considering the scale of investments required for transition, catalysing private finance might require significant investment support from the public sector and DFIs.
- ○ **De-risking measures:** Other de-risking methods such as financial guarantees, credit insurance, and credit enhancements can help also reduce risks significantly.

- **Dedicated financial instruments: Transition bonds/sustainability-linked bonds**: The choice of financial instruments depends on the scale of transition (entity level or activity level), technology type, and stage of development to name a few. Currently, the most talked about instruments are transition bonds and sustainability-linked bonds. The reader may also refer to the chapter 17 of this section for a more detailed discussion on transition bonds.

  A transition bond is a use of proceeds debt instrument, which means that finance is ring-fenced specifically for a particular transition activity or project. Transition bonds can be used at an entity level as well as an activity level for a particular technology. The transition bond market is currently small.

  Another popular instrument for financing transition technologies is sustainability-linked bonds (SLBs). SLB is an outcome-based instrument, in which financing costs are linked to the achievement of some pre-defined sustainability key performance indicators (KPIs) (Shrimali, 2022). These KPIs are usually at the company level. SLBs are immensely popular because they provide a direct link between financing and sustainability goals for investors and allow for awards and penalties depending on the achievement of KPIs.

  However, both instruments vary in terms of the level of financing and processes involved. It is noticed that SLBs are usually used for transition at the company (entity) level, while transition bonds can be used for both entity and activity levels. Table 18.4 provides a brief comparison of the instruments.

Table 18.4 Sustainability-linked bonds vs transition bonds

Instrument	*Sustainability-linked bonds*	*Transition bonds*
Type of finance	KPI-linked finance	Use of proceeds finance
Entity vs activity	Usually finances at the entity-level transition	Can finance both entity-level and activity-level transition
Due diligence	Company-level transition plans	Benchmarking of technologies for decarbonising Alignment with Paris Agreement Assessing emission reduction claims through best-in-class technology
Reporting	Baselining, regular reporting, audits (this can mean high transaction costs)	Might not have such stringent reporting
Standards	ICMA standards available	No standards
Issuance	About $123 billion was raised through SLBs in 2021. Out of this, more than $35 billion was directly for industries (Maino, 2022).	Since its inception in 2019, only 24 bonds worth $11.5 billion have been issued (Climate Bonds Initiative, 2022).

Source: Authors' own.

Conclusion and Way Forward

This chapter presents an introduction to the concept of transition finance. It traces back the emergence of the concept to EU Taxonomy's "transition activities" and presents multiple interpretations of "transition activities" and "transition finance" by different regulators and international organisations.

It discusses challenges of financing transition technologies such as lack of enabling environment, high cost of capital, and lack of innovative financial instruments. The chapter suggests that to ensure higher capital flows to transition finance, a host of solutions, requiring the cooperation of multiple stakeholders need to be implemented. This would include developing policy and regulatory frameworks defining transition activities; guidelines on transition pathways for different sectors at the country level need to be clear; risk and return profiles need to satisfy financier's appetite so de-risking mechanisms such as blended finance structures need to be in place and incentives through carbon pricing need to be established.

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19 Role of Domestic Institutional Capital in Funding India's Energy Transition

Shantanu Srivastava

Institutional Investors and Energy Transition

Institutional investments have evolved significantly over the last several decades, expanding beyond domestic fixed-income instruments to also invest in domestic and foreign equity, both public and private, hedge funds, real estate, and other alternative assets. The large scale of institutional investments makes them suitable for the capital-intensive requirements of energy transition. Institutional investors are also usually long-term investors whose liability streams, such as insurance claims or pension payables, usually define the duration of the investment. Globally, institutional investors typically invest in long-dated assets with tail-ended returns, which makes their portfolios most susceptible to climate risks. On the financing side, several of these investors also subscribe to debt instruments during the second round of financing, helping shift hands and create more capacity to lend for the first set of financiers. In the Indian context, however, bank finance dominates in the second round of refinance, and institutional investors usually come in only when bank finance is taken out by financial instruments.

Pension funds manage the largest chunk of assets among institutional investors globally, followed by sovereign wealth funds, banks, and insurance companies.[1]

Rising Prominence of ESG Investing

Institutional investors have been instrumental in propagating the growth of environmental, social, and governance (ESG) investing. The United Nations Principles of Responsible Investing (UNPRI), a network of some of the biggest asset owners (including institutional investors), asset managers, and investment service providers globally, with combined assets under management of ~US$120 trillion, have pledged to incorporate ESG issues into their investment analysis and decision-making processes.[2] The booming ESG investment and financing market have helped channel capital massively into clean energy technologies such as renewable energy generation. In fiscal year (FY) 2021, US$1.7 trillion worth of ESG loans and bonds were issued globally, an enormous feat by any measure.[3]

ESG-labelled equity and debt instruments are also issued by companies, which may or may not be truly aligned to a low-carbon pathway in their overall business strategy. This is more pronounced in the case of exchange-traded funds (ETFs) which invest in listed stocks. Hence, there is conflicting evidence in terms of whether ESG investing really leads to energy transition. Nonetheless, on an asset level, ESG funds have helped finance and de-risk several clean energy assets globally.

One of the reasons institutions are pivoting towards sustainable investing is because their long-term and risk-averse nature of investments makes them more susceptible to

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climate change risks. Moreover, the liability-driven investing style of most of these investors means they would want to avoid risks in their portfolio, even if that comes at the cost of lower returns. Thus, the "non-financial alpha" that ESG investments provide is gaining preference, more so in the case of ESG debt instruments such as green loans and bonds which invest particularly into low-carbon assets. According to a 2021 survey of global institutional investors by Ernst and Young, 90% of the investors gave greater importance to companies' ESG performance post the pandemic and 86% said that corporate decarbonisation is key to their investment.[4]

Renewable Energy Assets: A Perfect Fit

Renewable energy stands out prominently among the sectors that have raised capital through the ESG markets. As per Bloomberg New Energy Finance (BNEF), in the first half (H1) 2022, renewable energy projects or activities received over three-quarters of all the new bonds priced, totalling US$204 billion.[5] Historically too, renewable energy projects have received a large majority of proceeds from ESG issuances. Renewable energy is a carbon mitigation activity that helps fulfil the ESG investing mandates of several institutional investors and reduces their exposure to transition risks arising from climate change. Further, renewable energy assets enjoy policy support, such as stable subsidy schemes and long-term purchase agreements globally. These have helped de-risk investments by providing long-term cash flow visibility. Investments in renewable energy could also dovetail with other development objectives and form part of the financial ecosystem for India.

Institutional investors looking out for ESG investments that also provide long-term stable returns, low correlation to business cycles, and providing downside resilience find renewable energy assets a perfect fit for their capital commitments. Hence, many subscribers for ESG debt issuances have been institutional investors.

Foreign Institutional Investment in Indian Renewable Energy Sector

India has seen several global institutions invest in the renewable energy sector through debt and equity. On the equity side, several notable deals involving Indian independent power producers (IPPs) during the early part of the last decade helped set the stage for the sector's growth.

On the debt side, several Indian IPPs and utilities pivoting towards clean energy have raised green bonds, primarily in foreign markets. While the details of individual investments into debt issuances are not available, most green bond subscribers globally are institutional investors.[6] According to BNEF, Indian corporates have raised ~US$48 billion of green bonds and loans, of which a large part has been for renewable energy projects. Green bond issuances have primarily been in global markets and denominated in foreign currency since most ESG-aligned investors are from developed markets.

Domestic Institutional Investor (DII) Landscape in India

India is home to a large number of institutional investors, both private and public, including pension funds, insurance companies, and banks. While the Securities and Exchange Board of India (SEBI) also clubs mutual funds under the ambit of domestic institutional investors, they do not fit the definition of long-term patient capital. Excluding mutual funds, the insurance and pension sectors have the largest share of investor capital among domestic institutional investors. They are also among the largest investors in the Indian debt and equity markets.

Insurance Sector

The insurance industry in the country comprises 24 life and 34 non-life insurers. The insurance industry earned US$ ~104 billion in premiums in FY2021–2022 (~US$80 billion by life insurers), indicating the quantum of inflows of insurers each year.[7] The Insurance Regulatory and Development Authority of India (IRDAI) regulates the sector. Among other things, it mandates the pattern of investment by insurers.

The assets under management (AUM) of the entire industry stood at ~US$612 billion in FY2020–2021,[8] with more than 90% of the share from life insurers. The Life Insurance Corporation of India (LIC) is the largest among the life insurers, comprising ~70% of the entire industry AUM. Life insurer investments are either for assets from traditional products or the newer, unit-linked investment plans (ULIP) products, with the former forming ~88% of total investment assets.

Life insurers are longer-dated investors compared to other insurers due to the long-term nature of their liabilities, which can extend several decades into the future.

Investment Regulations as per IRDAI

According to IRDAI regulations, life insurers operating in the country must invest at least 40–50% of investment assets (varies between life insurer categories) in central and state government securities, such as bonds and debentures. The remaining investments should be in approved and other securities and social and infrastructure sectors, again depending on insurer type. Investments for ULIP providers vary depending on the investment plan subscribed by the customer, but here also, at least 75% of investments need to be in the approved investments category. Every insurer needs a separate fund manager for debt and equity up to a fund size of Rs. 100 billion (~US$1.2 billion).

IRDAI classifies renewable energy under the infrastructure sector with other assets, such as roads, airports, water supply, telecommunication and transmission, and distribution.

LIC's Investment Portfolio

While there seem to be several avenues for life insurers to invest in renewable energy assets, a look at LIC's current portfolio of debt and equity investments shows that its investments in fossil fuel-aligned sectors/companies dwarf its exposure to the clean energy sector. LIC's total AUM stands at ~US$510 billion,[9] of which ~24% is equity. Of its equity investment portfolio, unlisted equity is ~US$ 0.4 billion.[10]

Figure 19.1 Institutional investor types.

Source: IEEFA analysis.

Figure 19.3 lists the top five sectors of LIC's equity investments. LIC's equity portfolio stands at US$121 billion as of September 2022. Fossil fuel and utility investments total ~US$ 29 billion. Among its fossil fuel sector investments are Coal India, ONGC, Indian Oil Corporation, BPCL, Oil India Limited, and HPCL. Investments in utilities of major companies include Adani Total Gas, GAIL India, Indraprastha Gas, Torrent Power, and Mahanagar Gas. All the above-listed companies are susceptible to transition risks arising

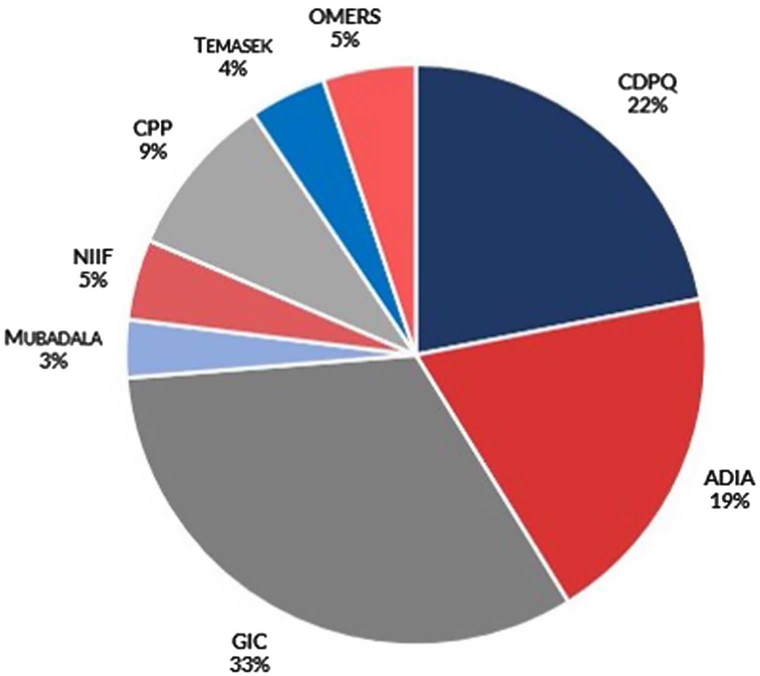

Figure 19.2 Institutional investment in Indian renewable companies.
Source: GlobalSWF.

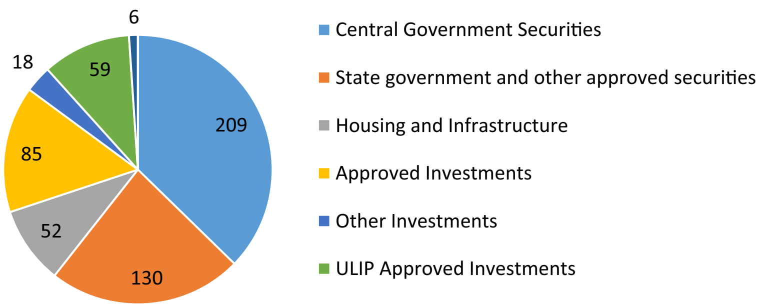

Figure 19.3 Investment pattern of life insurers as of March 2021 (US$ billion).
Source: IRDAI.

from climate change and pose a severe potential downside risk to LIC's overall portfolio value.

While LIC has investments in several utilities transitioning to clean energy, such as NTPC, JSW Energy, and Tata Power, the investments in these companies are minuscule compared to its investments in fossil fuel sector companies. It has direct investments of US$0.2 billion in renewable energy, a far cry from its investments in fossil fuels.[11]

LIC's total debt AUM as of September 2021 (the last available date) stood at US$353 billion, of which ~95% was in sovereign and AAA-rated securities. Of this, LIC has invested 62% in state and central government securities and ~11% in corporate debt. Due to a lack of disclosures, the sectoral exposure of LIC's debt portfolio is not known. Among state- and central-level securities, it is usually not tagged for specific projects/use.

Indian Pension Fund Industry

India has a small but growing pension sector. Over the five years between 2018 and 2022, the sector has seen subscribers multiply over 3x and AUM grow more than four-fold.[12] Several agencies provide pension schemes in the country. Central and state governments offer pension benefits to their employees, and several other public and local bodies run their pension schemes guaranteed by the government. The private sector pension choice has primarily been the provident fund offered by the Employees' Provident Fund Organisation (EPFO). The Pension Fund Regulatory and Development Authority (PFRDA) is the body responsible for regulating the pension sector in the country.

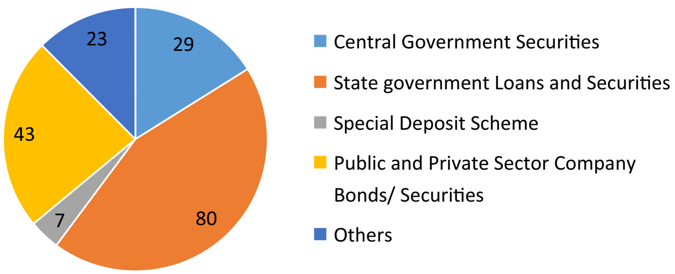

Figure 19.4 Combined Debt Investments of Schemes Under EPFO as of March 2021 (US$ billion).
Source: PFRDA.

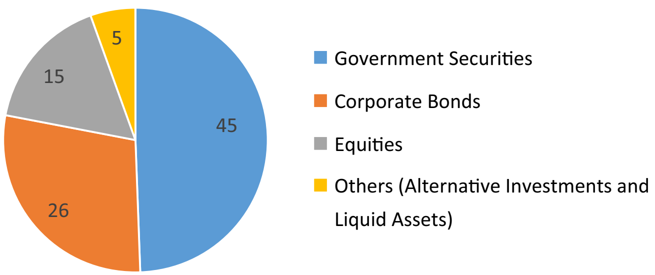

Figure 19.5 Investment pattern of NPS as of March 2022 (US$ billion).
Source: NPS Trust.

EPFO is one of the biggest social security programmes currently running worldwide in terms of clients and the volume of financial transactions undertaken. It is a statutory body under the Government of India. EPFO runs three schemes, namely the Employees' Provident Funds Scheme (EPF), Employees' Pension Scheme (EPS), and Employees' Deposit Linked Insurance Scheme (EDLI). Among them, EPF manages the largest corpus of US$108 billion as of March 2021 (last reported year), followed by EPS at US$67 billion.[13]

Another pension scheme under the aegis of PFRDA is the National Pension System (NPS). The central government rolled out NPS in 2004 for its employees as a defined contribution scheme and opened it for all citizens in 2009. In 2018, the government made NPS tax-exempt, similar to EPFO schemes. The combined AUM of NPS stood at US$92 billion as of March 2022.[14]

Investment Regulations as per PFRDA

PFRDA's investment regulations govern the investment pattern for assets managed by pension scheme providers in India. These regulations vary between EPFO and NPS schemes.

PFRDA regulations mandate that EPF funds, EPS private sector funds, and EDLI funds invest incremental deposits in the following ratio:[15]

- 45–50% in government securities.
- 35–45% in corporate debt instruments.
- 5–15% in equities through investments in exchange-traded funds (ETFs).
- Up to 5% in short-term debt instruments.
- Up to 5% in asset-backed, trust-structured, and other investments, including alternate investment funds (AIFs), real estate investment trusts (REITs), and Infrastructure Investment Trusts (InvITs).

Other funds of EPS, besides the private sector, invest in the public account of the Government of India.

For NPS schemes, PFRDA investment regulations permit the subscriber themselves to select among four asset classes, namely, E (equity), C (corporate debt), G (government

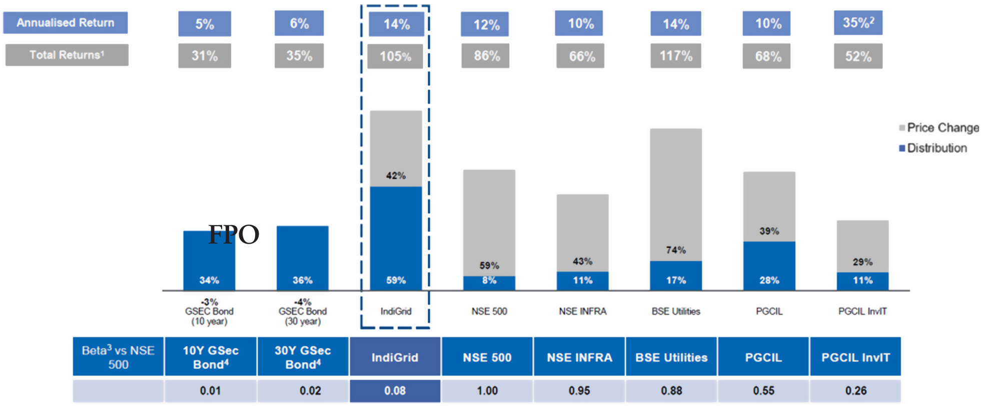

Figure 19.6 Risk-adjusted return metrics of IndiGrid InvIT investment compared to other similar investments.

Source: IndiGrid Q3 2023 Investor Presentation.

debt), and A (alternate investments). For equity, a subscriber's maximum exposure is 75%, which varies per the subscriber's age. For alternate investments, the ceiling is 5% of total investments. A subscriber can spread investments in multiple asset classes.

EPFO Schemes' Investment Portfolio

On the equity side, investments by EPFO schemes stand at US$15 billion as of March 2021 and are in one of four ETFs: Nifty-50, Sensex, Bharat-22, and CPSE (Central Public Sector Enterprises). All four are diversified ETFs with most investments in large market capitalisation stocks. More than 90% of investments to date have been in the Sensex and Nifty-50 indices, the two key market indices in India. On average, both indices have an ~12% weightage of the energy sector, primarily oil and gas companies, and ~2% of electric utilities like NTPC Limited and Power Grid Corporation of India Limited, as of date.[16] Direct investment in renewable energy companies outside the ETF universe is not permissible.

EPFO is one of the largest debt investors in the country, with a portfolio of ~US$181 billion or 92% of its total AUM.[17] The majority of investments are in state-level debt. EPFOs' share in state development loans (SDLs), used to bridge the gap between state government's spending and income, stands at 40.2% of total AUM and is the only category that has been increasing consistently over a 5-year period till March 2021.[18] However, similar to LIC's debt investments, individual exposure to the renewable energy sector is not known, and SDLs are not tagged for specific developmental uses.

NPS Schemes Investment Portfolio

On the equity side, the top pension funds offering NPS schemes manage assets with a current market value (11 November 2022) of ~US$16 billion, or more than 75% of total equity investments through NPS.[19] These funds also account for ~95% of all subscribers of NPS. Moreover, their combined exposure to the electric utility sector is nearly a fifth of the oil and gas sector.

The data on the debt exposure of NPS funds are unavailable, though more than 75% of total NPS investments are in the debt segment, led by government securities.

Investment of Indian Insurers and Pension Funds in the Renewable Energy Sector

As clear from the previous section, domestic institutional investors' funding in India's domestic renewable energy sector has been sparse compared to the global scenario.

While the specific reasons for their limited activity in the renewable energy sector can be found later in the chapter, their primary hurdle has been the lack of options for them to invest under the current regulatory environment.

Table 19.1 lists the various avenues that insurers and pension funds have to invest in the renewable energy sector in the country.

Reasons for Low Domestic Institutional Investments in the Renewable Energy Sector

Pension funds and insurers are inherently risk-averse investors. But from an Indian perspective, these entities have been overly restrictive in their investments due to regulatory mandates, which have often come at the expense of lower returns generated in their investment portfolios.

Table 19.1 Domestic institutional investors in India

	Pension funds[a]	*Insurance companies*
Types	Employee Provident Fund Organisation (EPFO), National Pension Scheme (NPS)	Life Insurers, General Insurers, reinsurers
Assets under management (AUM) (US$ billion)[b]	EPFO – 196 NPS – 92	Life – 560 General – 44 Reinsurer – 11
Regulator	Pension Fund Regulatory and Development Authority (PFRDA)	Insurance Regulatory and Development Authority of India (IRDAI)

Source: IEEFA analysis; PFRDA; IRDAI.
[a] Only including the major pension providers.
[b] Pension fund AUM for EPFO and insurance sector is as of March 2021 and for NPS is as of March 2022.

Table 19.2 LIC's equity holdings across top five sectors in terms of market capitalisation (US$ billion)

Sector	*Investment*
Banking and investment services	28.2
Energy – fossil fuels	20.1
Software and IT services	13.3
Utilities	8.8
Food and beverages	8.6

Source: Refinitiv; September 2022.

Bottlenecks with Equity Investments

In terms of equity investments, while life insurers like LIC have been making big bets on several sectors, investments in renewable energy companies have been limited due to the sector being clubbed along with the wider power sector. Moreover, due to sectoral investment limits, investments in pure-play renewable energy companies and several utilities pivoting to clean energy have been sparse.

LIC has a minuscule portfolio of equity investments in private companies. However, several unlisted renewable energy companies operating in India, which have both foreign and domestic shareholding, might benefit from primary equity capital contributions from LIC. The insurer has also said it has never had any difficulties selling unlisted securities in its portfolio.[20] In addition, LIC's long-dated nature of investments allows it to invest in unlisted equity where liquidity is low.

For pension funds, investments are to be done only through ETFs bind EPFO schemes and therefore prevent them from taking sectoral exposures. However, regulations allow NPS schemes to take equity exposures up to 75% of their total portfolio value. As a result, NPS funds have invested in listed renewable energy companies but have a restriction similar to LIC on investment in unlisted equity, thus missing out on investment opportunities in several renewable energy IPPs operating within the country.

Table 19.3 Avenues for renewable energy investment for domestic institutional investors

Debt	*Equity*	*Others*
• Central and state government securities designated for use in renewable energy projects • Debt securities issued by private and public corporates raising debt for investing in renewable energy projects • Infrastructure debt funds are another debt investment option for EPFO	• Listed equity of renewable energy companies for insurers and NPS • Investment in ETFs that include utilities and renewable energy companies for EPFO funds	• Asset-backed securities (ABS) having renewable energy assets as underlying • Debt or equity issued by infrastructure investment trusts (InvITs) investing in renewable energy assets • Investments in debt and equity mutual funds taking exposure to the renewable energy sector

Source: IEEFA analysis.

Table 19.4 Solutions for scaling up debt investments and key stakeholders

Solution	*Stakeholder Responsible*	*Priority*
Reduced issuance costs and faster issuing time for corporate bonds	SEBI	High
Develop credit derivative instruments and provide plain vanilla guarantees for de-risking lower-rated corporate securities	RBI, central government (budgetary support), multilateral/national development banks	Medium
Diversifying the investor base	Issuers (through investor outreach), SEBI	Medium
Higher thresholds for investment in investment-grade corporate bonds by pension and life insurers	IRDAI, PFRDA	Low
Decouple renewable energy sector from wider power sector	IRDAI, PFRDA	Low

Source: IEEFA analysis.

Investment in equity of InvITs (also see discussion in Chapter 17) has also been low, arguably due to the minimal presence of these instruments in the Indian market. For example, while there are 19 registered InvITs in India, in the power sector, three InvITs are operating currently – India Grid Trust (IndiGrid), Power Grid Infrastructure Investment Trust (PowerGrid), and Virescent Renewable Energy Trust. Of these, the first two invest primarily in transmission assets, while Virescent is the only pure-play renewable energy InvIT in the country, managing a portfolio of 500 MW of clean energy assets.

IndiGrid only has one renewable energy asset in its portfolio, while PowerGrid has none. On the bright side, domestic institutional investors, including several private sector insurers such as Birla Sun Life, Max Life, PNB MetLife, and Tata AIG, own 24% of IndiGrid.[21]

The above graph shows the risk-adjusted return generated while investing in IndiGrid InvIT compared to several other infrastructure investments from June 2017 to December 2022. The graph clearly shows that investment in the InvIT has generated far superior returns compared to equity investments and has a much lower risk. This showcases a clear investment case for insurers and pensions.

Table 19.5 Solutions for scaling up equity investments and key stakeholders

Solution	*Stakeholder responsible*	*Priority*
Equity investment options beyond ETFs for EPFO	PFRDA	High
Strategy for portfolio diversification away from fossil fuels	IRDAI, PFRDA, individual investment policy statement for investor	Medium
Allowing/increasing investments in unlisted equity	PFRDA, IRDAI	Medium
Project-level equity investments	PFRDA, IRDAI	Medium
Increase the threshold for investment in InvITs	PFRDA, IRDAI	Low

Source: IEEFA analysis.

Table 19.6 Solutions for scaling up institutional investments and key stakeholders

Solution	*Stakeholder responsible*	*Priority*
Separate fund manager with experience appraising RE investments	IRDAI, PFRDA	High
Incorporate climate risk considerations and ESG investing principles in investment decision-making process	IRDAI, PFRDA, investor board	High
Cover costs associated with sustainable bond issuance	Central government budgetary support	Medium

Source: IEEFA analysis.

Regulations do not allow insurers and pension funds to make investments in project-level equity, either private or public. This means that several de-risked operational cash-generating renewable energy assets, which have assured cash flows for 25 years underpinned by long-term power purchase agreements, are out of their reach. This is even as several global institutional investors are vying the domestic renewable energy assets to deploy project-level and company-level equity.

Developed market jurisdictions like Denmark have seen pension funds play a vital role in providing capital for scaling up renewable energy projects. Several domestic pension funds invested in operational, and even under construction, renewable energy projects, giving capital recycling opportunities for their developers.

Bottlenecks with Debt Investments

On the debt side, life insurers and pensions invest most of their capital into state- and central-level debt securities. Almost all of India's renewable energy infrastructure investments have been through private and public utilities and other corporates. State- and central-level governments have played the role of facilitators rather than investors. Governments have extended tax and non-tax benefits to the renewable energy sector, such as accelerated depreciation and generation-based incentives. However, these expenses are minuscule compared to the overall debt raised by governments. Furthermore, governments have discontinued several of these benefits as the sector has gained commercial viability.[22]

Several domestic institutional investors have subscribed to bonds and debentures issued by power public sector undertakings (PSUs), such as NTPC, NLC India, and SJVN. They have also subscribed to bonds issued by financiers, such as Indian Renewable Energy Development Agency (IREDA), Power Finance Corporation (PFC), and REC, which provide financing for renewable energy projects. There have been private sector bond subscriptions, too, with Tata Power and JSW Energy able to tap domestic insurance capital, but power sector PSUs dominate the overall market.

The primary reason is the underdeveloped bond markets in the country. A well-functioning capital market requires a vibrant bond market, especially to fulfil infrastructure funding needs. However, the corporate bond market as a percentage of Gross Domestic Product (GDP) stands at a mere 18% in India, while it is 120% in the United States of America (the US), 80% in South Korea, and 36% in China.[23] Among the total outstanding bonds issued by power sector companies in India, four companies – NTPC, UP Power Corporation, NPCI, and NHPC, all power sector PSUs – have issued 42% or US$23.5 billion.[24] Moreover, almost all issuances by renewable energy IPPs are in global markets, in dollar- or euro-denominated securities.

Further complicating the matters are the prudential regulations for investments in corporate debt by insurers. IRDAI investment regulations mandate at least 75% of investments in government debt. For pensions, even though they can invest up to 45% of total AUM in corporate debt, their risk-averse nature has meant investments primarily in PSU debt securities. Ratings of several private renewable energy sector issuers are AA and above, making them investable by insurers and pensions.

On the supply side, the small investor base, which is almost entirely sucked up by government and PSU issuances, the high cost of borrowing, and inadequate liquidity are reasons why private corporate issuances are low in the domestic market.

Non-consideration of Climate Risk and ESG Investing Principles

Another reason for subdued investments in renewable energy assets is the non-consideration of ESG and more broadly climate risk factors in the investment decision-making process. As pointed out earlier, insurers and pension funds have higher exposure to fossil fuel assets than clean energy assets. This is because neither PFRDA nor IRDAI has any regulations that consider climate risks carried on the portfolio of their regulated entities. Thus, low-carbon investments beyond just ESG investments (which is not always the most appropriate channel to deploy climate finance) have been subdued.

LIC claims to adhere to ESG standards through various initiatives but does not talk about decarbonising its investment portfolio per ESG investing principles.[25] Some private sector insurers, such as ICICI Prudential, have pledged to align their investments with ESG principles. But the push towards sustainable investments is largely missing. Pension funds have a similar story, with no regulatory or investor nudge to consider climate risks in their portfolios.

End of Low-Interest Rate Regime in Developed Markets

For renewable energy companies, the multi-decade low-interest rate regime and excess liquidity in developed markets globally in the aftermath of the COVID-19 pandemic were another reason to tap global markets rather than domestic. This has changed in the recent past, with central banks globally sucking out liquidity and raising interest rates to fight stubbornly high inflation.[26] The world has entered a monetary policy-tightening regime, leading to carnage in bond markets, especially emerging economies. Consequently, new issuances in global markets by Indian issuers have also shrunk due to concerns regarding the dollar's strengthening. There have not been any dollar bond issuances by Indian corporates and banks in the global markets this fiscal year.[27] Against this backdrop, it becomes all the more important to mobilise domestic institutional funds so that India's renewable energy goals stay on their intended trajectory. Avaada Green Energy and Vector Green Energy are two Indian IPPs that have issued AAA-rated green bonds in the Indian markets within the last 12–18 months.[28] These are positive developments in local bond markets for Indian renewable energy issuers.

Short Tenors of Domestic Green Bonds

The other issue with green bonds relates to their maturities. Pension funds and insurers are long-term investors and, thus, would be looking for issuances more than 10 years in tenor. However, in the past, local green bond issuances have had a maturity of 5–10 years, while the ones by Avaada and Vector Green had a maturity of three years. Therefore, these bonds would not qualify for pension funds and insurers looking to invest in longer-tenor bonds.

Lack of Internal Capacity to Appraise Renewable Energy Investments

Domestic institutional investors, especially state-owned ones, face an additional challenge of the lack of capacity to appraise renewable energy projects. Most fund managers for pension funds have experience investing in conventional power assets through the debt instruments of power sector PSUs. For equity, their investments are in diversified ETFs. For a dedicated research desk for clean energy technologies, these investors require a long-term dedicated pipeline of projects and regulatory mandates to invest in clean energy infrastructure.

Solutions for Scaling Up Clean Energy Financing by DIIs

Fresh investments made by EPFO schemes during FY2020–2021 stood at ~US$20 billion, while NPS' AUM increased by US$20 billion in FY2021–2022. In the insurance sector, new premiums received during FY2020–2021 stood at US$79 billion. For perspective, India's total new corporate bond issuances during FY2021–2022 stood at ~US$75 billion.[29] Thus, these are substantial flows from a capital market perspective. They are also essential to fulfil India's capital needs for its energy transition investments, estimated to be ~US$2.5 trillion by 2030.[30]

Several changes are necessary to scale up clean energy investments by domestic insurers and pension funds, including weeding out several structural issues that have plagued these institutions for long. In addition, corporates also need to revamp their business models to achieve scale.

Scaling Up Debt Investments

Within debt markets, the relatively shorter-tenured liabilities of banks usually constrain them from providing long-term financing. A corporate bond market with lower costs and faster issuing time offers a cost-effective source of long-term debt for corporates.

As a first step, IRDAI and PFRDA need to relook at the thresholds for investment in state- and central-level securities to accommodate a higher percentage of investment-grade corporate bonds. Additionally, there should be mandatory thresholds for investment in private sector bonds to facilitate the growth of this market segment. From the issuer's end, the issuance of longer-tenured bonds is essential.

Secondly, regulators should decouple renewable energy from the wider power sector to provide dedicated funds for clean infrastructure. While several underlying dynamics of renewable and conventional power are the same, their inherent risks and drivers vary due to the undergoing energy transition.

Developing credit derivatives is essential for lower-rated issuers to access institutional capital. In addition, developing a market for credit default swaps (CDS) will help spread risks and de-risk lower-rated instruments for insurers and pension funds. Globally, insurance and pension funds are among the most active participants in credit derivative markets. At the very least, providing plain vanilla guarantees for lower-rated issuers through state-sponsored or multilateral actors can help build confidence among investors by de-risking such instruments. When it comes to the issuance of credit guarantees in India, there are no comprehensive enabling regulations currently.[31]

Lastly, diversifying the bond market to retail investors will open up another latent investor class, which has essentially invested in debt markets through demand and time deposits by banks or through their investment in insurance and pension schemes. In addition, there has been a significant uptick in the quantum of flows going to equity mutual funds through popularising the systematic investment planning (SIP) route. Similar efforts are also needed for the debt markets so that long-term patient capital can fund long-dated renewable assets.

Scaling Equity Investments

Among life insurers, LIC has been a major investor in the country but has overwhelmingly invested in PSU stocks, often being the investor of last resort for several PSUs. At other times, it has helped the government in its divestment programme. But, besides being ill-thought-off, these measures also pose a severe portfolio risk for the country's largest investor. Thus, a relook at the overall portfolio is needed to diversify it further and provide capital for sound investments.

For pension funds, PFRDA rules have been overly restrictive on EPFO, allowing investments only through ETFs, which primarily mirror the broader markets. As a result, lower returns on the EPFO corpus have been a point of contention, directly linked to the fund's low equity exposure.[32] While broad market investments are a sound proposition, the EPFO board also needs to provide provision for direct equity investments in any company to undertake active portfolio management and tactical investments.

On the unlisted equity side, both sector regulators need to allow a certain threshold of investments. A gradual opening up of these investments can help in capacity building by domestic institutional investors. Here domestic institutional investors can come post-project operationalisation once the project is de-risked.

Regulators also need to increase the investment thresholds for investment in InvITs by insurers and pension funds, along with mandatory investment requirements, to provide market signals to developers and other investors to set up these investment vehicles.

Other Reforms Needed for Scaling Up Institutional Investments

Regarding internal capacity building, while insurers have been investing in the equity markets across the board, project-level exposure to renewable energy assets would require a specific skill set. Therefore, the IRDAI should mandate the need for a separate equity fund manager with expertise in the renewable energy sector. EPFO's fund management is outsourced to two portfolio managers, which may not have the requisite sectoral expertise. Hence, more portfolio managers need enrolment, depending on their expertise in specific assets and sectors. Additionally, specific funds should be allocated to them based on PFRDA investment guidelines.

Insurers and investors need to incorporate climate risk consideration and ESG investing principles. IRDAI and PFRDA should take cues from global regulators and start acting on the climate risk carried on the portfolios of their regulated entities. Further, mandating ESG-aligned investments and incorporating an ESG strategy is also necessary. This will help provide capital naturally for renewable energy technologies.

In tandem, for sustainable finance issuances, such as green bonds, the government should provide grants to cover the costs of external review, credit rating, and other costs linked to green bond issuance or tax deduction for issuance costs. This will help build a domestic market for instruments.

Conclusion

Insurance and pension funds have played a major role in helping grow the domestic capital markets. They have been anchor investors and capital providers for central- and state-level debt securities, which have been used to fund several developmental needs. On the equity side, LIC is today the largest investor in the domestic equity markets.[33] PSUs have also relied on these investors for raising bonds and debentures, often raising debt at ratings at par or, at times, better than sovereign.

The steady and timely inflow of funds for insurers and pension funds in India has helped them consistently provide for the nation's development needs. The country's mammoth capital needs for energy transition now need these funds.

Given the politically sensitive nature of these issues, there must be a strong resolve to undertake reforms for channelling capital from these investors. Additionally, sectoral regulators will need to take cognisance of the climate risks plaguing these sectors and work towards incorporating ESG principles.

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Appendix 19A

Financial Ecosystem for Scaling Up Renewable Energy

Vinay Jaju and Sayantan Dey

The most critical difficulty facing India's financial environment is the lack of creative financing solutions (guarantee funds, blended finance) that would have supplied larger volumes at lower interest rates and for longer periods. The sector's deconstructed financial map demonstrates that private investors are the sector's driving force, while banking institutions rely on the government to raise the necessary funds. The financial community has been reluctant to finance RE initiatives.

According to a report by a panel of the Indian Parliament (2021), the sole dedicated public sector financial organisation, IREDA, has been asked to provide the required funding for the installation of RE projects. Public sector banks have also come up with schemes to provide financial assistance to this sector such as the State Bank of India's Surya Shakti Solar Finance Program, and the World Bank's US$165 million support to India's RE market. The RBI has included financing of RE projects under the priority sector lending limit, which includes loans up to Rs. 10 lakhs to individuals, but not much lending has taken place so far.

Banks are reluctant to lend in this sector owing to three types of risks: off-taker risk, technology risk, and policy uncertainty. It is crucial that the government play the role of a facilitator and develop creative policy measures that will both provide novel funding instruments and foster an atmosphere that reduces associated risk factors. Foreign investment is severely constrained in developing nations by currency risk. The largest risks for investors are currency and off-taker (or counterparty) risks. Given the emphasis on expanding the capacity for RE, the Indian government needs to understand the potential contribution of counterparty and currency risk mitigation measures, as well as the justification for developing such mechanisms using public funding sources. Through public–private partnerships, these creative financial frameworks may make sure that the deployment of RE occurs at scale.

One such innovation at the policy level calls for cooperation and a variety of investment contracts. It is possible to significantly reduce the risks by working together with a number of stakeholders, including the central and state governments, financial institutions, investors, and research groups. Additionally, in order to lower the transaction costs related to such systems, it is necessary to enhance and make the approval and clearance procedures more visible. The provision of better technological data, better policy environments involving ongoing regulatory and tariff reforms, enforcement of regulations, and implementation of strong and robust systems of permitting and approval for new projects can address and create the necessary ecosystem for financing RE in India.

Appendix 19B

India's Energy Sector: Redefining Business Models and Adopting New Clean Energy Technologies

Shantanu Srivastava

Electricity markets are undergoing an unprecedented transformation globally. This transformation has reignited the competitive forces within power markets, with existing companies pivoting to green energy and new entrants rapidly scaling up renewable capacities. Companies are redefining their business models and moving beyond the conventional business of plain vanilla generation, transmission, and distribution to offer more.

In India, too, several conventional utilities and independent power producers (IPPs) have been expanding their product offerings and adopting new technologies to address the multiple business opportunities that energy transition offers. Government reforms and policies have provided momentum for corporate actions in several areas.

Value-added products and services, such as Energy-as-a-Service (EaaS) and corporate decarbonisation solutions, are emerging as new revenue lines as customer requirements move beyond typical power purchase agreements (PPAs). The EaaS business model offers several energy-related services to the customers besides electricity supply. Several commercial and industrial (C&I) customers are embracing digitalisation and monitoring energy savings to reduce energy-related costs. Companies like Tata Power help them by providing energy efficiency services, including energy audits and demand-side management. Tata Power also offers Internet-of-Things (IoT)-based home automation solutions for its retail customers. Similarly, Greenko recently launched cloud energy storage solutions, offering energy storage solutions on demand to state electricity distribution companies (DISCOMs) and C&I customers. This will provide the customer with firm and dispatchable clean energy solutions without incurring capital expenditure on storage assets.

Corporate decarbonisation is gathering steam globally and in India. A total of 79 Indian companies have pledged to reduce greenhouse gas (GHG) emissions under the Science-Based Target Initiative (SBTi) – a global alliance enabling businesses to establish their own climate pledges. Several C&I customers are off-taking green energy through open access from renewable energy IPPs. Corporate Power Purchase Agreements (CPPAs) are a win-win proposition for IPPs and corporates. C&Is can lower energy costs and fulfil decarbonisation pledges, while IPPs can generate higher tariffs and returns than "plain vanilla" bids where the competition is more intense.

Green hydrogen holds great promise for deep decarbonisation of hard-to-abate sectors, such as steel, cement, chemicals, and refining. Companies are betting on exploiting green hydrogen's use in storage, mobility, and industry while also foraying into the manufacturing of electrolysers. India aims to produce 5 million tonnes per annum (MTPA) of green hydrogen by 2030, a target that will have massive corporate support. NTPC, for instance, is working on setting up the country's first Green Hydrogen Mobility project in Ladakh, India's first green hydrogen micro-grid project and several projects to demonstrate hydrogen co-firing at its gas-based power plants. Others, such as Reliance Industries and Adani Enterprises, have ambitions to produce the world's cheapest green hydrogen and have pledged billions of dollars towards fulfilling that target. Several other IPPs, such as Greenko, ReNew Power, and Acme Solar, are also actively pursuing opportunities in the sector.

Another technology, battery energy storage systems (BESS), is fast being mainstreamed in the power system, helping companies supply firm dispatchable clean energy to their customers. Several grid-scale tenders from entities like the Solar Energy Corporation of India (SECI) are helping the technology attain commercial viability. BESS assets have multiple value streams, such as use in ancillary services, integration with grid transmission, and distribution assets and capacity firming of renewables. These are helping scale up domestic BESS capacities. Corporations like JSW Energy, Tata Power, Hero Future Energies, ReNew Power, and others are actively participating in grid-scale tenders involving BESS technology. JSW Energy recently won SECI's tender for a 1 GWh) BESS (Mercom India, 2022). Tata Power has set up India's first grid-scale energy storage system in Delhi (Tata Power. (February 2019) and won the tender to install the first large-scale BESS project co-located with a solar photovoltaic (PV) plant (Renewable Watch, 2021).

Companies are also diversifying across the value chain into module and battery manufacturing and downstream into the distribution business for better cost control through economies of scale. Several Indian renewable energy companies participated in, and oversubscribed, the government's production-linked incentive (PLI) scheme for solar module manufacturing and Advanced Chemistry Cell (ACC) batteries, launched last year to diversify upstream in the value chain.

Another way of achieving scale is through horizontal integration. The government had mulled over the privatisation of state-owned DISCOMs, which have been the weakest link in the power value chain with fragile financial conditions and substantial dues to power generators in the country. Such a move will invite much interest from private companies already in the distribution business as they see enormous potential for efficiency gains. Past privatisation of DISCOMs in Delhi, Mumbai, Odisha, and Bhiwandi have seen impressive results with lower aggregate technical and commercial (AT&C) losses and better collections.

Redefining business models and adopting new clean energy technologies will provide much momentum to India's energy transition efforts and transform the energy markets in the process.

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20 Operationalising Just Transition in India

Financing Challenge and Options

Neha Kumar and Suranjali Tandon

Introduction

India has managed some bold economic transformations in the past while pursuing equity. Once again, India is set to embark on an economy-wide transition with its net-zero ambition. The impact of the transition will be far-reaching, as 80% of India's energy needs are met by either coal, oil, or solid biomass.[1] Furthermore, India's budgetary receipts are linked to such fossil fuel consumption. For the transition to be "just" financial interests would have to be aligned with the interests of workers, consumers, and communities. Chapter 5 of Section 1 and Chapters 7, 10 and 11 of Section 2 address the macroeconomic and governance aspects and international experiences with Just Transition (JTs). In this chapter, we reflect on how Just Transition can be operationalised into financial mechanisms for the energy transition.

Operationalising Just Transition will produce simultaneous effects across the financial and real sector, firms, and people. Both public and private financial flows will need to be managed and augmented such that resilience of financial and non-financial entities as well as that of workers, communities, and consumers improve as a result of the transition. Demands for reskilling, income support, and financial aid for technological transfers will become important considerations as the transition gets underway. These are mandates of the state. So, managing the fiscal space to fund India's progress on climate action and the Sustainable Development Goals (SDGs) will need to go hand in hand with massive efforts required at increasing the sources of capital, especially private capital, to finance the transition. The loss of revenues in one sector, raising of subsidies for another, will need deft fiscal management and an understanding of some inevitable trade-offs that will emerge. This will further impact the fiscal autonomy of states and the centre, thus necessitating systematic planning.

Further, transitional sectors such as electricity and agriculture constitutionally lie in the concurrent and state lists, making the role of the states critical in steering and managing "Just Transition" (also see Chapter 3). In fact, the centre and states will need to evolve a comprehensive framework for coordinated action and demarcate their common and differentiated responsibilities. Up until now, the centre and some state governments have established working groups or task forces looking into the just element of the energy transition. For example, coal-dependent state of Jharkhand has established the Sustainable Just Transition Task Force.[2] The Ministry of Coal, under the central government, will have a "Just Transition division" supported by the World Bank.[3] The risk of a silo-ed approach is also clear and present, unless departments looking at SDG and climate develop a coordinated approach with the planning and finance division.

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Just Transition will also need to be articulated in the international context as the EU and other countries embark on the ambitious plan to ratchet costs associated with carbon (see Chapter 5). Besides technology and technical assistance, this will get reflected in demands, negotiations, and measures to lower the barriers to increase the volumes of capital flow from the Global North to the Global South just as much as in calibrating trade taxes, which would need to respect common but differentiated responsibility and not pressure the trading sectors in developing countries to aggressively decarbonise.

In this chapter, we start by framing Just Transition in the context of its key stakeholders. We then discuss the impact of Just Transition on public and private finances and on international financial partnerships. The section "Mainstreaming Just Transition" concludes with a discussion on how Just Transition can be integrated into the discourse of development finance.

Just Transition and Its Key Stakeholders

Just Transition was introduced to the lexicon of climate change in CoP27, which took full cognisance of the need for social dialogue and inclusion[4] for sustainable and just solutions to climate crisis. It was decided that a work programme on Just Transition for discussion on pathways to achieving Paris Agreement will be established. Earlier, CoP21 had acknowledged that far-reaching mitigation policies will change global, regional, and national economies in potentially profound ways and severely disrupt the lives of affected workers and their communities. Accordingly, it suggested two areas for further work: (1) economic diversification and transformation; and (2) Just Transition of the workforce, and the creation of decent work and quality jobs.[5]

While the scope of this chapter is restricted to the energy transition, the digitisation of the economy also presents a challenge as jobs become increasingly automated. In essence, Just Transition implies that equity becomes a key marker for transition to a less fossil fuel-dependent economy. *It also means that Just Transition isn't merely treated as a safeguard, rather as an opportunity for growth and investment* (please also see Chapter 9). It is also helpful to locate the transition within the broader and fast-maturing sustainability context where businesses, including financial firms, evaluate their risks and value creation based on a "triple bottom line" approach centred on the conjunction between profit, people, and planet. This is, as some contend, merely a managerial view of dealing with the transition. Undeniably, this can't be a substitute for the broader and more fundamental societal shifts and political commitment to steering an orderly, if not an inexpensive, transition.

It is expected that the process of moving away from a predominantly fossil fuel-based economy to a low-carbon pathway would require a shift in the processes of production adopted in fossil fuel-dependent sectors such as power, transport, iron, steel, and cement. The National Foundation for India estimated that the direct and indirect job loss in mining and allied sectors (power, iron and steel, bricks, and transportation), respectively, could affect 13 million jobs.[6] By some estimates, the total labour force participation in India is 471 million, and even though the impact of the transition on jobs may seem tractable in numbers there are two important considerations: the extent of informality entrenching some of the sectors and the spatial impact on jobs. For example, coal-linked states are primarily located in the central and eastern states of West Bengal, Jharkhand, Chhattisgarh, Odisha, and Madhya Pradesh.[7]

Workers: In the coal sector, stakeholder consciousness and overall perception about "Just Transition" is stronger among the direct coal dependents than indirect ones.[8] Coal mine workers tend to care more about the livelihood dimension than the adverse impact of coal. On the other hand, people from the power plants see the adverse impact of coal as real and therefore agree with coal phase down. RE ramp up on the other hand creates more jobs in the decentralised RE (DRE) space rather than solar parks where most jobs are temporary and disappear after asset construction. This is well evidenced. In 2023, DRE in India is expected to employ nearly 90,000 workers,[9] due to the acceleration of grid electrification.

Just Transition for workers in the transport sector would have its own challenges. The current automobile industry is largely occupied by informal employees,[10] while the low-carbon Electric Vehicle (EV) sector is emerging as a more formal worker's space.[11] Hence, appropriate policy interventions for informal employees would need to be proactively factored into policy prescriptions that are being put in place to boost EV production in the country.[12]

Agriculture sector, which employs nearly half of India's people and contributes 20% of the gross domestic product (GDP), could be a sector where climate adaptation and resilience-led pathway lead to Just Transition opportunities. Ecologically and economically sound agroecological practices exist, but making a shift requires time and would require compensation or income and livelihood support especially to agricultural labourers along with training.

Consumers: The transition poses challenges of affordability and access to consumers. This means that the consumer can afford to purchase the equipment to support low-carbon technologies which include EVs or access energy from renewables. Furthermore, the consumer that receives subsidies linked with access in case of electricity, clean cooking, or passenger travel in railways[13] would need to be replicated in the renewable space that is currently only a fraction of the fossil fuel subsidies.[14] There are examples of how consumers can be integrated into the conversation or agenda on Just Transition. Amundi Institute[15] illustrates this with three examples. First, the creation of environmentally sustainable products and services can bring about large-scale improvement in the quality of consumption. As companies begin to shift to sustainable products, this particular aspect may be taken care of. The second aspect is related to the access to affordable energy. Low-income households should be able to afford clean energy. Third, the equipment that provides energy savings can be costly and the benefits can arise in the long term. Therefore, incentives to invest in processes that deliver sustainable products and affordable equipment and continuous RE supply will be necessary.

Communities: Beyond the consumers and workers, communities currently reliant on the fossil fuel-based economy will be impacted by the shift. These are communities that may not be employed in the sectors of interest but are part of the economic structure. With any tapering off of the economic activity in regions, these communities can get stranded. Therefore, it is imperative that the spatial implementation of energy transition is paid heed to and is well articulated, which in turn would require a detailed mapping of skills and jobs along with detailed proposals to diversify local economies away from fossil fuels. Scholars such as Pai argue that states such as Jharkhand can potentially diversify their "economies to sectors such as agriculture, tourism, and renewable energy to mitigate the impacts of coal transition and generate new opportunities for affected workers and communities."[16]

The discussion in this section can be encapsulated using one of the well-known frameworks. Greener, low-carbon economy with decent jobs at a large scale with social protection is the underlying principles of Just Transition (JT).[17] International Labour Organization (ILO) guidelines[18] JT is presented in Figure 20.1. Interestingly, among the various principles identified by ILO guidelines, India is already focusing on skill development, environmental regulations, and a comprehensive approach to SDGs (also see Chapters 7 and 11).

Just Transition and Public Finances

We now turn our attention to the impact of Just Transition on public finances. The Indian government, both at the centre and the state level, raise a significant portion of tax revenue from fossil fuels. With the phasing down of fossil fuels, the tax collections and associated subsidies will also decline. These impacts will be temporally distributed.

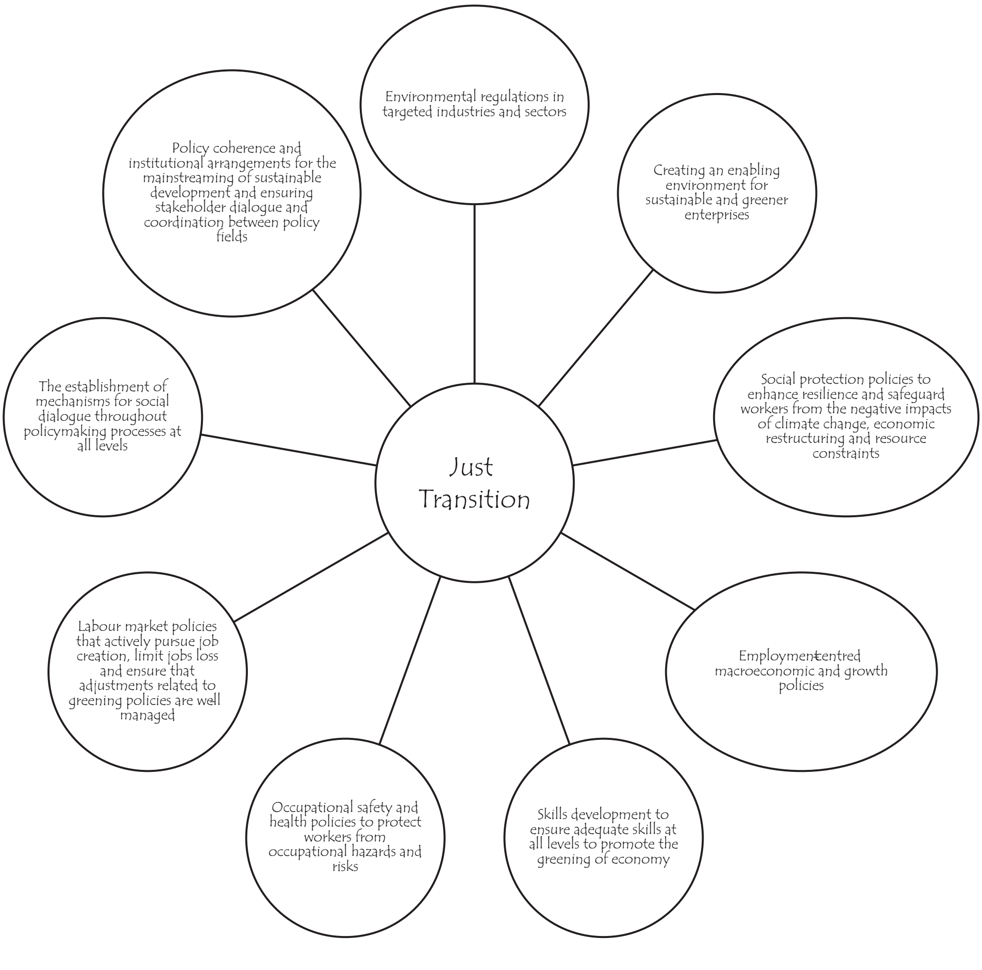

Figure 20.1 ILO framework on Just Transition.

Source: Drawn by the authors based on ILO guidelines.

Subsidies

Fossil fuel-based subsidies that consist of electricity, oil and gas, and coal subsidies have declined over a decade but remain large in comparison to RE subsidies. Moreover, even though the subsidies on fossil fuels by the union government declined by 742% between 2014 and 2021–2022, the subsidies on coal, oil, and gas increased by nine times in the same period,[19] i.e., the composition of subsidies changed. This is indicative that the subsidies will be in a state of flux as there will remain the need to continue with the scale of subsidies, only replacing support for fossil fuels with support for renewables. These subsidies should take care of the consumers, however as has been explained earlier, income support measures may also be necessary. There is also a large fiscal strain on account of unviable electricity distribution companies (DISCOMs) which will free up fiscal space (also Chapters 2 and 3).

Taxes

At the same time, there is a continued need to spend on SDGs. This further requires revenue-raising measures. The tax revenues from fossil fuels not only account for close to a fifth of the tax revenues but also underpin the fiscal autonomy and sufficiency of state and central governments. India collects multiple taxes at the state and central levels on coal,[20] oil, and natural gas.[21] Furthermore, non-tax revenues including royalties are collected from companies. These account for 17% of total government revenue[22]. A phase down of coal is estimated to result in a revenue gap of $178 billion[23]. While it is expected that RE power sector and its value chain will generate taxes, no comparable resources or inputs will replace fossil fuels to generate equivalent taxes.

Not only are the losses significant but they will also be spatially uneven. The proportion of taxes from fossil fuels in certain states such as Maharashtra is higher. The share of states in total fossil fuel revenue collected in India is concentrated among a few states such as Chhattisgarh, Gujarat, Maharashtra, and Odisha which are likely to be fiscally impacted by transition (Tandon, 2022).[24] While the annual revenue gap will depend on the design of pathway to phase down, there is a reasonable estimated loss. Unless the economic activity from cleaner technology options including internal combustion engines and electric vehicles can replace the tax base, there would be a shortfall. Therefore, if the shift to cleaner technologies is to be incentivised, then more fiscal space should be devoted to them. The exact tax structure will remain fuzzy during the transition period. What is certain is that the revenue loss on account of phase down will be noticeable in the absence of proper planning. Therefore, a Just Transition must be such that it allows the states time to adapt their tax base.

It is therefore important that Just Transition is framed not just in the context of the loss of employment, but in the larger context of macroeconomic stability including the size of the government. It is also essential to bring out the dimension of the financial system that links back intricately with the fiscal side. Sovereign borrowing and banking liabilities are the remit of the central bank. Weak public finances can make it costly to borrow, putting pressure on currency where the fiscal strains erode confidence in private finance. Then there are state and private assets which are pressured to wind down and can risk the financial system on account of assets that no longer remain viable or are "stranded." This poses a significant risk as 50% of the installed capacity is owned by the public sector.[25] It is likely that with the restricted public finance available, social goals may be put on the back burner. Just Transition should envision a fiscally stable transition pathway, which makes it necessary for international communities to ask for a

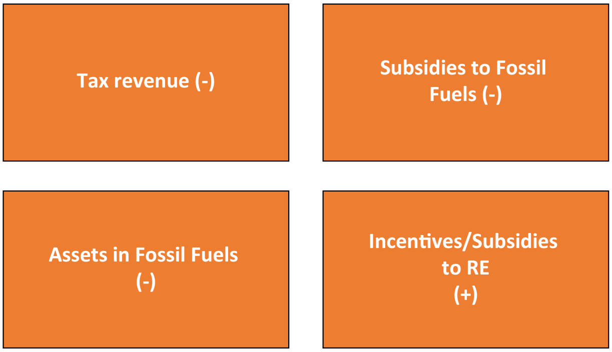

Figure 20.2 Fiscal impact of transition.

Source: Authors' own.

phase down in line with the stated national and fiscal limits. Figure 20.2 summarises the simultaneous impact of the transition on the fiscal space.

One way to support the fiscal cost of Just Transition is to price carbon. India does not have an explicit carbon tax, but there is fuel excise that works in a manner similar to a carbon tax. If a carbon tax is considered, the use of its proceeds will require equal attention. The capital raised could be invested in mitigating the social and economic impacts of the transition. This would, however, require further ironing out of the distribution of proceeds between the centre and states. India recently implemented windfall tax, which is exclusively levied on companies to ensure they do not profit from a rise in energy prices. It is expected to raise Rs. 30,000–35,000 crores.[26] While these proceeds would accrue to the centre and be spent on the general budget, there is a need to put in place a process earmarking these taxes and their pass forward to consumers.[27] It will be important to understand the extent to which rise in prices on account of a higher tax is passed on to consumers.

Just Transition and Private Sector Finance

Given the massive financing gap for green transition and its impact on public finances, private finance will be increasingly important (also see Chapters 17 and 19). Overall, green finance in India reached an average of USD 44 billion per annum from public, private, domestic, and international sources in 2019–2020. Yet, this is still a fourth of the requirement to reach the 2030 targets.[28]

It is observed that decarbonisation and social outcomes continue to remain mutually distinct objectives for borrowers/issuers and lenders/investors. Environmental Social and Governance (ESG) policies of borrowers are a good add-on but are not yet demanded by green investors or lenders in India. Just Transition, as a separate label, or as an embedded requirement for investment or lending, does not yet exist, even as we see a rising interest among investors on coverage of SDGs and social impact. Notably, the rising investor interest is characterised in a significant measure, by a surge in thematic debt markets globally, as well as in India, propelled also by progressive announcements and policies towards net zero. By June 2022, the cumulative volume of Green Social Sustainable and sustainability-linked debt issuances reached USD 30 billion since 2015.[29]

Just Transition also creates an opportunity for a green plus approach, i.e., existing investment products could have additional features, or new products focused on Just Transition could be developed. International Investor coalitions are upping the ante on the need for both these approaches. For example, Impact Investing Institute (UK) launched a Just Transition Finance Challenge in July 2022, which brings together leading global financial institutions with over £4 trillion of assets under management, to set out criteria for a new "Just Transition" label for public and private asset owners and asset managers. This would aim to make it easier to identify investment products that deliver the three critical elements of a Just Transition – climate and environmental action; socio-economic equity and distribution; community voice.[30]

Finance for Tomorrow, a French Initiative of asset managers and asset owners, announced the launch of "Investors for a Just Transition" in 2021. The coalition aims to promote a socially acceptable transition to low-carbon economies. In a further example, more than 160 investors representing US$10.2 trillion in assets have endorsed the UN PRI's Statement of Investor Commitment to Support a Just Transition on Climate Change. In doing so, they have committed to integrating workforce and social dimensions in their climate practices, laying out expectations for businesses to achieve a Just Transition to a net-zero and climate-resilient economy.

Just Transition and International Financing Partnerships

There are different ways in which countries can access international capital to fund their transition. These include the Just Energy Transition Partnership (JETP), climate investment funds, and loans from multilateral development banks. In recent times, there has been a growing demand for just energy transition partnerships. South Africa, Vietnam, and Indonesia have signed a JETP. These partnerships focus on the impact on disadvantaged social groups while decarbonising. This source of funding comes with its own set of challenges.

Even with the flow of finance through multilateral development banks and financing facilities, there remains significant funding gap, especially for developing countries both for adaptation and mitigation. United Nations Environment Programme (UNEP) estimates that efforts on climate adaptation would require US$160–340 billion by 2030 and the financial flows to developing countries is 5 to 10 times below the required. It is also estimated that for a low-carbon transition of the economy, US$4–6 trillion needs to be invested annually. Therefore, when considering the just element of the transition, it is important to also compare the current flow of international finance with that required, especially from the North to the South. Just Transition should also ensure equal terms while negotiating financing partnerships, including grants and concessional loans. An instance of this is a JETP deal for India, proposed by the G7 with multiple financing options on the table, which has run into choppy waters because of the G7 proposed coal phase out.[31]

Mainstreaming Just Transition

Financial markets have, willy nilly, been able to integrate sustainable development goals into their discourse and functioning. We propose that the efforts on SDGs should not be seen as separate from Just Transition. Figure 20.3 demonstrates that the Just Transition agenda is the "connective tissue" that binds climate goals with social outcomes.[32] Therefore, as a first step to mainstream Just Transition, the conversation on SDGs and

Figure 20.3 SDGs and JT.

Source: Robins, N., Brunsting, V., and Wood, D. (2018).

climate action must be carefully knit with the dialogue on it. In doing so, the existing spend on activities that are Just Transition-aligned can be mapped to demonstrate that Just Transition is not synonymous with "phase out" of coal. Instead, it is about the pace, process, and performance of energy transition across sectors that should be carefully and systematically crafted and monitored.

For Just Transition to be embedded and mainstreamed into the discourse of development finance, it must form a part of disclosure mechanisms and accepted taxonomy and integrated into funding requirements for energy transition-related projects. Sovereign issuances should include Just Transition objectives and they should feature prominently in collaborative agreements at all levels.

Embed by Taxonomy and Disclosures

To start with, taking a connected view, as mentioned above, of climate, social, and economic goals based on science and evidence will be essential to making it operational for government, corporate, and financial sector actions. There is often an argument that "social" is difficult to measure and hence interferes with the pace and credibility of green transition actions and their financing. This argument is inherently inconsistent if Just Transition is accepted to be imperative in the first place. Experience suggests quantitative and qualitative measurements are possible with contextual considerations in place. Treating climate (green) and social objectives at par expands the investor and finance pool; presents a better and clear picture of trade-offs and the choice of action taken thereof; provides a better handle on risk management to financiers, businesses, and governments; and affords the chance of a genuine social dialogue. For Just Transition to be credible, the process of contributing to Just Transition outcomes is equally important. This means that entities should also be able to carry out a thorough assessment of environmental and social opportunities and risks, put together a mitigation plan, monitor action and improvement, and report to internal and extremal stakeholders. Translating these considerations into a sustainable finance taxonomy for India is the first step in making a coherent identification tool to judge and screen Just Transition activities to guide capital.

Illustratively, elaborating social objectives around sustained job creation, equitable access to goods and services to all, and empowerment of vulnerable population groups could potentially cover "Just Transition" aspects across the three stakeholder groups of workers, consumers, and communities we talked about earlier in the chapter. India's homegrown Business Responsibility and Sustainability Report (BRSR) and many standards and frameworks such as the World Benchmarking Alliance, Climate Action 100+, JSE Guidance, and ICMA Issuers Guidance reiterate the common themes of decent job creation, economic diversification, human capital capacity and capability development, improved access to services, restoration and sustainable utilisation of natural capital, and social protection. These can be utilised to build the relevant metrics.

The Ministry of Finance (GoI) developed a draft taxonomy in January 2021 which awaits release at the time of writing. It proposes "Just Transition" as a core tenet and presents options to operationalise it along with a mapping of the SDGs for proposed enlisted sustainable activities. Alignment between BRSR disclosures[33] and the forthcoming taxonomic classification can provide the required interoperability and help reduce translation and opportunity costs that are important for raising capital from domestic and international sources. This should also help investors and lenders seeking to move corporate action in line with the goals of a Just Transition.

Recent trends point that investors are able to view the reputational risks and costs associated with acting unsustainably. World Benchmarking Alliance tracks the performance of companies on Just Transition. In their dataset,[34] it is observed that companies which include IOCL, NTPC, GAIL, Mahindra & Mahindra, ONGC, and RIL are looking at retaining and re- and/or up-skilling workers for an inclusive, balanced workforce, and creating and providing or supporting access to green and decent jobs for an inclusive and balanced workforce, but there is inadequate focus on social dialogue and social protection.

It is possible that the linking of SDGs with JT and their broader acceptance within the ESG framework can help mainstream the concept, which when integrated with taxonomy can help guide capital more effectively to JT opportunities in green transition activities.

It should be noted that even though ESG-based assets under management (AUM) are projected to be a third of total AUM,[35] climate and social markers have continued to worsen. Cases of greenwashing show that responsible capital stewardship can't be entirely left to the market actors and necessitates more robust standardisation through taxonomies and disclosure requirements.

Embed through Integration

India is planning to decommission around 50–60 GW of thermal power plants in the coming ten years. Although, the work on decommissioning has not yet advanced. An estimated Rs. 239 billion will be needed by 2030 to close plants that are older than 25 years, as proposed by the Ministry of Power. Estimates say that due to these measures, nearly a million people will lose their livelihood, a large amount of land would need closure or repurposing and taking care of several toxic materials would be required.[36] While these plants are planned to be closed for techno-commercial reasons, it should be possible to assess the possible decarbonisation gains, making them attractive to a larger pool of financiers. In a separate study (CEEW, 2021), the costs associated with the early decommissioning of surplus, old, inefficient assets equalling 130 plants amount to USD 32 billion with another USD 7.8 billion as payout to workers. This could help reduce greenhouse gas (GHG) emissions, improve financial viability, and release capital to support future RE growth.[37]

A set of guidelines[38] released for comments and discussion jointly by Climate Bonds Initiative, Rocky Mountain Institute, and Climate Policy Initiative propose a high-level principle-based framework to establish credibility on all three aspects: green, social, and economic. These guidelines focus on applying Just Transition principles at the asset level – where coal plant owners are likely to have greater influence – with a strong focus on protecting workers and communities, and can be used to assess their applicability in the Indian context.

Embed by Demonstration

First, green sovereign and sub-sovereign issuances can include Just Transition considerations by incorporating social objectives explicitly. This capital could be directed to place-based interventions for Just Transition where the private sector would find it difficult to invest.

India's debut green sovereign issuance for FY2023 mobilised USD 2 billion. As per the Green Bond Framework[39] formulated by the Ministry of Finance, the issuance would support green projects and attendant social co-benefits *where possible*. The methodology and metrics for measuring social co-benefits needs granular indicators. It is hoped that these will evolve and be incorporated in time for future issuances. The draft taxonomy which is yet to be released can be a useful reference point here. The sovereign green bond has already generated a demonstration effect with interest increasing in boosting the local green bond market and for sub-sovereign issuances where financing needs for just green transition will be most felt. Like any other borrowing, though, this will need to balanced with the limited fiscal headroom. That said, transparency in public borrowing for credible Just Transition within the fiscal limits is seen to be a good strategy, especially when it diversifies investor and lender base, while creating positive socioeconomic outcomes.

Second, development banks could play a much larger role as they are able to provide the longer-term, affordable financing necessary for public goods. They can also play a much greater catalytic role in using blended finance mechanisms to create more favourable risk-adjusted returns for international private investors. This argument also extends to National Development Banks and national and subnational Development Finance Institutions. On Just Transition, EBRD's initiatives are good examples.[40] In India's case, NABFID as well as other national (EXIM, SIDBI, NHB, NABARD) and state DFIs would be well placed to understand and price risks; build pipelines; originate investment opportunities; and intermediate public and private domestic and international capital. To be able to do so, however, they will need to be well capitalised and repurposed for SDG and climate-aligned investment.

Embed by Collaboration

To bring about Just Transition at the asset, regional, national, and international levels, collaboration and partnerships will need to be forged. These partnerships ideally with local authorities, public finance institutions, peer investors, and lenders will be instrumental in designing and supporting Just Transition-aligned project development plans and financing initiatives. India's vast and past experience in large development projects has produced a rich body of knowledge which gives practical insights into designing and developing Just Transition roadmaps (see the discussions in chapter 11).

Notes

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33 https://www.sebi.gov.in/sebi_data/commondocs/may-2021/Business%20responsibility%20and%20sustainability%20reporting%20by%20listed%20entitiesAnnexure1_p.PDF

Top 1000 companies will be reporting on BRSR from FY2022-23. There and nine principles that cover the E,S and G dimension of an entity's operations and impact. The BRSR provides a list of core and leadership indicators and focuses both on quantitative and qualitative indicators that can track change/improvement with each year of reporting.

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Appendix 20A

Decarbonisation Goals: Benchmarking NTPC and Tata Power with Enel and Recommending a Sustainability-Linked Finance Framework

Saurabh Trivedi

India requires a massive investment of US$8.4 trillion (Singh & Sidhu, 2021) to achieve its net-zero target by 2070 and revised Nationally Determined Contribution (NDC) targets. Power sector giants such as NTPC and Tata Power could take a leadership role in mobilising investment for decarbonisation, helping India to achieve its NDC goals. However, this would entail these companies providing a detailed decarbonisation plan to transform into clean energy companies by establishing ambitious and credible targets that align with their investment strategy. Similar credible outcome-based financing frameworks to quash any doubts about implementing a decarbonisation strategy have been adopted by energy sector companies in other countries.

Italy's Enel, for example, has shown great success in financing its energy transition through issuances of several outcome-based sustainability-linked debt instruments worth more than US$33 billion. These instruments are structured around decarbonisation targets measured through key performance indicators (KPIs) laid out in a sustainability-linked finance (SLF) framework.

Sustainability-linked finance framework is a detailed document which lays out the guidelines that the company will follow in issuing new sustainability-linked financing instruments. The objective of the SLF is to provide a guidance to investors as to how sustainability is integrated in the issuer's financing strategy. It highlights the mission of the issuing company and its commitment to the integration of the UN's SDGs into its financing plans. The SLF mentions the KPIs of an issuer to measure their SDGs which are then assessed against pre-defined sustainability performance targets (SPTs).

The Institute for Energy Economics and Financial Analysis (IEEFA) recommends that, as an important step, NTPC and Tata Power should establish a formal SLF framework as Enel and many other global peers have done (Trivedi and Chrstina, 2022). The SLF should have robust, science-based greenhouse gas (GHG) emissions, reduction targets, and financing strategies aligned with these targets. A credible SLF could help the two companies unlock new avenues of capital by raising sustainability-linked debt instruments.

Currently, only 111 power sector companies globally, including Tata Power, have committed to aligning their energy transition goals to Paris climate goals as analysed by Science Based Target Initiative (SBTi) (*Tata Power Set to Reduce Emissions in Alignment with Science Based Targets Initiative (SBTi)*, n.d.). However, to date, only 52 companies' transition targets have been approved by SBTi. Of those certified by SBTi, none are from India. This indicates that investors interested in financing the credible energy transition of power sector companies do not have enough investment options in this space, especially in India. It also indicates there is a great opportunity for Indian power sector companies to attract the huge untapped transition finance capital by establishing robust science-based decarbonisation targets.

The current decarbonisation plans of NTPC and Tata Power appear less ambitious and less credible than their global peer, Enel. Both companies stated GHG emissions reduction targets do not align with science-based net-zero targets. NTPC plans to reduce its GHG emissions intensity by only 3% by 2022 and 17% by 2032. Similarly, Tata Power's emissions reduction targets are 12% and 20% by 2026 and 2030, respectively. These targets are nowhere near Enel's emissions reduction target of 64% by 2023 and 80% by 2030 and are well below the science-based emissions reduction targets. The Intergovernmental Panel on Climate Change (IPCC) special report estimates the power sector must reduce its emissions by 70–92% between 2020 and 2035, approaching zero by 2040 and 2045.

NTPC is constructing 11.8 GW of coal-based power plants, which will not only weaken its low-carbon transition ambition but also add huge coal-fired capacity with a significant risk of stranding, that is, the economic life of these investments may be curtailed on account of technology, regulatory, and/or market changes. Tata Power has committed to not adding any new coal-based capacity and to completely phasing out around 9 GW of existing coal-based power capacity by 2045, once the asset life is over or existing power purchase agreements expire. In contrast, Enel is retiring many of its coal-based power assets well before their useful life.

NTPC, Tata Power, and Enel all have commendable targets to deploy clean energy assets across technologies – solar, wind, battery, green hydrogen, and clean transportation. NTPC has set a target to install a renewable energy capacity of 60 GW by 2030 from the current installed capacity of 5.1 GW. Tata Power has a target of 80% clean energy in its total generation mix by 2030 – that is, 25 GW by 2030 from its current installed renewable energy capacity of 4 GW – and 100% of clean energy assets by 2040–2050. Enel plans to achieve 80% of total installed capacity from renewables by the end of 2030 and 100% by 2040.

However, only Enel has published a roadmap and corresponding investment plan in its SLF outlining how the company aims to achieve its clean energy installation targets. It plans to invest approximately €45 billion into renewable energy and allied infrastructure in 2022–2024 and €170 billion by 2030.

NTPC and Tata Power can draw important lessons from Enel's strategy of tapping massive sustainable finance capital to meet its decarbonisation targets. It has used the SLF framework to structure its sustainability-linked debt issuances to raise more than US$33 billion of debt. It has also outlined a capex plan of €170 billion in its SLF, which aligns fully with its 2040 net-zero targets.

Tata Power has raised a loan of US$320 million in August 2022 via sustainability-linked loans; however, the SLF used to structure the loan is not available publicly (Das, 2022). The loan will be offered in two tranches – a term loan by the Bank of America and a club loan from Bank of America and Sumitomo Mitsui Banking Corporation. Interest cost incentives are attached to the loan, including no expansion in thermal power in the next few years and increasing renewable power generation by 1.5–2 GW per year.

In the absence of any formal SLF and corresponding KPI details, it is difficult to comment on the robustness of Tata Power's KPIs. However, it does validate our recommendation that establishing an SLF to issue outcome-based financial instruments can attract a significant amount of investment from global investors.

21 International Climate Financing and Just Energy Transition

Exploring the Synergies

Pradip Swarnakar and Rajshri Shukla

Introduction

The scientific evidence for climate change and its anthropogenic origins has been firmly established (IPCC, 2021). Transitioning away from fossil-driven energy systems to a renewable-based system has been identified as a critical solution to the crises. As the energy transition unfolds, the scale and challenges of the transformational process differ across countries based on their financial and technological resources. The evolution of international climate negotiations has also reflected this difference.

In 2022, the world leaders met for the 27th year in a row to discuss and find solutions to climate change in Egypt. Thirty years ago, when they met in Rio, a line was drawn between developed and developing countries as Annex 1 and Non-Annex countries, respectively. The countries in the former group were held responsible for the global warming causing emissions produced due to decades of their industrial and developmental activities. On the other hand, the latter were exempted from any binding responsibility for mitigating the emissions so that the required developmental activities can continue to deliver gains to the millions in need of basic life amenities. The distinction was formalised as the principle of Common but Differentiated Responsibilities (CBDR) at the 1992 United Nations Convention on Climate Change. It means that the responsibility to deal with climate change is common across nations, but the nature and scale of response should depend upon the historical responsibility and resources of each country.

According to CBDR, the responsibility for leading the energy transition predominantly lay with the developed countries as they possessed the financial and technical resources required for this large-scale structural shift. The principle also lays down that these resources be shared with the developing countries for assisting them in mitigation and adaptation activities. To operationalise this transfer of financial resources from developed to developing countries, international climate finance mechanisms were set up. At the 15th Conference of Parties (COP) meet at Copenhagen in 2009, US$ 100 billion were pledged by the developed country parties to aid climate mitigation and adaptation activities in the developed countries. The Global Environment Facility (GEF) and later the Green Climate Fund (GCF) were constituted as the operating entities of the climate finance mechanisms. Apart from these, Adaptation Fund (AF) and Clean Technology Fund (CTF) are major financial mechanisms in the climate landscape.

As countries initiate and implement measures for decarbonising their energy systems to achieve their climate targets, the enormous socio-economic impacts of such activities are becoming apparent. The fossil fuel-driven economy of the world provides livelihood to millions of people across the globe and especially in coal-dependent countries like

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India.[1] The economic and social security of these workers and communities stand threatened as countries embark on climate change-induced energy transition away from fossil fuels. To mitigate the adverse consequences of fossil phase out and to ensure the socio-economic security of this workforce, there is a need to mobilise huge financial resources. This calls for

> mainstreaming the assessment and integration of social and employment impacts in Climate Funds, such as the Green Climate Fund and the Global Environment Facility, and developing targeted Just Transition financing windows in these funds would allow further expansion of the asset base and a better exploitation of the transformational potential of climate finance.
>
> (International Labour Organization, 2022, p. 16)

It is evident from the discussion that transition is already in progress, but it is not clear how this transition will impact coal-dependent communities. Most of the international financial resources are targeted to large-scale mitigation projects through the installation of renewable energy with less or no attention to coal-dependent communities. The financial resources need to be governed and allocated in such a way that ensures maximum social benefits for fossil communities so as to make this energy transition a "Just Transition."[2]

This chapter explores the ways in which the concerns and demands of just energy transition can be integrated into the international climate finance mechanisms. It is divided into six sections. The second section unpacks the theoretical underpinnings of justice in the global climate negotiations. The third and fourth sections, respectively, map the climate finance and Just Transition landscape at the international and national levels. The fifth section elaborates on key prerequisites and action points needed for anchoring Just Transition concerns in international climate finance. The last section concludes the discussion.

Conceptualising Justice in Climate Change and Energy Transition: Distributive, Procedural, and Restorative Dimensions

If we are to look for financial resources in international climate finance mechanisms, it is pertinent to unpack justice-related underpinnings in the overall climate negotiations. In principle, equity and justice have been central to the international climate negotiations. It is difficult as well as undesirable to straitjacket something as subjective as justice into a standard definition. While exploring the potential of current climate finance landscape to incorporate the concerns of Just Transition, the chapter borrows two principles described in the Rawlsian theory of justice: distributive and procedural and the concept of restorative justice from the emerging energy justice scholarship (Rawls, 1971; Heffron & McCauley, 2017; McCauley & Heffron, 2018).

The principle of *distributive justice* is concerned with fair distribution of scarce resources by seeking to determine what is due to each person. In terms of climate change and energy transition, it translates into the issue of distribution of cost and benefits of the climate-related activities and energy systems. For example, while the transition of energy systems away from fossils is an absolute necessity for producing climate mitigation benefits, the process also entails costs in the form of job and social insecurity for the sector's workforce (International Labour Organization, 2022). Distributive justice provides a conceptual space where such unequal distribution of cost and benefits can be spelled out, discussed, and mitigated.

Procedural justice entails the conception of justice regarding just outcomes and just procedures and is concerned with devising just procedures so as to achieve just outcomes. The procedural justice, thus understood, translates into decision-making around climate and energy becoming more inclusive, democratic, and fair at the international, national, and local levels (McCauley et al., 2013). In terms of Just Transition, the procedural justice dimension will require that all the major stakeholders, from the workers, communities, and trade unions to the national government are included at every stage in formulating the definition and requirements of Just Transition (also see Chapter 7).

When the costs of a process are estimated and the bearers are recognised, the *restorative justice* stipulates that those bearing the cost are compensated to the extent that their previous condition is restored. In terms of climate and energy, this translates into restoring the social and economic security of those who have paid or may pay the cost of climate adversities or climate-induced energy transition. The restorative dimension is particularly central to Just Transition as it is not limited to restoring the social and economic security of the fossil-dependent workforce but finding restorative solutions to the historical and existing inequities related to environmental degradation and vulnerable social groups (McCauley & Heffron, 2018, p. 5).

That climate change is an issue of distributive justice which is an accepted notion (Jafino et al., 2021; Meyer & Roser, 2006). Developing countries are more vulnerable to climate-related adversities without having contributed much to climate change. The principle of CBDR based on polluter pays principle takes cognisance of the inequity and has strong distributive justice underpinnings. It seeks to distribute the carbon budget as a globally scarce resource based on the historical responsibility of the nations and to redistribute financial gains of industrial growth to help mitigate its cost. The procedural and restorative justice elements of climate negotiations in general and climate finance, in particular, remain unexamined. For making climate finance mechanisms more transparent and effectively incorporate Just Transition concerns, their procedural and restorative justice elements need to be evaluated and analysed.

International Climate Finance: Mapping the Global and Indian Landscape

The US$ 100 billion pledged by the developed countries form the cornerstone of the international climate financial mechanisms. Instead of significantly increasing this target, given the enhanced commitments from developing countries, the developed countries have dismally and consistently failed to pull their weight. Of the promised amount, only US$ 51.8 billion has been delivered till 2018 (UNFCCC, 2018). Moreover, 80% of the delivered public finance is in the form of loan and non-grant instruments and only 20% is in the form of grants (Carty et al., 2020). If the developing countries are made to fall into a debt trap in the name of climate finance, it defeats the very basic premise of the international climate finance mechanism and CBDR, i.e., distributive justice. The countries who are least responsible for climate change but are bearing its disproportionate cost are made to pay more cost for arresting the climate consequences. The distinction between grant and non-grant finance acquires greater salience as the financial demands of Just Transition are expanding and diversifying. Unjust finance mechanisms cannot deliver Just Transition. For example, the much-hyped US$ 8.5 billion Just Energy Transition Partnership (JETP) that the G7 countries have forged with South Africa delivers around

96% of the promised amount as loan and non-grant instruments (Lopes, 2022). Levying more debt on an already debt-ridden South African energy sector defies all logic of justice and hardly makes a strong case for Just Transition. The problem is made more complex by the lack of a clear definition of what constitutes climate finance (Mandal, 2019, p. 382).

Although India is considered to be one of the forerunners in securing international climate finance, the fund inflow falls largely short of requirements. As of January 2022, the total amount of finance India received from international funds comes to US$ 1.5 billion (Climate Funds Update, 2022) which falls terribly short of the US$ 2.5 trillion required for meeting the country's commitments in Nationally Determined Contributions (NDCs). Of the total green finance flows in the country including domestic and international, 50% is in the form of debt or loan (Khanna et al., 2022).

Moreover, a strong, integrated regulatory and institutional setup is lacking in the country as the existing setup remains fragmented and dispersed (Singh 2017). The main coordinating agencies for the multilateral and bilateral finance agreements are the Ministry of Environment, Forest and Climate Change (MoEFCC), the Ministry of External Affairs (MEA), and the Ministry of Finance (MoF) (Jha, 2014). For GCF, the main operating entity of financial mechanisms under UNFCCC, the MoEFCC, serves as the National Designated Authority (NDA) in India. It is the mediating entity and is responsible for streamlining the GCF and the climate priorities of the country. For accessing and managing finance, GCF accredits individual organisations in each country. In India, five private and public institutions have been accredited: National Bank for Agriculture and Rural Development (NABARD), Small Industries Development Bank of India (SIDBI), Yes Bank Limited, IDFC Bank Limited, and IL&FS Environmental Infrastructure and Services Limited (IESL) (Green Climate Fund, 2022).

Just Transition Scenario in India: Research and Implementation

For integrating the concerns of Just Transition in an already complex landscape of international climate finance, it is useful and necessary to take into account the complexity, contextuality, and dependencies of the Indian coal ecosystem. Coal is not only the backbone of the Indian energy system but is deeply rooted in the sociocultural and economic life of the coal-rich regions. Bearing the resource curse, these regions have remained economically backward and been disproportionately subjected to environmental degradation. The Just Transition discourse in India is nascent but evolving, but the Indian scholarship has engaged with the complex socio-economic conditions of the coal sector and the existing structures of inequality and injustices.

There are multidimensional aspects in the Indian context that need to be taken into consideration while designing a Just Transition roadmap. First, around 13 million people are dependent on the entire coal value chain. The number goes beyond 20 million if we include informal workforce with no or little social benefits (Dsouza & Singhal, 2021). Second, the existing and emerging socio-economic structure of the coal mining sector is riddled with crippling social inequalities based on indigenous identity, gender, income, and power dynamics (Lahiri-Dutt, 2014, 2014; Oskarsson et al., 2021). Third, the coal-rich regions have remained economically backward with little economic diversification beyond the coal sector (Urpelainen & Pelz, 2020). The sector is predominantly state owned with dependence in terms of tax revenue amounting to US$ 8 billion which the Coal India Limited (CIL) pays to various levels of governments: central, state, and local (Pai, 2022).

These points not only demonstrate the deep-rooted dependence on coal but highlight the complex multiplicity of stakeholders, ranging from federal government institutions to grassroots actors like workers and communities, which have much to lose in the absence of people-centric and justice-driven energy transition in India (also see Chapters 4 and 5).

Although in its initial phase, the Just Transition planning at the institutional level has been initiated at both the central and state levels. The Union Ministry of Coal (MoC) has recently launched a "Just Transition division" which is entrusted with the responsibility for formulating and implementing mine closure plans that are sustainable and just. The World Bank has committed US$ 1.15 million for the division, the report for which will include grassroots stakeholders like worker's unions (Jai, 2022). At the state level, Jharkhand, which is one of the largest coal-producing state, has constituted a "Sustainable Just Transition Task Force." The task force is responsible for mapping the vulnerability and impact assessment of coal mine closure. It is in the process of conducting multiple rounds of consultations before framing its final Terms of References (TOR) (Angad, 2022). Under the India–US Strategic Partnership, an Inter-Ministerial Committee on Just Transition from Coal has been constituted with representatives from government, public sector units from coal sector, think tanks, and academic institutes. It is responsible for conducting a detailed analysis of coal sector dynamics and formulating actionable policy recommendations for Just Transition targeted at the communities who will be impacted by the reducing dependence on coal (Niti Aayog, 2022).

Firms can also learn from international best practices to be able to link their decarbonisation goals to their requirements for financial flows in a manner that the international community recognises and contributes to. Appendix 19B benchmarks the best practices at Enel, an Italian multinational firm, with Tata Power and NTPC.

Anchoring Just Transition to the Climate Finance: the Pre-requisites and Action Points

When cast into the language of donor and recipient, the climate finance discourse often delinks the process from its basic premise which is based on distributive justice. The finance from the developed countries is not a donation or a loan. It is the amount that these countries owe to the developing countries for their relentless and heedless use of natural resources to feed an international economic system that has benefited few at the cost of many. Keeping this in mind, the following paragraphs elucidate what is required and what actions need to be taken to strengthen the integration of Just Transition demands into the international climate mechanisms.

- Need for clear, inclusive justice-driven definitions: ensuring distributive justice.

  Since the time of its inception, a clear definition of climate finance has eluded the international negotiation and this has been a matter of complicity than complexity. Even as the COP 27 meets in Egypt in 2022, the developed countries show marked reluctance in defining what exactly constitutes climate finance (Pardikar & Shreeshan, 2022). It is nearly impossible to effectively anchor the Just Transition agenda in climate finance without the latter being given a standard definition which allows for transparency in terms of access, deployment, and tracking.

  One of the most contentious bones in defining climate finance has been concessionality (Mandal, 2019). The debate around loan versus grant has grown intense over the years with a majority of the international climate finance in the form of loan or non-concessional instrument. A report released by the Organisation for Economic

Co-operation and Development (OECD) in 2015 (OECD, 2015) that overestimated the delivery of climate finance flows from developed to developing countries was heavily criticised. A discussion paper released by the Ministry of Finance accused the report of "greenwashing," the climate finance by not differentiating between the loan and grant elements and misrecognising projects as having climate "co-benefits" (Dasgupta et al., 2015; Sethi, 2015). As such, the legitimacy of various projects being classified under climate finance stands questioned.

Such a trend fails to deliver distributive justice by pushing recipient countries into debt trap. For making climate finance mechanisms sensitive to Just Transition, it is pertinent to enhance the grant-based share in the pledges and delivered finance. For this to happen there is a need to devise inclusive procedures for defining climate finance while incorporating the elements of economic and social restoration for the people affected by climate-induced impacts.

Moreover, there is a need to define the role of international financing agencies in implementing or drafting policy. These agencies often extend their financing role into the implementation and execution of the project (Jha, 2014, p. 12). When this happens, the whole process runs the risk of being based more on financing entities than the contextual realities of the recipient countries. It is, therefore, important that the role of the financing entity in drafting and implementation is defined in such a way that does not compromise the needs of the recipient country.

Finally, defining what would Just Transition mean for each country will go a long way in incorporating its concern in the international climate finance. There are significant gaps in aligning Just Transition goals to climate finance mechanisms (Lee & Baumgartner, 2022). Specific areas needing resource allocation in terms of Just Transition should be identified. For India, the rehabilitation and restoration of large coal communities including the informal workforce need to be central to any Just Transition agenda. The Just Transition needs to be defined in such a way that it creates a niche of its own in the overall climate financing mechanism while staying firmly linked to its basic premise based on distributive justice.

- An effective institutional set-up for accessing, governing and allocating climate finance: ensuring restorative justice.

Strongly linked to and needed for realising the last point, an integrated and dedicated institutional framework is needed to direct international climate finance towards the Just Transition needs of the country. Presently, the country lacks a proper institutional setup for effectively coordinating and allocating climate finance (Jha, 2014; Singh, 2017). The complex needs of the Indian Just Transition, which will require the implementation of resource-intensive restorative activities, will not be met if this continues. While integrating the climate finance coordination and governance in the country is significant, there is also a need for it to diversify in order to cater to Just Transition demands.

The union and dedicated ministries like the Ministry of Coal and the Ministry of Mines who are stepping towards addressing Just Transition need to be roped-in in the climate finance governance structure while enhancing inter-ministerial coordination. The constitution of Inter-Ministerial Committee on Just Transition from Coal and Sustainable Just Transition Task Force in Jharkhand is a welcome step in this direction. Such steps can also be replicated in other coal-producing states that will enable a context-specific response to the vulnerabilities arising from declining coal dependence. Both the committee and the task force have strong elements of restorative justice in their mandate and their effective implementation is a key to ensure that the impacted communities are sufficiently compensated for their losses due to mine closure.

In its first report, the Inter-ministerial Committee has suggested the establishment of a dedicated fund for energy transition in the country and recommended international climate finance as one of the sources from where resources for this fund can be raised (Niti Aayog, 2022, pp. 6–7). This will open ways for the integration of Just Transition concerns of the country into the international climate governance.

Accrediting coal and mining-related governing institutions to the GCF and designating them as implementing entities for other multilateral and bilateral finance mechanisms. This will ensure that they and the committees and task forces constituted under them have easy access to the required finances for implementing Just Transition schemes in the country.

- Stronger science–policy interface to formulate evidence-driven and grassroots-based Just Transition framework that can leverage climate finance.

  There are wide knowledge and data gaps in both the areas of climate financing and Just Transition. The decision-making on both should target towards making conducive conditions so that emerging research on Just Transition and climate finance can feed into policy-making. An informed policy framework is needed for an effective access and allocation of climate finance. This will allow for a more targeted approach towards securing and allocating finance and one that is relevant to the historical, social, and economic realities of the Indian coal sector. Moreover, a rigorous methodology needs to be developed to ascertain the contribution that any fund touted as climate fund is actually making towards climate mitigation or adaptation (Singh, 2017).
- An effective engagement of multiple stakeholders: ensuring procedural justice.

  The recent evaluations JETP between the G7 countries and South Africa have highlighted the lack of transparency and inclusive decision-making including a complete absence of consultation with any Civil Society Organization (CSO) (Chris Vlavianos, 2022). This complete lack of procedural justice will render any engagement of climate finance with Just Transition imperative incomplete and ineffective in delivering restorative justice which is the cornerstone of Just Transition.

  In the Indian context, the recognition of avenues that need Just Transition financing will be incomplete without engaging the grassroots actors. For an effective access and allocation of climate finance for the demands of Just Transition, actors like trade unions, civil society organisations, and local governance institutions need to be strongly integrated into Just Transition decision-making. Without strengthening the procedural justice component of the Just Transition and climate decision-making, the finance will not yield the effective and desired results and may amplify the existing inequalities and injustices.

Conclusion

The chapter discusses the possibilities and requirements for integrating the concerns of Just Transition in India with the broader agendas of international climate finance. The unique requirements, dependence, and vulnerabilities of the Indian coal-producing regions need a carefully tailored, multilayered, and justice-driven response. As a by-product of the larger climate crises, the energy transition and its impacts should be strongly integrated into the international climate negotiations as well as financing frameworks. International climate finance, with all issues related to the violation of justice principles, cannot cater to the requirements of Just Transition effectively and in true sense. For this to happen, the underlying justice principles and implications of both, international climate finance and Just Transition, need to be revisited, clearly defined, and strongly institutionalised through inclusive and research-driven processes.

Notes

1 Coal accounts for nearly 70% of the total electricity generation in India (International Energy Agency, 2021). In 2021, the country consumed about 932 million tons of coal, of which 77% came from domestic production (Dsouza & Singhal, 2021).

2 For the purpose of this chapter, we borrow the Just Transition definition given by McCauley and Heffron (2018, p. 2): "a fair and equitable process of moving towards a post-carbon society" that into consideration concerns based on ethnicity, income, gender." We are specifically concerned with the ways in which this process will impact the large workforce and communities that are dependent on fossil fuel sector.

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