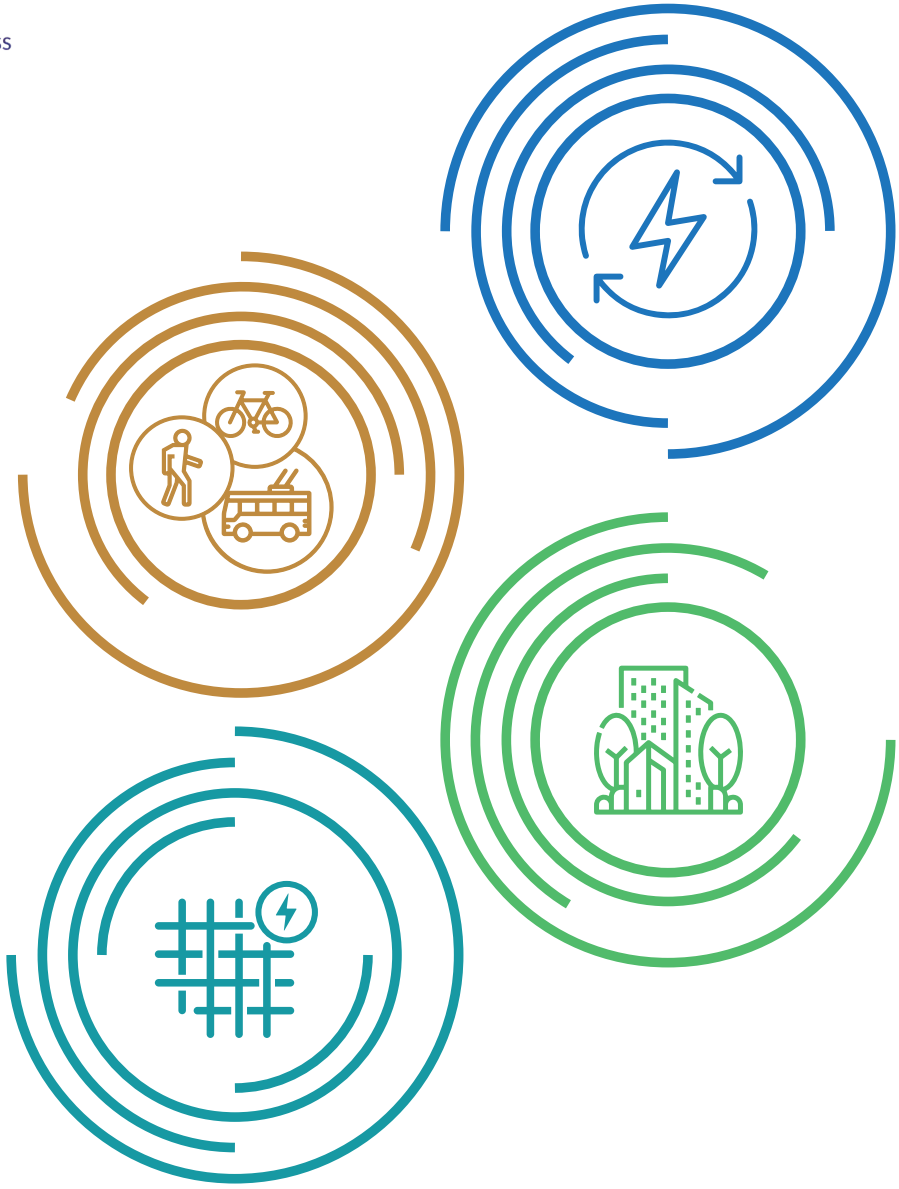
etpi ENERGY TRANSITION PREPAREDNESS INITIATIVE



ENERGY TRANSITION
PREPAREDNESS INITIATIVE

INDICATOR GUIDEBOOK

A state-level framework to assess plans, actions, and governance processes towards an energy transition

Ann Josey
Bharath Jairaj
Ashwini K. Swain
Shantanu Dixit
Navroz K. Dubash
Catherine Ayallore
Sarada Prasanna Das
Manasi Jog
Chaitanya Kanuri
Shivani Kokate
Arunesh Karkun
Sumedha Malaviya
Narendra Pai
Varun Potty
Rushabh Soni
Niharika Tagotra
Deepak Tewari
Krithi Venkat

ETPI (2023): Indicator Guidebook - Energy Transition Preparedness Initiative. Centre for Policy Research, Prayas (Energy Group), & World Resources Institute India.

ENERGY TRANSITION PREPAREDNESS INITIATIVE

ENERGY TRANSITION PREPAREDNESS INITIATIVE

INDICATOR GUIDEBOOK

A state-level framework to assess plans, actions, and governance processes towards an energy transition

ABOUT THE CONSORTIUM

ETPI is a joint initiative by CPR, PEG, and WRI India.

The Centre for Policy Research is an independent, non-partisan, research institute and think tank established in 1973. ETPI will be implemented by the Initiative on Climate, Energy and Environment (ICEE) at CPR. CPR-ICEE aims to stimulate an informed debate on the laws, policies, and institutions shaping climate, energy, and environmental governance in India. Our research focuses on an improved understanding of climate, development, and environmental challenges—and pathways to improved outcomes—in three key areas: climate policy and institutions, the political economy of energy transition in India, and air quality governance.

Prayas (Energy Group) is a non-governmental organisation working toward furthering public interest in the electricity sector through analysis-based research. It has been active in this field for more than 25 years. PEG works on theoretical, conceptual, regulatory, and policy issues in the energy and electricity sectors. Our activities cover research and engagement in policy and regulatory matters, as well as training, awareness, and support to civil society groups.

WRI India is a research organization that turns big ideas into action at the nexus of environment, economic opportunity, and human well-being. WRI India is enabling the deep sectoral shifts needed in key geographies like India, and in sectors like energy, transport, and buildings where emissions are high.

PREFACE

India's energy transition is critical to achieving its global climate commitments and domestic economic growth aspirations. India has been recognized for its ambitious targets for clean energy generation and usage. To achieve these goals, several initiatives have been introduced at the central and state levels, with a focus on domestic developmental imperatives and energy security concerns.

Much of the progress towards the transition is taking place at the state level, with them having introduced policy innovations to enable the transition and have developed unique practices. Understanding these state-level trends and exploring opportunities for cross-state learning is crucial for achieving the transition.

Energy Transition Preparedness Initiative (ETPI), a joint initiative by the Centre for Policy Research, World Resources Institute India, and Prayas (Energy Group), is an attempt to understand the state level preparedness and facilitate productive engagement with the transition. The ETPI Indicator Guidebook, a product of collaborative research by the three institutions, provides a state-level framework for assessing plans, actions, and governance processes towards an energy transition.

The three partner institutions have a long history of engagement with India's energy policy and governance processes and the research team was also involved in a multi-year, multi-country initiative – the Electricity Governance Initiative (EGI) – implemented over the 2000s.

The framework developed for ETPI is informed by our collective understanding of the energy transition and sectoral trends and priorities in the electricity, building, and transport sectors. It encapsulates indicators to study sector progress, including the techno-economic drivers, sector-specific enablers, the role of planning and implementation processes, as well as the socio-economic and equity-related impacts of the transition. The framework has been developed by incorporating state-level status and stakeholder consultations and reflects what is necessary for a people-centric transition. The aim is for this framework and assessments based on it to complement the existing sector discourse, highlight state-level trends, and underscore good practices.

The indicator framework, assessment reports, and all other knowledge products developed as part of ETPI will be available at www.etpi.in . We hope that these research outputs will help policymakers, regulators, sector actors, and researchers to make informed decisions and contribute to achieving India's energy transition objectives.

TABLE OF CONTENTS

A state-level framework to assess plans, actions, and governance processes towards an energy transition

EXECUTIVE SUMMARY

Highlights

- Driven by falling renewable energy (RE) prices, rapid transformation in the energy technology landscape, and climate change considerations, India's electricity sector is undergoing a transition.

- The contours, costs, and pace of this transition will be determined by the nature of policy responses; institutional preparedness; and recognition of the complex interdependencies among jurisdictions, sectors, and governance processes. Governance aspects at the state level, though critical for the energy transition, are often not fully understood and, thus, overlooked.

- The Energy Transition Preparedness Initiative (ETPI), drawing on an indicator-based assessment of transition preparedness in 10 Indian states that together account for about 63 percent of national electricity demand, seeks to fill the research and knowledge gaps, including the governance aspects.

- This guidebook presents a set of 24 indicators that can be used to assess states on their preparedness to undergo an energy transition across various sectors. This will enable stakeholders to gauge the specific and tangible actions by sub-national entities taken to further the energy transition in India and promote cross-learning among actors.

- The 24 indicators were designed as a composite set, together covering policy intent, effectiveness of processes, institutional capacity, and outcomes across various drivers and enablers of the transition.

The initiative, especially the annual assessment, currently focuses on three sectors—electricity, buildings, and transport; as these sectors constitute the bulk of energy demand, these sectoral transitions are critical for achieving the energy transition.

Context

India's long-term commitment to achieving net-zero emissions by 2070 and mid-term target of reducing the emission intensity of its gross domestic product (GDP) by 45 percent from the 2005 level by 2030 are critically dependent on its ability to decarbonise its energy sector. This linkage is well evident in India's 2030 targets for the electricity sector, which set

ambitious trajectories for the transition to non-fossil (primarily RE) electricity capacities and generation, as well as updated policies on energy use in buildings and electrification of transport. Despite the clear policy signals, this transition is unlikely to be straightforward or linear. The challenges and impacts of the technology shifts and decarbonisation efforts in the energy sector are complex and multi-dimensional. The transition to RE will require preventing locking in conventional (fossil-dependent) technologies, managing the transaction costs, minimising the pressures on natural resources, and addressing the existing and consequential political-economic challenges. Simultaneously, the transition will also be characterised by greater decentralisation of generation sources, digitalisation of processes, adoption of newer and energy-efficient technologies, and increased market operations. Given the fundamental nature of the transition in a developing country like India, it will also require addressing distributive questions intrinsic to the energy sector and assessing the role, capacity, and strength of institutions, especially sub-national bodies, in facilitating the transition.

About this guidebook

The ETPI guidebook is organised into four sections based on sectoral—electricity, transport, and buildings—and crosscutting indicators.

The four sections of the guide are as follows:

- **Electricity sector**: Electricity is central to the energy transition and low carbon development.
- **Transport sector**: Energy demand and emissions from the Transport sector have increased drastically.
- **Buildings sector**: Buildings are a key source of growing energy demand in India.
- **Crosscutting indicators** are relevant to energy transition preparedness across the above three sectors and pertain to aspects like low-carbon development, climate mitigation strategies, and development plans for these sectors.

Within each sector, each indicator provides a general overview of the topic, normative framework, and necessary explanations and guidelines for completing the assessment. In total, there are 24 indicators that each have five attributes. Each attribute consists of one to six sub-attributes depending on the components of the energy transition within the sector. The 24 ETPI indicators are as follows:

1. **Electricity Sector**

- Indicator E1: Long-term vision for electricity sector transition
- Indicator E2: Development of renewable energy and electricity storage
- Indicator E3: Management of coal thermal capacity
- Indicator E4: Integrated resource planning
- Indicator E5: Demand side management
- Indicator E6: Financial health of Electricity Distribution Companies
- Indicator E7: Electricity demand and supply for agriculture
- Indicator E8: Affordable and reliable supply for small consumers
- Indicator E9: Access to competitive supply alternatives for industrial and commercial consumers
- Indicator E10: Preparedness of state-level transmission and distribution network
- Indicator E11: Regulatory governance and processes

2. **Transport sector**

- Indicator T1: Accessibility of transport networks
- Indicator T2: Development and performance of public transportation
- Indicator T3: Transport electrification
- Indicator T4: Sustainable vehicle growth and road safety
- Indicator T5: Integrated policy and governance of the transport sector

3. **Buildings sector**

- Indicator B1: Energy Conservation Building Code compliance and Eco Niwas Samhita preparedness
- Indicator B2: Promotion of grid-connected rooftop solar photovoltaic and solar water heaters in urban buildings
- Indicator B3: Promotion of energy-efficient appliances and equipment in buildings
- Indicator B4: Energy efficiency and clean energy considerations in public buildings
- Indicator B5: Energy efficiency and clean energy considerations in affordable housing projects

4. **Crosscutting indicators**

- Indicator C1: Comprehensive state-level low-carbon development strategy
- Indicator C2: Local and frontline capacity in the states
- Indicator C3: Articulation of a just energy transition at the state level

The indicators were designed to capture state-level plans, actions, and governance processes on an annual basis to promote cross-learning, not to rank or compare states.

Way forward

The ETPI team will use the guidebook to carry out annual assessments of the progress states are making. The team will collate these and other learnings in reports analysing sectoral trends and the overall performance of states toward India's energy transition. We will use data compiled on a fiscal year (FY) basis, starting with FY 2020–21, and conduct assessments in subsequent years. We may update certain data thresholds within sub-attributes to accommodate sectoral developments, but the indicator set has been prepared to be relevant in the medium term. Over time, we may revise indicators and sectors based on the priorities of the country.

ABOUT ENERGY TRANSITION PREPAREDNESS INITIATIVE

The Energy Transition Preparedness Initiative (ETPI) is a state-level framework to assess plans, actions, and governance processes toward an energy transition in India.

India has emerged as a leader in the global energy transition with progressive ambitions for clean energy production and consumption. While the country has made an international pledge to achieve 50 percent cumulative electricity generation capacity from non-fossil sources by 2030, it has also set ambitious domestic capacity targets of 500 gigawatts (GW) of non-fossil energy, including 450 GW of modern renewable energy, and has increased generation targets (i.e., renewable purchase obligations) to 43 percent to be met by 2030. Comparable targets are being developed for cleaner transportation and sustainable and energy-efficient buildings. The central and several state governments are working on multiple legislative, policy, and institutional reforms to help achieve these targets.

Despite the clear policy signals, this transition is unlikely to be straightforward or linear. The challenges and impacts of the technology shifts and decarbonisation efforts in the energy sector are complex and multi-dimensional. Also, while national targets and legislative, policy, and institutional frameworks are critical to enabling an energy transition, many of the practical decisions and execution will take place at the state level, by the state governments and their agencies. Divergent state capacities and political and economic contexts necessitate better understanding of and engagement with state institutions. The transition to renewable energy will also require preventing lock-ins to fossil fuel–dependent technologies, managing the transaction costs, minimising the pressures on natural resources, and addressing the existing and consequential political-economic challenges. Simultaneously, the transition is likely to be characterised by greater decentralisation of generation sources, digitalisation of processes, adoption of newer and energy-efficient technologies, and increased market operations. Given the fundamental nature of the transition, it also requires addressing distributive questions intrinsic to the energy sector.

The transition will be shaped by multiple drivers and enablers, including techno-economic changes, social environmental impacts, planning processes, investment, and capital mobilisation as well as institutional capacity and accountability. Moreover, the transparency of these drivers and enablers, their influences, and avenues for public input and participation in the processes are critical to addressing distributive justice issues, ensuring public legitimacy of complex decisions, and, thus, smoothing the disruptive transition.

ETPI—led by a consortium of the Centre for Policy Research (CPR), Prayas (Energy Group) (PEG), and World Resources Institute India (WRI India)—is an effort toward meeting these objectives. It is a multi-year trans-sectoral initiative to assess energy transition preparedness and progress in Indian states through regular and systematic assessment of state-level electricity and allied sectors with significant energy consumption and transition potential. Through these assessments, ETPI aims to build evidence and understanding around critical governance and political-economy aspects of the transition as a necessary complement to the techno-economic discourse. With assessments across states and over time, ETPI will track progress, highlight good practices, and underscore lessons learned from variegated transition trajectories in the states.

ETPI covers three sectors—electricity, transport, and buildings—as well as crosscutting aspects relevant to energy transition preparedness across these sectors. The indicator-based assessment of transition preparedness covers 10 Indian states—Bihar, Delhi, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, and Uttar Pradesh. For the purposes of our research, we primarily relied on information available in the public domain (e.g., policies, tariff filings, financial data, reports). Any gaps in publicly available information were filled through consultation with relevant stakeholders.

ETPI aims to inform sub-national energy transition preparedness in India and accelerate efforts toward a cost-optimal and just energy transition through multiple knowledge products, including annual assessments of the indicators for ten states, case studies on transition-related initiatives, and articles to share critical analysis based on the assessments.

We hope that our project will serve as a resource for multiple actors in the energy space—state and central government policymakers, regulators, journalists, researchers, civil society and consumer organisations, investors, and utilities. The guidebook aims to help stakeholders understand state-level developments and support informed, agile, and time-sensitive decision-making. All the knowledge products along with supporting evidence and notes are available on the ETPI website (www.etpi.in).

INTRODUCTION TO THE GUIDEBOOK

This guidebook outlines an indicator-based framework to evaluate plans, actions, and governance processes toward an energy transition in Indian states. It also provides the normative basis for each indicator, its relevance to the energy transition, and necessary guidelines for researchers.

The ETPI assessment focuses on three sets of indicators for the electricity, buildings, and transport sectors along with three crosscutting indicators that look at broader state-level transition preparedness. In total, the guidebook contains 24 indicators organised into four sections: electricity, buildings, transport, and crosscutting indicators.

These indicators will help determine where states are in their energy transition preparedness. Using a governance lens to understand the energy transition, ETPI will support the quicker uptake of clean energy technologies and inspire cross-learning among state-level actors.

ETPI identifies benchmarks and good practices and highlights governance gaps. The indicators were developed based on a normative framework, sector trends, and, where relevant, national commitments. While national commitments and legislative, policy, and institutional frameworks are necessary for the energy transition, much of the implementation will happen at the state level, by state governments and their agencies. Different state capacities and political economy contexts require a better understanding of these frameworks. We developed the indicators in this guidebook to measure, assess, and track the following on an annual basis across the three sectors:

- Policy intent, vision, and commitment to accelerate the energy transition
- Transparency and fairness in the process and effectiveness of procedures
- Institutional capacity and actions to enforce stated commitments
- Outcomes of stated efforts to aid in the transition

While these aspects may not be evident in each indicator, the indicators were chosen to balance measures related to intent, process, enforcement, and outcomes across each sector.

Objectives

Building on the indicator-based assessment and case studies, ETPI aims to contribute to the following:

- Electricity, buildings, and transport sector decision-makers and stakeholders demonstrating greater awareness and sensitivity to existing practices and opportunities leading to progress in the energy transition
- Public institutions and decision-makers at the state level being informed of effective processes and practices by learning from experiences in peer states
- Consumer groups, civil society organisations (CSOs), and other stakeholders having better information and evidence on relevant aspects of public proceedings

Methodology

This guidebook uses indicators to annually assess the progress of states and collate these data and other learnings into an assessment report analysing overall trends and state-level performance. The assessment report will trace overarching inter-state trends, highlight good practices, and underscore lessons that will aid future implementation. The data available to satisfy sub-attributes and attributes will be compiled on a fiscal year basis, starting with FY 2020–21.

The indicators were developed after extensive and rigorous deliberations by the team comprising senior researchers from the consortium partners—Centre for Policy Research, Prayas (Energy Group), and World resources Institute India. We shared draft indicators with sector experts and researchers to seek feedback on their relevance and depth. Once all 24 indicators were developed, they were subject to internal and external review by close to 20 sectoral experts, practitioners, researchers, and consumer groups working on the focus sectors. The peer review comments received were discussed by the ETPI team, and the indicators were updated accordingly. The ETPI team then conducted pilot assessments with the updated 24 indicators in three states—Delhi, Maharashtra, and Kerala—to seek feedback on the attributes and sub-attributes at the state level. Further refinement of the indicators was carried out based on the pilots before the indicators were finalised.

Each indicator focuses on a major aspect of the sector that we believe is critical to the state's energy transition. Each indicator includes a set of five attributes and each attribute has multiple sub-attributes that are scored based on compliance and availability of data. Cumulatively, the sub-attributes help validate the attribute; the attributes help validate the indicator; and the

indicators allow for an assessment of state preparedness and performance. However, the emphasis on each of these aspects can vary by indicator. The number of sub-attributes also varies across attributes to account for differing state-level practices (when checking any one sub-attribute) and to evaluate performance on a specific but critical parameter (where there is only one sub-attribute). The indicators were designed to be forward-looking and transition-oriented while being rooted in current contexts and considering existing state-specific realities where relevant. The intent is to provide a normative framework that tracks specific and tangible transition-related changes, but that is not prescriptive.

Each indicator assessment is accompanied by a rationale for scoring as well as notes for data sources, gaps, assumptions, and limitations so there is clarity on the scoring methodology and rationale for each state. The assessment sheets are also available on the ETPI website (www.etpi.in). Table 1 shows the number of indicators and corresponding attributes per sector in the order in which they appear in this guidebook:

Table 1: Overview of indicators by category

Indicator categories	Indicators	Attributes	Sub-attributes
Electricity	11	55	137
Transport	5	25	70
Buildings	5	25	52
Crosscutting	3	15	32
Total	**24**	**120**	**291**

Structure of the indicators and scoring design

Each of the indicators has five attributes and each attribute has multiple sub-attributes, all with certain qualifying thresholds. Each attribute is assigned a threshold above which the attribute is scored 1 and below which it is scored 0. Based on the attribute scores (either 1 or 0), the indicator can get a maximum score of 5 and a minimum score of 0. Structure of the scoring is shown in Figure 1.

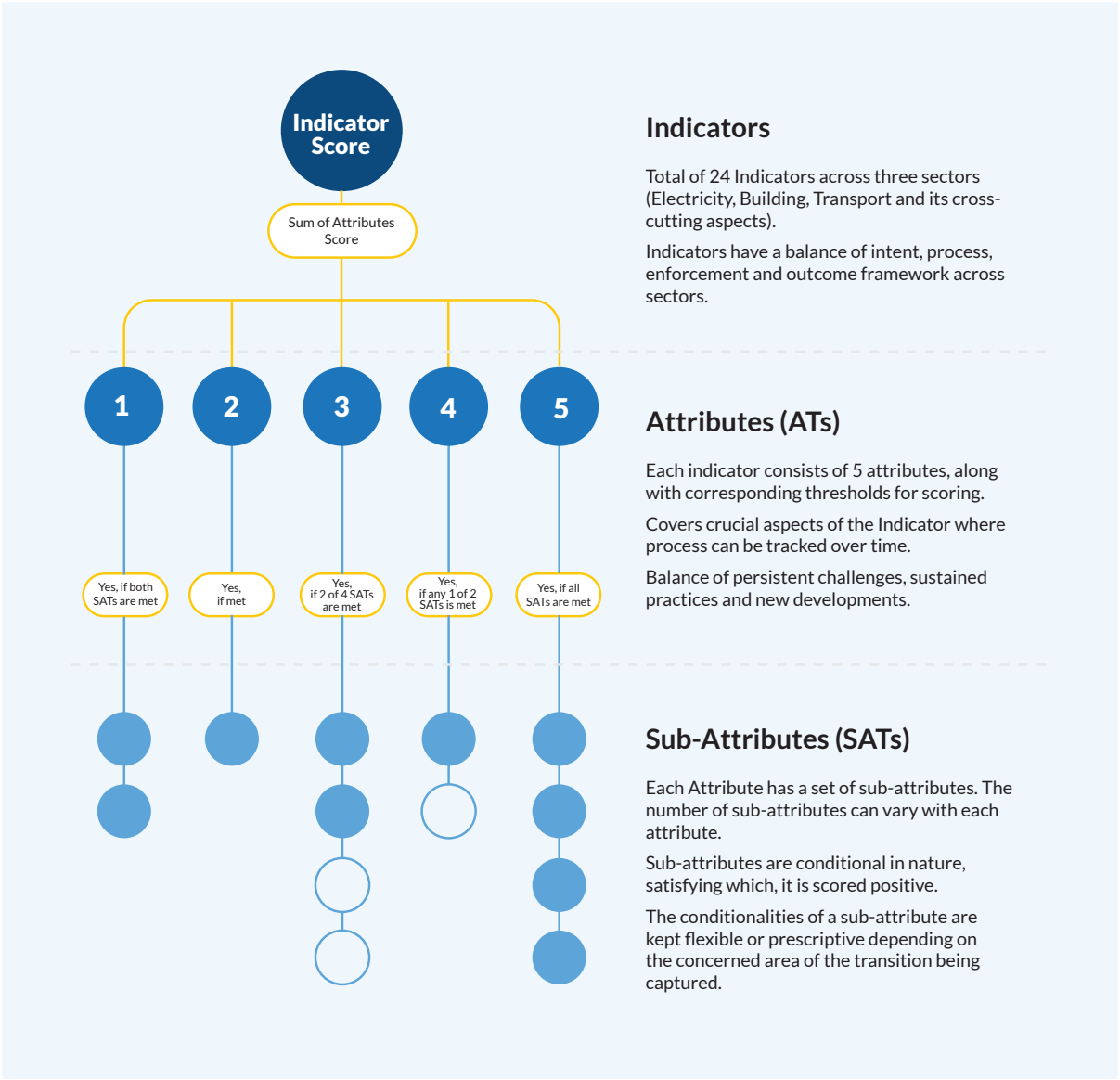


Figure 1: Structure of indicators and scoring

The attribute scores are based on sub-attributes, which vary in number across indicators to capture different dimensions at the state level. The thresholds for each sub-attribute are based on normative criteria that will remain the same in subsequent assessments. They are assigned based on state-level pilot assessments and vetted based on feedback from sector experts.

This guidebook is organised into four main sections around the sectoral and crosscutting indicators.

Section I covers the electricity sector, which is central to the energy transition and low-carbon development. While the electricity sector is set to change radically in the coming decade, it is still straddled with chronic

challenges and inefficiencies. The indicators assess measures taken to aid transparency in procedures, performance accountability, and investment in state institutional capacity toward an effective and equitable transition. There is a particular focus on measures to increase renewable energy penetration, management of coal thermal capacity, grid preparedness of the state, and demand-side management measures in the state. The indicator set also looks at state ambitions, the presence of planning processes, the financial health of electricity distribution companies (discoms), the availability of cost-competitive power for industries, effective regulatory oversight, and measures to ensure affordable and reliable supply for rural and small consumers.

Section II covers indicators for the transport sector. Energy demand from the transport sector has increased drastically in the recent decades, with petrol demand increasing at an 8.9 percent compound annual growth rate (CAGR) and diesel demand growing at a 3.9 percent CAGR between 2009–10 and 2019–20 (PPAC 2023). This has led to a significant increase in emissions from the transport sector. Therefore, decarbonisation of the transport sector is critical and consequential to India's energy transition as well as for meeting its climate commitments, addressing local air pollution, and managing energy import dependency. The indicators track accessibility, development, and performance of public transportation, sustainable vehicle growth and road safety, and integrated policy and governance of the transport sector. The focus is on those aspects that states are primarily responsible for such as road transportation, vehicle governance, and inter- and intra-city transport services. Given the disproportionate concentration of road transport networks and vehicles in urban centres, many of the attributes and sub-attributes in this indicator set have an urban focus.

Section III covers buildings as a key source of growing energy demand in India. The clean energy transition and energy efficiency, including the energy efficiency of buildings, should go hand-in-hand. This indicator set tracks the ambition and outlook of state decision-makers, and the commitment capacity and preparedness of state-level agencies, to support the transformation of the buildings sector through energy efficiency and integration of renewable energy. The set assesses measures undertaken to streamline processes, compliance with directives, investments in institutional capacity, and progress toward aspirational actions needed. The focus is on Energy Conservation Building Code (ECBC) compliance, Eco Niwas Samhita (ENS) preparedness, grid-connected rooftop solar photovoltaic (PV) and solar water heaters, energy-efficient appliances and equipment, public buildings, and affordable housing projects.

Finally, S**ection IV covers crosscutting aspects** relevant to energy transition preparedness across the above three sectors. India's energy transition is driven by a complex set of parameters—development, technology cost, and climate mitigation. State-level low-carbon development plans and climate

strategies become critical to understanding state preparedness for the energy transition. There are three indicators in this section which track and analyse state-level planning, frontline capacity, and just transition.

Intended use of this guidebook

This guidebook is designed as a resource for stakeholders in the energy space to understand sector trends and information gaps and support informed, agile, and time-sensitive decision-making. For any state, the indicators in the guidebook can help develop a comprehensive, robust dataset with 286 parameters covering major developments in three sectors. We developed this indicator set to be relevant in the medium term to assess state-level developments and transition-related progress.

The indicators were designed to comprehensively capture state-level plans, actions, and governance processes on an annual basis in the context of state practices and realities to promote cross-learning. They were not designed to rank or compare states and are thus not suitable for such an exercise. Further, the indicators were designed as a composite set to capture multiple facets in a sector. As such, they should be assessed collectively and in relation to each other.

We expect that relevant stakeholders will be able to assess the energy transition preparedness of Indian states not covered in this guidebook. This guidebook can also be used by other countries after adjusting for the local context. Our goal is to communicate the importance of the energy transition and help relevant stakeholders track progress toward it. We also want to highlight certain actions by policymakers and decision-makers that are important for achieving the energy transition.

ELECTRICITY INDICATORS

The indicators capture the legacy challenges, ambitious goals and critical importance of a sector at the forefront of the energy transition.

The electricity sector is set to see a rapid transformation in the coming decade, driven by falling renewable energy prices, changes in the technology landscape, and the environmental imperative. At the same time, the sector is straddled with chronic challenges and inefficiencies which constrain effective, cost-optimal, and accelerated shifts. These include poor financial health of the sector, particularly the discoms; significant challenges with supply quality; metering and billing issues; sustained technical and commercial losses; and inefficient investment planning and power procurement. While addressing these challenges, the technology-driven transition could also spur the electrification of other end uses, a widening and deepening of electricity markets, decentralised generation, digitalisation of processes, reduced dependence on coal-based capacity, and an evolution of new business models for sector operations.

Thus, the transition toward increased reliance on renewable energy is complex and multi-dimensional. Accelerated transition efforts which address several techno-economic, political, and equity considerations will take place only if the long-term vision, planning processes, existing oversight mechanisms, incentive structures, and sector governance structures are gearing up the sector for such changes. Right now, state-level institutions seem to be mostly responding to technology and market changes rather than investing in and driving sector changes.

This indicator set tracks the ambition and outlook of state decision-makers and the commitment capacity and preparedness of state-level agencies to accelerate the transition within the electricity sector. The indicators assess techno-economic, regulatory, policy, financial, and pro-poor transition-oriented actions in the state sector. The indicators also assess measures taken to aid transparency in procedures, accountability for performance, and investment in state institutional capacity toward an effective and equitable transition in the state electricity sector.

The focus is on measures to increase renewable energy penetration and manage coal thermal capacity. However, the indicator set also looks at state ambitions, the presence of planning processes, the financial health of discoms, the availability of cost-competitive power for industries, attention to grid strengthening and metering, effective regulatory oversight, and measures to ensure an affordable and reliable supply for rural and small consumers.

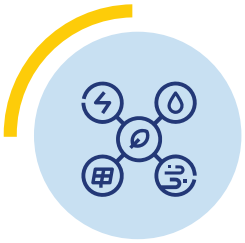
While many of these indicators and attributes track broad state-level progress, some focus on the preparedness of state-level agencies, such as regulators and utilities. In states where there are multiple discoms, the indicators cover only those discoms with at least 15 percent of state-level demand in the selected states as seen in 2018-19. These discoms are referred to as assessed discoms in the indicators, and the list of assessed discoms is available in Annexure 1. Scoring is based on

compliance of all the assessed discoms in a state.

The attributes were selected based on data availability and appropriateness given the local context. Thresholds and benchmarks for scoring were developed based on existing data and our understanding of sector trends. The annual indicator-based assessment will be based on publicly available data from regulatory orders, petitions, audited accounts, other statutory data provided by utilities, and documents published by state and central government institutions.

List of indicators for the Electricity Sector

E1. Long-term vision for electricity sector transition



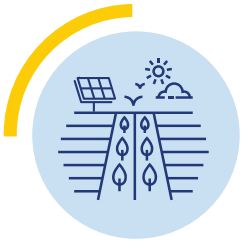
E2. Development of renewable energy and electricity storage

E3. Management of coal thermal capacity

E4. Integrated resource planning

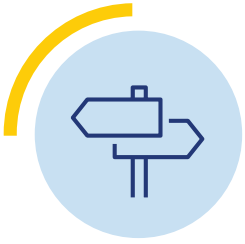
E5. Demand side management

E6. Financial health of electricity distribution companies



E7. Electricity demand and supply for agriculture

E8 .Affordable and reliable supply for small consumers



E9. Access to competitive supply alternatives for industrial and commercial consumers

E10. Preparedness of state-level transmission and distribution network

E11. Regulatory governance and processes

INDICATOR E1:

Long-term vision for electricity sector transition

India has set ambitious and progressive targets at the national level for a transition toward clean energy, with increasing attribution of climate action goals to this transition. Subsequently, the states have developed policies and plans on various aspects of the transition. While many states seek to align with the national aspiration and approach, there is significant variation in state-level plans, targets, and actions. While some states have attempted to create a coherent long-term vision-based action plan, others follow an ad hoc policy approach to achieving the transition.

A state-level vision for the electricity transition, backed by coherent mid-term sectoral policies and targets, is critical for achieving an effective and sustainable transition (Singh and Swain 2018; PEG 2016). With that normative basis, this indicator studies state-level plans and actions to assess if they constitute a long-term vision. We asked the following questions:

- If the vision is present, is it backed by clearly identified goals, strategies, and government support?
- Are medium-term sectoral and sub-sectoral policies progressive?
- Are there adequate processes for public consultation and monitoring?

Findings from this indicator assessment will bring clarity on the articulation and robustness of state-level intent to transition toward cleaner energy. The assessment can be done using the attributes and sub-attributes in Table 2.

Table 2: Electricity indicator 1: Long-term vision for the electricity transition

S. No	Attribute (Score: Yes =1, No = 0)	Remark
E1.1	**The state has a long-term vision for the electricity sector.** (Yes, if both are met) a. The state government/cabinet has approved a long-term vision or policy within the past five years. b. The vision covers topics such as long-term policy approaches on power procurement, demand-side management, clean energy transition, adoption and promotion of new technologies, emissions reduction, affordability, safety and quality of supply, and service to consumers.	• It is necessary to track whether the state government has formulated a coherent and comprehensive plan that considers the dynamics of the power sector. • The approval of the state government/ cabinet is important in ascertaining whether the said vision has political commitment. • The medium term is considered to be 5 years and the long term, 10 years. However, considering the importance of the 2030 milestone in India's energy policy, any plan, projection, or target for 2030 will be considered long term, even if falling short of 10 years. • The document has been approved by the cabinet and gives a comprehensive view of the sector.
E1.2	**The vision is backed by clearly identified goals, strategies, and government support** (Yes, if any two are met) a. The state has set targets toward the long-term vision.	

S. No	Attribute (Score: Yes =1, No = 0)	Remark
	b. There are specific milestones for financial turnaround of discoms or the state electricity sector. c. The functions/responsibilities of various state institutions (government departments, state-owned utilities, regulatory commissions) in achieving the specified goals or the vision are clearly articulated. d. Broad direction of government support (e.g., in terms of tax incentives, tariff support, grants, investment support, measures for enabling markets, competitive bidding) to meet goals of the transition-oriented vision is specified.	• The targets could include, for example, trajectories for capacity addition, demand-side management, use of storage applications, and electric vehicle penetration. • The underlying analysis for arriving at the targets should be clearly specified.
E1.3	**The vision was developed through a public consultation process.** (Yes, if both are met) a. The draft vision document was put together by a committee which included non-governmental representatives, or stakeholder consultations were held as part of draft vision development. b. Written responses were provided to comments raised during the public consultation and both are available in the public domain.	• Public consultation with adequate time for comments and recording comments and objections are necessary. • Three weeks are typically provided to respond to regulatory and policy documents.
E1.4	**The long-term vision has mechanisms to monitor its progress.** (Yes, if both are met) a.Monitoring mechanisms are specified in the vision document to track progress and for annual public reporting of specific parameters for achieving the long-term vision. b. The State Electricity Regulatory Commission (SERC) or the state energy department plays a major role in the monitoring process. .	• Involvement of the state energy department or the SERC is indicative of how much importance the process is given. • Monitoring should include periodic reporting of progress and mid-term review of progress based on an impact analysis. • Tracking should be publicly reported to aid accountability.
E1.5	**The state has progressive medium-term policies with specific goals and targets:** (Yes, if all are met) a. The state has introduced sectoral/ sub-sectoral policies with specific goals and targets. b. There are provisions to review the sectoral/ sub-sectoral policies to assess progress and make mid-course corrections if necessary. c. Public or stakeholder consultations were held for some of these medium-term sectoral/sub-sectoral policies.	• The long-term vision needs to be supported with medium-term sectoral policies. Even in the absence of a long-term vision, good medium-term sectoral policies can bring about substantial progress in the sector. • Sectoral or sub-sectoral policies include those related to renewable energy, electric vehicles, industrial policy, energy efficiency, and storage, among others. • Programmes include state government capital subsidy programmes, revenue incentive programmes, and debt restructuring schemes, among others.

INDICATOR E2:

Development of renewable energy and electricity storage

India's ambitious RE targets of 175 GW by 2022 and 450 GW by 2030 are expressions of a political commitment at the national level to increase the RE share in India's energy mix. Despite the policy commitment and competitive prices, RE development is still contingent on efforts taken by discoms to procure RE. While the economics are set to drive long-term RE capacity addition, policy push is still needed in the medium term to accelerate the transition toward clean energy in a just,[i] cost-optimal manner.

The status of and compliance with renewable purchase obligation (RPO) targets is an ideal measure to gauge overall state-level commitment and procurement. By FY2021-22, about 13 percent of the total annual electricity generation in India was attributable to RE sources (CEA 2022). An RPO is a statutory requirement that is currently the primary driver of RE capacity addition for discoms because it mandates purchase of a fixed amount of electricity from RE. RPO targets are scale agnostic (can be centralised or decentralised), enforceable, and revised periodically.

RPO targets are specified by the SERC, in line with national RE commitments and state policies. There are separate targets specified for purchase from solar and non-solar sources. Non-solar includes energy from wind, bagasse, small hydro, and municipal solid waste. Many states have aligned their RPO targets with the trajectory notified by the government of India in June 2018 and are likely to align their targets with the national targets stipulated for FY 2029-30 (MoP 2018; 2022). The SERCs play a crucial role in not only setting targets and tracking progress but also ensuring compliance by issuing directives and imposing penalties. Regulatory oversight in this regard is also tracked in this indicator.

In addition to setting RPO targets, efforts to integrate solar and wind generators while maintaining grid security are required. These include creating a regulatory framework to encourage forecasting exercises for better scheduling of variable solar and wind power. Further, measures to increase transparency in procedures and reporting of instances of curtailment of RE are also captured.

While the push to meet RPO commitments by discoms, increased procurement of RE by consumers, measures to improve forecasting and scheduling, and increased utilisation of RE capacity are beneficial, accelerated RE deployment is also contingent on the pace of adoption of electricity storage technologies, especially modular and scalable battery-based electricity storage systems. Recognising this, many states have initiated pilots and bidding processes for storage investments. In July 2022, the government of India specified annual targets for storage (on an energy basis) such that by 2030 the target is 4 percent of energy consumed (MoP 2022). Many states are currently in the process of adopting this trajectory in their state regulations. This indicator also captures initiatives by 'early mover' states in the storage space as such initiatives (i.e., investments in pilots, specification of targets) accelerate on-ground deployment and demonstrate scalability and robustness of technology, and business models, that would be fundamental to large-scale storage investments and a reduction in storage costs before 2030. The criteria researchers can use to assess the development of renewable energy and electricity storage are in Table 3.

Table 3: Development of renewable energy and electricity storage

S. No	Attribute (Score: Yes=1, No=0)	Remark
E2.1	**Commitment to RE procurement in the assessment year is comparable to the national aspiration.** (Yes, if met) a. RPO targets set by the SERC are at least 90% of the national-level RPO target for the assessment year.	• RE procurement by discoms is still contingent on RPO compliance. Hence, there is a need to track adequacy of the state-specific solar and non-solar targets in accelerating the transition as compared to the national commitment.
E2.2	**RE procurement by the discoms complies with the state target.** (Yes, if met) a. Discoms comply with at least 90% of the target set by the SERC.	• Compliance of the discoms with solar and non-solar targets is tracked. This would account for the majority of the RPO compliance in the state.
E2.3	**In the case of non-compliance, the SERC has taken necessary action as stipulated in the regulations.** (Yes, if either is met) a. The assessed discoms comply with targets in accordance with SERC regulations. b. The SERC has imposed penalties in the case of non-compliance by discoms in accordance with the regulations.	• Our intention is to track regulatory action to ensure compliance. • Action in the case of non-compliance should be in accordance with SERC regulations. • Carry forward can be considered if explicitly allowed by the SERC in accordance with its regulations. • Penalty is often issued in compliance orders.
E2.4	**Steps/policies to encourage better utilisation of wind and solar exist.** (Yes, if any two are met) a. The SERC has notified forecasting and scheduling (F&S) regulations. b. The State Load Dispatch Centre or the SERC has taken steps to ease implementation or issued reports on the status of implementation of F&S regulations for wind and solar. c. The SERC has provided a clear framework regarding the process for curtailment, its necessity, and its reporting. d. There is tracking and transparent public reporting of instances of curtailment in the state by the State Load Despatch Centre, discoms, or the SERC.	• Major drivers of RE are wind and solar, which are known to be variable/ intermittent. Processes to encourage better forecasting and scheduling will help with grid integration. • This parameter tracks publicly reported steps taken by the State Load Despatch Centre or SERC to implement regulations. • The framework for curtailment is provided by the SERC through an order or regulation such that it is applicable to the entire state.

E2.5	**Steps have been taken to encourage the adoption of storage.** (Yes, if either is met) a. The SERC has published draft/finalised regulations that specify storage purchase obligations. b. The state has undertaken pilot projects to establish battery-based energy storage systems.	• Our objective is to recognise state initiatives that spur investment and deployment of energy storage systems as a necessary complement to their ambition to promote RE. • The storage purchase obligation can be technology agnostic, but the pilot projects should recognise 'early movers' piloting battery-based energy storage systems to test for implementation challenges with, encourage further investment in, and reduce costs for such modular, scalable options.

INDICATOR E3:

Management of coal thermal capacity

The tariff for renewables—particularly solar and wind—is less than ₹3.5/unit and is expected to continue to fall (PEG 2016). In contrast, the average cost of electricity generation from coal-based capacity commissioned after 2015 has been around ₹4 per kilowatt-hour (/kWh) and is increasing (MoP n.d.). Although the discovered prices for solar are not directly comparable with the cost of coal-based generation, the price trend is nonetheless instructive. Going forward, the economic viability of coal will reduce. A commitment to coal-based capacity addition, especially to meet baseload, long-term power requirements, should ideally be avoided. Long-term contracts could lead to stranded assets and resource lock-ins for the discoms. Since most states have significant baseload capacity, it is imminently possible (with investments in storage technologies) to manage demand growth without adding new coal thermal capacity (PEG 2021a).

Along with the promotion and development of low-cost renewable energy power, it is important that existing coal thermal capacity, which is currently responsible for 70 percent of the power supply in India, is managed effectively in the transition (MoP 2021). This will help avoid such risky investments in the future and ensure a cost-efficient transition. Further, there should be a framework within the state to decide which plants should be considered for retirement and how to manage socio-economic impacts within the existing state's context.

Several modelling studies have shown that effective grid integration of renewables, especially with variability and intermittency inherent in more mature RE technologies such as wind and solar, would require the existing coal fleet to be more flexible and efficient. Flexibility would require coal plants to operate with multiple starts and stops and at lower plant load factors and lower technical minimums and would also require faster ramping of generation to meet changes in demand (in a high RE system where availability of RE can change diurnally). At the same time, thermal plants should ideally be efficient given the rising cost-competitiveness of other technologies and availability of market options for short-term power procurement. This indicator measures if most of the states' contracted capacity, irrespective of ownership, is prepared for flexible, efficient operation while mitigating some environmental impacts.

To move toward decarbonisation and a high RE future in a cost-optimal manner without sustained power shortages, it is critical that management of coal thermal capacity is given importance in planning, monitoring, and practice. This should ideally be accompanied by a demonstrated commitment to not contracting baseload coal capacity and planning for retirement of existing capacity based on techno-economic and environmental considerations. Table 4 denotes criteria to assess the management of coal capacity.

Table 4: Management of coal thermal capacity

S. No	Attribute (Score: Yes=1, No=0)	Remark
E3.1	**Regulatory measures exist to encourage cost-optimal and flexible operation of contracted coal-based power stations.** (Yes, if all are met) a. There is a framework for Merit Order Dispatch specified by the regulator and the merit order is periodically reported on discom/State Load Despatch Centre websites in a transparent manner. b. The appropriate commission has specified a compensation framework for part load operation of contracted coal-based plants. c. There is regulatory scrutiny (cost, tariff impacts, impact on the demand-supply mix due to unrequisitioned capacity) reported by discoms under assessment. d. The appropriate commission has stipulated that coal-based generation capacity is to be able to operate at a technical minimum of 55% or below.	• This will be applicable to all contracted capacity in the state. • The Central Electricity Regulatory Commission (CERC) would be the appropriate commission for inter-state plants. Scoring is to be awarded only if provisions exist under the CERC and SERC when there are within-state and out-of-state capacities. • Part load operations of thermal capacity is a defining characteristic of the transition with demand uncertainty and renewable energy uptake. • Compensation for operating at lower load factors, multiple start-stops, a stipulated procedure for dispatch based on economic principles, and scrutiny of capacity available but not dispatched will optimise operations. • The ability to operate at lower technical minimums allows for effective grid integration of RE.
E3.2	**Assessed coal thermal plants in the state operate in an efficient manner.** (Yes, if both are met) a. At least 90% of the contracted capacity by assessed discoms shows availability greater than or equal to the normative availability stipulated by the appropriate regulator. b. Regulatory vetting of coal quality, availability, and costs takes place for the majority of the cost-plus contracted generating stations.	• The intent is to track whether contracted capacity is efficient. Thus, the parameter is being evaluated for in-state and out-of-state capacities. • In terms of vetting coal quality, price, and availability, this typically takes place for cost-plus capacity.
E3.3	**There are actions toward adhering to emission norms stipulated by the Ministry of Environment, Forest and Climate Change.** (Yes, if both are met) a. In the past two years, most of the coal capacity contracted by the assessed discoms has a new/revised plan for the installation of pollution control equipment submitted to the appropriate regulatory commission and is available in the public domain. b. The appropriate commission has provided regulatory dispensation to address cost impacts due to the installation of pollution control equipment for both cost-plus and competitive projects under its jurisdiction.	• The plan submitted by the assessed generating company to the appropriate SERC should at least include station-specific timelines and the type of pollution control equipment to be installed.

S. No	Attribute (Score: Yes=1, No=0)	Remark
E3.4	**Actions have been taken to limit future addition of coal-based capacity.** (Yes, if any two are met) a. The coal-based capacity in the pipeline is limited to replacement capacity such that the net capacity addition is limited or negative. b. The state government has announced that there will be no more coal-based capacity addition beyond the existing pipeline, or the SERC has decided to defer approval of capacity addition based on the current demand-supply situation. c. In the past three years, the state government or the SERC has formally abandoned coal power plants at the pre-construction stage where not much progress has been made. d. Discoms have taken steps to surrender central/state sector coal-based capacity from upcoming plants.	• Limited net capacity addition in the past three years implies that capacity addition is less than 10% of the total contracted capacity of the discoms under assessment. • Commitment to reducing coal-based capacity should be based on a formal announcement or government/regulatory order.
E3.5	**Plans for capacity retirement are analysis-based.** (Yes, if both are met) a. There is a comprehensive, publicly available framework in the state being used for the techno-economic assessment of value of cost and alternatives for those units which have completed either 25 years or the PPA term, whichever is later. b. There is a framework or mandate in the state for provision of a publicly available action plan or there is documented clarity on the retirement schedule and how site restoration and repurposing as well as socio-economic impacts will be addressed.	• The techno-economic assessment should include aspects such as the contribution to capacity of better grid integration of renewables, economic cost of capacity and cost of potential alternatives, and the potential for installation of pollution control equipment, among others. • The action plan could include detailed environmental restoration of the site, especially reclamation of the land, water bodies, and air quality, and ensure management of waste and infrastructure associated with project operations. It could also include actions to address socio-environmental impacts of plant closures (including, for example, addressing environmental impacts during operation, loss of livelihoods) • The Central Pollution Control Board has published draft guidelines for closing thermal plants. Once these are finalised, the action can be evaluated using those guidelines. • Action on restoration and repurposing is relatively new and states are in the learning stage.

INDICATOR E4:

Integrated resource planning

Integrated resource planning (IRP) is the process followed by discoms when preparing a detailed plan for meeting the future energy requirements of their consumers, while ensuring cost-effective investments, risk minimisation, and compliance with environmental and policy goals.

While electricity resource planning is done by the discoms and approved by the state regulators, the process is often guided by the central projections on energy requirements[ii]. Along with state-level commitments (e.g., toward higher industrial growth, longer hours of supply for agricultural consumers, commitment to 24x7 supply to consumers), periodic central government policy guidelines, backed by fiscal incentives, have also shaped state- and utility-level resource choices.

Robust IRP processes and practices are critical to the energy transition in many ways. First, they not only help optimise use of economically and environmentally efficient resources, but also identify resources that can be retired for larger gains. Second, IRP processes help in diversifying the energy mix toward cleaner resources, and exploring demand-side resources and transmission needs. Third, IRP processes are instrumental in managing transition-induced uncertainties. Managing these uncertainties requires an agile framework to plan electricity resources. Finally, progressive attribution of environmental/climate objectives to the electricity sector requires greater planning, coordination, and monitoring at different levels, which can be achieved through IRP.

This indicator seeks to track and assess IRP readiness in states by analysing states' current practices and engagement with energy transition objectives: Are the power procurement and resource planning processes followed by discoms in sync with energy transition goals?

States have adopted and evolved different processes to conduct IRP and have varying objectives, consider different time periods, and use different terminology to detail the process. The focus of this indicator is to check for any long-term (at least 10 years) plan to forecast demand and plan supply/investments from various resources and technologies for the discoms. As the primary load-serving entity and manager of wires, much of the planning decisions rest with the discoms. The indicator assists in assessing the status of integrated resource planning and, as indicated in Table 5, checks for the following:

- **The presence of a regulatory mandate for such a plan:** The mandate for approving costs and scrutinising the performance of distribution companies lies with the state regulator
- **The presence of a recent plan approved by the regulator:** Such that the plan is approved through a participatory, transparent regulatory process
- **Robustness of the plan from an energy transition perspective:** To ascertain if changes in technology, uncertainty in demand, and the potential for new technology have been considered through various scenarios, scientific modelling exercises, and sensitivity analysis rather than thumb-rule planning approaches
- **Clarity on the implications of the plan:** Such that the investment requirement, resources required, and consumer cost/tariff impact are clearly articulated, ideally for various options deliberated in the planning process; also checks if progress as per plan targets and commitments are periodically monitored
- **IRP based procurement:** Use of plan to approve power procurement such that future power procurement is part of the IRP and approved on the basis of an IRP exercise

- **Investment planning through competitive processes:** Existing cost-plus regulatory approaches do not provide the incentives to ensure timely, cost-effective completion of work; competitive bidding, if implemented in letter and spirit, would be better for many investments to ensure cost-optimal price discovery; the indicator thus tracks if required investments to meet demand are based on technologies amenable to competitive price discovery and made through competitive bidding rather than cost-plus processes

Table 5: Integrated resource planning

S. No	Attribute (Score: Yes=1, No=0)	Remark
E4.1	**The regulatory mandate and process for the IRP are clear if regulations stipulate the following:** (Yes, if all are met) a. Mandate for all distribution licensees to provide a resource plan (or demand and supply projections) for 10 years for SERC approval b. Stipulation that all assumptions and data used in the resource plan are available in the public domain c. Requirement that the resource plan is revised at least every three years and approved by the commission d. Specification that all long-term power procurement would be based on an approved, periodically monitored plan from the SERC	• IRP processes have been emphasised in power procurement planning in India for over a decade. However, not all states have clear regulatory mandates toward periodic approval of demand and supply projections of utilities. • The plan may be called a resource plan, a capital investment plan, or a business plan. A plan which has projections and planning done for 10 years or more will count. • This attribute checks if the regulatory commission, which is responsible for approving investments, power purchase agreements, and pass through of cost impacts, stipulates in its regulations that such a process is conducted on a regular basis over a 10-year period and ensures that the plan is revised to account for technological/policy changes in a sector undergoing transition-related flux.
E4.2	**The plan has recently been approved through a transparent, participatory process and is used for procurement decisions in the state.** (Yes, if all are met) a. The resource plan has been approved or revised in the past three years. b. Petition, data, and assumptions are publicly available for the resource plan and approval takes place through a public consultation process. c. Ten-year demand and supply projections in the resource plan include source-based supply projections as well as separate projections for base and peak load. d. No approval for power procurement is provided by the SERC unless the project is part of the approved plan.	• This indicator is used to check if the IRP process is indeed being followed. If the plan is not used while assessing requirements of specific projects, it remains a paper tiger. Thus, it is important to check if projects are approved only if they are in line with the plan.

E4.3	**The latest approved resource plan is based on transition-oriented assessment methodologies and clearly articulates potential options.** (Yes, if all are met) a. The resource plan states well-defined priority areas, targets, and goals which it would seek to achieve. b. Scenario building and sensitivity analysis for demand and supply projections based on advanced modelling techniques are part of the plan. c. Demand and supply projections incorporate RPO targets, variability of RE, projection of various new end uses, operational characteristics of different resources, the impact of sales migration or solarisation of agriculture, use of storage options, capacity planned/contracted/under construction in the pipeline, and capacity retirement schedules. d. The decisions recorded in the approval order are based on the assessments and adequate evidence and justification is provided.	• The intent is to check if the process itself is comprehensive and captures the status and future trends/scenarios to aid in cost-effective decision-making. • The list for demand and supply projections can change based on the state context but the idea is to see if major transition-oriented changes which affect load shape demand and if potential supply options are captured. For sub-attribute c, the demand and supply projections should include at least six of the eight specifics listed.
E4.4	**To articulate the result of the IRP exercise, the order clearly states the following:** (Yes, if all are met) a. Capacity requirement, if any, along with technology type/source requirements b. Estimate of investment requirements and/or potential tariff impact due to investment requirements c. Directives, targets, or measures toward meeting future requirements in a cost-optimal manner d. Provision for monitoring progress vis-à-vis plans	• A clear monitoring process and articulation of impacts (in terms of increase in tariffs, investment requirements) are necessary. Ideally, this assessment should also be there for multiple scenarios considered in the exercise, but the IRP process may not be available.
E4.5	**Future power procurement is based on transparent, competitive processes.** (Yes, if both are met) a. All power purchase agreements (PPAs) (except in the case of nuclear and hydropower) signed in the assessment year are procured based on competitive bidding. b. Regulatory approval of contracts signed in the assessment year has undergone a public consultation process.	• Competitive bidding is transparent and, unlike cost-plus processes, helps discover more efficient prices. To ensure least-cost investments, it would be useful if capacity addition in the future is based on transparent competition, especially for technologies where this is possible. • Most future capacity addition is for renewable energy which is mostly competitively bid. However, in many states the approval of such contracts does not take place through a public consultation process, which involves regulators seeking comments on the salient features of the proposed agreement or arrangement for power procurement and the impact on the utilities' power procurement cost and tariff. This should be conducted for approval of RE PPAs as well. Even if the quantum is small, public participation should be allowed for approval.

INDICATOR E5:

Demand-side management

Demand-side management (DSM) has a key role to play given India's electricity sector transition goals involve higher integration of RE while ensuring reliable, affordable supply to all. The share of variable and intermittent RE is increasing, making it imperative to shift the load as much as possible where RE availability is high. Further, an increase in demand for cooling from residential, commercial, and industrial sectors and additional energy requirements for increasing water heaters, electric vehicles, and induction cook-stoves, among others, will make the utility load curves peakier and uncertain. This enhances the role of DSM in balancing the grid in a least-cost manner. Finally, increasing digitalisation is enabling more sophisticated and reliable DSM programmes, leading to increased uptake by the utilities. For example, smart meters being installed as a part of the national roll-out programme can record granular data on electricity consumption and price sensitives, and reliably compute the outcome of the DSM programmes.

Demand-side management can include tariff and non-tariff measures as well as utility- or market-driven strategies. With market development, bulk procurement programmes, and advances in metering technologies, market- and tariff-related measures get policy attention. However, utility-scale, non-tariff DSM programmes which have significant potential to manage and shift demand through incentives are often neglected. This indicator tracks discom activities and progress for all non-tariff programmes as well as regulations which promote utility-driven DSM efforts that can potentially change the energy and load patterns of consumers. The scale of the DSM programmes has so far been limited in India for multiple reasons such as a lack of priority, lack of regulatory/policy incentives, and lack of innovative and reliable business models. However, this can change significantly due to aforementioned reasons. Hence, DSM is an important indicator to track and gauge the success of the impending transition, which can be done using criteria provided in Table 6.

Table 6: Demand-side management

S. No	Attribute (Score: Yes=1, No=0)	Remark
E5.1	**Energy efficiency (EE)/DSM plans have specific targets.** (Yes, if both are met) a. The state government or SERC has prescribed specific targets for all the discoms in terms of avoiding peak capacity and/or savings in energy. b. Discoms have submitted DSM plans in their latest MYT petitions with clear targets.	• Targets may be a part of the state's energy policy document or specific energy conservation/ efficiency policy document, or a separate order issued by a SERC. • A broad target, along with sector-based targets, is preferred. • Targets shall be both end-of-the-policy-period targets, e.g., 2030, and annual targets till the end.

E5.2	**Regulations exist to facilitate EE/DSM. These should cover the following:** (Yes, if any two are met) a. Broad DSM implementation framework b. Cost-effectiveness framework c. Evaluation, monitoring, and verification framework d. Mandate for consumer engagement for DSM programmes requiring consumer participation	• There may be one consolidated regulation or multiple regulations or orders that cover all the aspects. • In cases where there are demand response, appliance replacement, and behavioural intervention schemes, there should be specific programmes to increase awareness.
E5.3	**Adequate financial resources are available to meet the EE/DSM targets.** (Yes, if either is met) a. The state has identified the budget required to meet the targets and allotted at least 75% of the annual requirement identified in the energy efficiency policy to the state designated agency. b. Discoms have spent (consider whichever is higher): i) At least 0.2% of their annual revenues toward DSM programmes or ii) 75% of the annual requirement identified to meet their DSM target	• Adequate financial resources are crucial for large-scale implementation of EE/DSM.
E5.4	**Targets are being tracked and non-compliance is penalised.** (Yes, if both are met) a. The discoms have submitted a report on their EE/DSM programmes and compliance report on evaluated savings with the targets. b. The SERC has assessed the reported savings by the discoms and imposed penalties in case of discom non-compliance.	• Discoms may submit an annual report of their EE/DSM activities in their tariff petitions. There may also be a separate report submitted to the State Designated Agency (SDA).
E5.5	**Periodic end-use research is being conducted, enabling better design of DSM programmes.** (Yes, if either is met) a. SDAs/discoms are conducting load research at least once every three years to assess consumer category wise load profiles. b. SDAs/discoms are conducting market research and/or incentivising energy audits of consumers.	• Demand patterns for various consumer categories will have crucial information on appliance use and consumer behaviour. Research and analysis of these data can aid various tariff and non-tariff measures to reduce or shift loads. Check discom tariff petitions or SDA reports, and compliance with SERC directives.

INDICATOR E6:

Financial health of electricity distribution companies

Without a financially viable discom, it would be challenging to ensure affordable, reliable supply to consumers, adopt new technologies, provide confidence to investors with respect to payment certainty, and commit to decarbonisation efforts through forward-looking innovation. In FY20, the accumulated losses of electricity utilities amounted to ₹4.5 trillion, comparable to 8 percent of the state and union budget size and 2 percent of GDP (MoP 2020). This was the status five years after the last power sector bailout—UDAY (Ujwal Discom Assurance Yojana), with an outlay of ₹2.65 trillion, was launched to aid financial turnaround of the discoms (MoP 2018).

The metrics typically tracked to assess discoms' financial health do not comprehensively capture their financial status. For example, 'aggregate technical and commercial losses', one of the key elements to a discom's performance metrics, does not present a comprehensive picture as line losses are often underestimated due to challenges with metering. In addition, the veracity of reported data is seldom checked with energy audits. Further, loss estimation methodologies are not standardised across states, leading to a possible four to five percentage point variation in Aggregate Technical & Commercial loss estimates based on methodology alone (PEG 2019). Another often-used statistic is the 'outstanding dues to generators'. While this captures the risk to generators, it does not consider the financial predicament of discoms as the issue can be mitigated with short-term borrowing without addressing larger distress.

To track discoms' financial positions, this indicator assesses the extent to which working capital or short-term borrowing is used to meet short-term crises, which enables discoms to postpone fundamental efforts required for financial turnaround of the sector and, thus, cannot be a sustainable practice. It also tracks revenue gaps for the assessed year as well as cumulative revenue gaps which together provide a comprehensive picture of the amount to be recovered from consumers through tariffs or to be compensated via subsidies. Dependence of the discoms on subsidies and cross-subsidy support, timely payment of subsidies and bills from the government and delays in payment from consumers are also covered in this indicator. It is of course critical that the state government's political commitment toward the subsidy is matched by its fiscal ability to provide the subsidy. Sustained delays in payment of a committed subsidy indicates that this is not the case. The sufferer in such a case is the discom which in the absence of subsidy compensation would have to rely on short-term borrowing to cover day-to-day expenses.

Discoms tend to overestimate unmetered demand and thus underestimate line losses (PEG 2018a). To assess changes in power theft and technical line losses, it would be more appropriate to see a reduction over time of unaccounted energy. Unaccounted energy consists of estimated unmetered energy consumption and line losses reported by the discoms. If the share of unaccounted energy itself reduces over time, it speaks to better metering and energy accounting practices which will aid in cost reduction and therefore improve utility finances. Table 7 shows the criteria used to assess discoms' financial health.

Table 7: Financial health of electricity distribution companies

S. No	Attribute (Score: Yes=1, No=0)	Remark
E6.1	**There is transparent reporting and management of short-term debt.** (Yes, if both are met) a. There is clear and consistent reporting of working capital borrowing by the assessed discoms to the regulator. b. Borrowing to meet working capital requirements of all assessed discoms together is less than 25% of their annual expenses.	• Actual working capital borrowing is to be reported and recorded by the discoms each year to the regulator. Only then will it qualify as clear and consistent. • Short-term loans or working capital borrowing is to be restricted to 25% of the annual revenue requirement as per the conditions specified in the UDAY scheme.
E6.2	**There is transparent reporting and management of accumulated losses.** (Yes, if both are met) a. Regulatory approval of past revenue gaps has taken place in a clear and consistent manner in the assessment year b. The cumulative revenue gap together for all assessed discoms in the assessment year, carried over from previous years, is less than 15% of the annual expenses in the assessment year.	• Less than 15% indicates that the recovery of such costs is possible with significant efforts to reduce costs or increase tariffs or subsidies.
E6.3	**Discoms' dependence on subsidy revenue sources and annual losses are in check.** (Yes, if both are met) a. The subsidy contribution (government subsidy plus cross-subsidy) is less than 25% of the annual expenses of all assessed discoms taken together. b. The annual revenue gap is less than 5% of the annual expenses of all discoms assessed together.	• High dependence on cross-subsidy and subsidy is an indication that costs cannot be met through tariffs alone. This is measured as a percentage of discom expenses. • Five percent losses are in line with inflation and can be met with limited tariff increase in the future.
E6.4	**Energy losses are decreasing and there is sustained collection efficiency for revenue.** (Yes, if both are met) a. The sum of unaccounted energy (distribution losses and sales to unmetered categories) as a proportion of total power procured input has consistently reduced over the last three years for assessed discoms. b. The collection efficiency of all non-agricultural consumer categories over the past three years is on average more than 90%.	• Counting unmetered consumption as well as transmission and distribution (T&D) losses measures the effort taken by the discoms toward metering and better energy accounting practices. It ensures that low T&D losses are not seen as the only indicator for reduced losses. • In the same vein, it is crucial to track discoms' efficiency in collecting revenue in a timely manner from their non-agricultural consumers (which is easier as they are billed on time and metered).

S. No	Attribute (Score: Yes=1, No=0)	Remark
E6.5	**Government payments to discoms are disbursed in a timely manner.** (Yes, if both are met) a. Pending payments from public bodies are less than 10% of total consumer arrears in the assessment year. b. At least 90% of the subsidy promised by the state government in the assessment year was paid in that year.	• Revenue collection from consumers and arrears affects discom receivables. For some consumers, like subsidised agricultural consumers, this issue might take significant effort to resolve. However, for public bodies, the appropriate government can ensure timely payment. This attribute tracks timely payment in the year and the extent of arrears.

INDICATOR E7:

Electricity demand and supply for agriculture

Agriculture accounts for one-fifth of electricity demand in India, making it the third-largest consumption category (PFC 2022). Moreover, agricultural electricity supply and subsidies have been a weakness of the sector, often blamed for the financial distress in the distribution business. The impact of subsidy dependence and delayed payments is captured in Indicator 6. While mounting agricultural electricity subsidies and the competitive populism associated with them have been a long-standing pressure on the state exchequer as well as cross-subsidising consumers, farmers' access to free or subsidised power comes at the cost of unreliable and poor quality of supply.

Due to poor revenue recovery, the quality of supply and service as well as maintenance of networks in agricultural areas are often neglected by the discoms. This neglect contributes to the trust deficit, reluctance toward consumer-level metering, and poor revenue recovery. Transparent and periodic reporting of supply and service quality parameters in a disaggregated manner is the first step toward increasing accountability.

The transition to clean energy offers an opportunity to unwind this low-level equilibrium. Low-cost solar power, aligned with agricultural demand, offers the opportunity to manage subsidy demands as well as improve reliability and quality of supply to agriculture. Accordingly, the central government and several state governments have prioritised and supported separation of agricultural feeders and solarisation of power supply to farmlands through specific schemes [iii]. Both these interventions offer win-win solutions for all concerned stakeholders, including the discoms, state governments, paying consumers, and farmers, and balance the economic and political imperatives of the sector. Moreover, the solarisation of agricultural electricity demand, with the potential to decarbonise one-fifth of total electricity sales, is critical to expediting the electricity transition and providing daytime supply to farmers. This indicator seeks to assess state-level progress in implementing these interventions and the implications for the quality of supply to agriculture. It also tracks the extent of cross-subsidy support provided to agricultural consumers.

In addition to solarisation, metering and energy accounting of agricultural demand is crucial as a lack of adequate metering typically results in theft and technical losses being attributed as agricultural consumption (PEG 2018c). This is particularly the case as most states have agricultural consumers that are unmetered [iv]. This makes energy accounting, demand estimation, and consequently power procurement planning challenging. It would also be important to check if assessing agricultural demand, especially unmetered demand in the state, is based on rigorous study using consumer survey data or meter readings. This can be done using Table 8.

Table 8: Electricity demand and supply for agriculture

S. No	Attribute (Score: Yes=1, No=0)	Remark
E7.1	**Progress in feeder segregation and metering is on track.** (Yes, if both are met) a. More than 80% of identified feeders have been separated to ensure dedicated feeders for agricultural supply.	• Feeder segregation and remote metering is a prerequisite for installation of decentralized MW scale solar systems dedicated to agriculture at the feeder level and for better energy accounting of agricultural consumption.

S. No	Attribute (Score: Yes=1, No=0)	Remark
	b. More than 80% of the dedicated agricultural feeders are Advanced Metering Interface/ Automatic Meter Reading (AMI/AMR) enabled.	• Identified feeders can be based on assessments provided under the Revamped Distribution Sector Scheme.
E7.2	**The estimation of unmetered agricultural demand is based on a rigorous scientific study using metered data.** (Yes, if one is met) a. Feeder-level AMI/AMR readings from segregated/dedicated agricultural feeders; a widespread agricultural consumer survey conducted at least once in the past five years; or data from consumer-level meter readings of agricultural consumers	• The data for the survey and the readings should be representative (e.g., multiple zones, circles, agroclimatic zones, consumer types). • It is important that the sample size is sufficient, representative, and drawn from a wide pool. • The attribute tracks if the sales approved by the commission are based on studies using metered data.
E7.3	**The dependence of low-tension (LT) agriculture category consumers on subsidy and cross-subsidy is balanced.** (Yes, if met) a. The regulated tariff (including subsidy) for LT agriculture in the assessment year is at least 80% of the average cost of supply, in line with the national Tariff Policy.	• The national Tariff Policy prescribes that the cross-subsidy for any category should be less than 20% of the cost of supply.
E7.4	**Progress in the solarisation of the agricultural supply is on track.** (Yes, if either is met) a. At least 2% of the total grid-connected agricultural connections in the state have been solarised through decentralised schemes. b. There is a state scheme to shift agricultural demand toward daytime solar power through centralised RE procurement for agriculture.	• Decentralised schemes for solarisation can be through MW-scale, feeder-level efforts, and solar pump sets through state and central government schemes. • Centralised procurement of RE with the explicit intention of shifting agricultural supply to daytime can be considered.
E7.5	**There is public reporting of parameters regarding the quality of supply to agriculture.** (Yes, if both are met) a. There is public reporting of the DT failure rate for predominantly agricultural areas/ circles by all assessed discoms. b. There is public reporting of hours of supply to agricultural feeders in the discoms' areas.	• Reporting on website or in regulatory filings should be checked. • Reporting should be by all assessed discoms to score. • Predominantly agricultural circles can be assessed based on circle-based sales data. • Feeder-level or DT-level data reporting that are mapped to circles/agricultural sales can be used for scoring.

INDICATOR E8:

Affordable and reliable supply for small consumers

Cross-subsidy revenue in many states is now shrinking, with many large consumers migrating away from the discoms due to the availability of alternate supply through open access, captive, and grid-connected solar at competitive rates. On the other hand, due to existing techno-economic and regulatory constraints, it will not be feasible for smaller consumers to migrate. Large-scale sales migration due to the energy transition further exacerbates the financial vulnerability of the discoms. In such a scenario, two possibilities arise. The first is that the burden of high costs gets passed onto these small consumers in the form of higher tariffs. While many state governments do give some amount of subsidy for agricultural and domestic consumers, no such explicit subsidy exists for low-tension commercial and industrial consumers. With state finances already strained, the state government may not be able to further take on the subsidy burden for such small enterprises. Developmental objectives of electrification can only be realised when consumers, especially these small consumers, are able to afford and make productive use of electricity. If such small consumers pay more than the cost of supply, it also indicates that they are cross-subsidising other categories that possibly have options for competitive supply.

The second possibility is that financially strained discoms may cut down on operation, maintenance, and capital expenditures and neglect areas where they anticipate a lower revenue recovery. Unreliable, poor-quality supply with frequent interruptions will increase the existing trust deficit among consumers. This would not only impede the developmental multiplier effect of electrification but also contribute to a culture of non-payment, further increasing discom losses. To mitigate this, monitoring discoms' performance and holding them accountable becomes essential. Moreover, Standards of Performance (SoP) regulations set benchmarks for several parameters such as metering, billing, and reliability. It is important to ensure that these regulations do not remain mere paper tigers and, thus, this indicator, using the criteria in Table 9, checks the effectiveness of these regulations on the ground.

Table 9: Affordable and reliable supply for small consumers

S. No	Attribute (Score: Yes=1, No=0)	Remark
E8.1	**Power supplied to small enterprises is affordable.** (Yes, if either is met) a. All low-tension commercial and industrial consumers using less than 300 units per month are subject to the same tariffs (after subsidy) as all low-tension residential consumers. b. All low-tension commercial and industrial consumers using less than 300 units per month are charged tariffs (after subsidy) not higher than the cost of supply. c. The SERC has a clearly outlined process for assessing captive status. d. There is a clearly outlined process for registering all behind-the-meter systems.	• Enterprises using less than 300 units every month and with connected load of less than 5 kW are considered small commercial and industrial consumers and include home-based enterprises, kirana stores, and tiny manufacturing units, among others. Charging them the same telescopic tariffs as domestic consumers would reduce the need for separate connections and decrease harassment of these small consumers by discoms for unauthorised use where penal provisions are draconian. For the assessment, the average bill (fixed and variable charge) for a typical consumer with consumption and load is estimated.

S. No	Attribute (Score: Yes=1, No=0)	Remark
E8.2	**Power supplied to small domestic consumers is affordable.** (Yes, if either is met) a. All low-tension residential consumers, and not just below-poverty-line (BPL) cardholders, using less than 30 units per month are eligible for lifeline, concessional tariffs. b. Tariffs (after subsidy) for all low-tension residential consumers using up to 100 units per month are less than the average cost of supply but more than 80% of the average cost of supply of the assessed discoms.	• Those paying BPL concessional tariffs should be electrically poor (using less than 30 units per month) rather than those having BPL cards. • This will increase access to concessional tariffs to a wide number of consumers. With increased sales migration, domestic consumers are cross-subsidising. Thus, a consumer using less than 100 units should be charged less than the average cost of supply to ensure affordability.
E8.3	**The regulator periodically evaluates supply and service quality and revises benchmarks.** (Yes, if both are met) a. In the past three years, the SERC or assessed discoms have conducted studies including consumer surveys to assess metering and billing issues, supply challenges, and other issues, and these studies are publicly available. b. The Standards of Performance (SoP) regulations have been revised or amended in the last five years to tighten standards/ benchmarks.	• It is important that the surveys are made by third parties and/or are based on a wide, representative sample. • It is important that the revision or amendment of the regulation resulted in a tightening of standards, the addition of new standards, or the removal of the distinction between urban and rural standards.
E8.4	**SoP compliance is reported regularly, and the regulator uses reported data to hold discoms accountable.** (Yes, if both are met) a. The discoms under assessment publish compliance reports for SoP every quarter or as stipulated in the applicable regulations. b. The SERC uses SoP data reported by assessed discoms to hold them accountable for supply and service quality.	• The Electricity Act of 2003 and the commission's regulations mandate periodic publication of compliance to SoP regulations with data to be filed in formats prescribed by the commission. Only a few states currently comply.
E8.5	**Supply and service quality has been improving for the past three years.** (Yes, if any two are met) a. There has been an improvement in reliability indices at the feeder level. b. There has been an improvement in hours of supply as measured at the feeder/DT level. c. There has been a state-level decrease in fatal human accidents per 100,000 mid-year population. d. There has been a decrease in the DT failure rate.	• Reliability indices (like the System Average Interruption Frequency Index) or supply hours can be used based on availability. • Accident fatalities are reported in a consistent manner by the National Crime Records Bureau which can be used for this assessment.

INDICATOR E9 :

Access to competitive supply alternatives for industrial and commercial consumers

Many consumers, specifically from commercial and industrial categories, are migrating away from the discoms via open access and captive routes. Open access consumers are those contracting power directly from generators and are allowed to use the existing transmission and distribution network to pay requisite transmission and wheeling charges. They are also required to pay a cross-subsidy surcharge and an additional surcharge to compensate the discom for revenue loss due to their migration. Captive consumers are those that procure power from generating stations in which they have some ownership stake and are exempt from paying charges such as a cross-subsidy surcharge.

Currently, the share of sales migration stands at close to one-fifth of the total discom sales in India (PEG 2021c).[v] This is a significant share, despite the sector remaining mired in administrative hurdles, litigation, unclear provisions, and uncertainty in sales migration charges (such as the additional surcharge and cross-subsidy surcharge). With the high cost of supply and availability of cost-competitive options for consumers, going forward, a move away from cost-plus regulation and expansion of competitive choices is inevitable (PEG 2018b). However, this can only happen if proactive steps are taken to combat these above-mentioned hurdles and actively create a conducive policy environment that promotes competition.

Such an environment constitutes the following:

- **Clarity** in procedures and policy processes, especially with regard to access to competitive supply options
- **Certainty** in sales migration charges and processes, which is an important parameter for private players to plan their investments
- **Adequate compensation** for the discoms is essential as they face significant revenue loss due to migration of cross-subsidising consumers and a lack of measures to value grid services provided by the utility
- **Tracking** these developments in the market is also vital; open access and captive sales data need to be explicitly tracked and transparently reported by state agencies

Table 10 includes the criteria to help assess alternative supply options for industrial and commercial consumers.

Table 10: Access to competitive supply alternatives for industrial and commercial consumers

S. No	Attribute (Score: Yes=1, No=0)	Remark
E9.1	**Processes to facilitate access to competitive options for electricity consumers are streamlined.** (Yes, if any two are met) a. The option of filing applications online exists for open access, captive, and kW-scale grid-interactive RE systems. b. Open access regulations have been revised within the past three years to account for recent changes in the sector. c. The SERC has a clearly outlined process for assessing captive status. d. There is a clearly outlined process for registering all behind-the-meter systems	• Applicants should be able to track their applications online and view records of delays in processing at each stage. • Revisions in open access regulations can even include amendments or the issuance of practice directions to account for changes.
E9.2	**There is certainty in charges and procedures applicable for open access, captive, and rooftop consumers.** (Yes, if either is met) a. There has been certainty regarding open access charges (on a ₹/kWh basis) for the last five years. b. All of the following are satisfied: • There are no instances of retrospective applicability of charges and processes by the regulator, utilities, or state government. • Introduction of new charges or procedures is preceded by a period of non-applicability post-announcement to allow for adaptive changes. • There is clarity on the period for which concessions are provided with a clear sunset clause for applicability.	• Certainty in charges and processes incentivise investment. If charges increase more than the average rate of inflation (say, 4-5%), it increases the risk for investors. • This attribute should check for major instances of retrospective applicability which could be challenged such as removal of concessions for existing capacity. • Ambiguity on the tenure of applicability of concessions makes it difficult to ensure changes can be made at a later date, which is taken into account in this attribute.
E9.3	**Price signals exist to ensure equitable sharing of risk between consumers and utilities.** (Yes, if either is met) a. The banking charge and framework, electricity duty, and standby charge/parallel operation charges applicable for captive power plants have been revised within the past 5 years. b. There are regulatory measures in place to discourage short-term open access.	• Unlike open access, charges for captive consumers are not revised on a regular basis, which results in inadequate compensation to discoms. • Open access can be discouraged through measures such as higher open access charges, disincentives for repeat applications, and limits in duration.

E9.4	**There is transparent reporting of sales migration trends by some state-level agencies.** (Yes, if any two are met) a. There is reporting on the status of open access, captive, and grid-connected rooftop systems by consumers in the assessed discoms' areas of supply. b. There is reporting on the number and capacity of behind-the-meter systems in assessed discoms' areas of supply. c. There is separate reporting for RE- and non-RE-based sales migration in assessed discoms' areas of supply. d. There is reporting on pendency and average time taken to process applications (for, e.g., open access, captive, kW-scale grid-interactive RE) in the assessment year and consumers can track their applications online.	• Typically, there is no distinction in reporting of sales migration data from RE and non-RE sources. However, with variability of certain RE sources as well as concessions awarded in some cases, separate reporting is useful. • Procedural issues and delays in application processing are cited as a major impediment toward increasing competitive options. Transparency in delays will aid accountability and build investor confidence.
E9.5	**Consumers can exercise choice to source power at competitive tariffs.** (Yes, if either is met) a. Discom energy charges for industrial consumers are lower than the cost of power (including applicable charges) for open access and captive consumers. b. There is a year-on-year increase in cumulative sales to open access and captive consumers in the state.	• Ideally, pendency of applications or an assessment of procedural barriers would be required to assess if there are barriers to consumers accessing competitive options. • There may be some consumers that are willing to stay with the discom despite high tariffs due to a lack of reliability of competitive options or due to better services provided by discoms. It is assumed that the proportion of such cases is low in a market with increasing competition.

INDICATOR E10 :

Preparedness of state-level transmission and distribution network

With significant changes in demand as well as supply options, strengthening the transmission and distribution networks in states is necessary and has been the focus of several state- and centrally sponsored schemes. As investments in the next decade in T&D networks will be substantial, it is important that plans consider the following:

- Capital works projects in the transmission and distribution grids will be required to aid accelerated and timely RE addition and integration
- Cost-optimal investments in technologies such as battery storage which can be applied to multiple applications
- System strengthening, given changes in future demand due to behavioural changes, end-use appliance/technology adoption changes, and electrification of various energy end uses.
- Structural shifts in load and generation centres due to decentralised systems and the development of robust power markets

In addition, planning for distribution networks or wires should take place at least at the zone or circle level to account for decentralised development of resources, changes in demand, and shifts in agricultural and rural demand.

Along with detailed, comprehensive, transition-oriented investment planning, there should be transparent monitoring of capital works projects. Transparent monitoring will increase accountability for delays and encourage timely action to ensure completion of critical works.

To track state-level preparedness, this indicator assesses plans of the state transmission utilities and discoms to prepare the grid for the energy transition and RE integration.

Going forward, the T&D network will not be used just to cater to the demand of distribution licensees in the state as there will be multiple users due to open access and captivity. Further, supply could also be from decentralised sources. In such a system, robust metering systems are of paramount importance. Thus, consumer metering, where feasible, and complete interface metering in the distribution network must be ensured.

With robust metering systems, consumers can also be encouraged to shift their demand to time periods and seasons when there is higher availability of low-cost renewable energy. This would help with grid integration and reducing system costs. Over time, with improvements in metering technologies and billing practices, pricing can be more dynamic in its resolution and responsiveness. The preparedness of grid-level transmission and distribution utilities can be assessed using criteria in Table 11.

Table 11: Preparedness of state-level transmission and distribution network

S. No	Attribute (Score: Yes=1, No=0)	Remark
E10.1	**Transmission planning in the state accounts for transition-related impacts and has regulatory oversight.** (Yes, if both are met) a. The state transmission perspective planning process accounts for aspects such as RE capacity addition, change in load patterns due to electrification of new uses, and the potential role of storage applications. b. The perspective plan is approved by the SERC and reviewed every three years in a transparent manner.	• Transmission investments need to be flexible, considering multiple alternatives to strengthen transmission capacity. • Review of plans at least once in the multi-year tariff period would aid in mid-course correction.
E10.2	**Discoms have undertaken disaggregated planning to strengthen the distribution network, which has regulatory oversight.** (Yes, if both are met) a. There are zone-/circle-based plans for distribution capital investment which include plans for load growth, rural network strengthening, role of storage applications, and decentralised renewable energy generation growth, among others. b. The plan is approved by the SERC and is reviewed every three years in a transparent manner.	• Distribution capacity planning would need to be flexible, dynamic, and detailed in a disaggregated manner to account for changes in load, decentralised generation, and viability of alternate options given that the lock-in period for such investments is 10 to 25 years.
E10.3	**Status and progress of capital works in transmission and distribution in the state are publicly disclosed.** (Yes, if both are met) a. There is public reporting of the status of all intra-state transmission projects, including cost outlay, delays, and cost overruns, at least once a year. b. There is public reporting on the status of all discom capital investment projects, including cost outlay, delays, and cost overruns, at least once a year.	• Tracking delays is crucial to understanding cost overruns and infrastructure adequacy.
E10.4	**Progress in consumer and interface metering is on track.** (Yes, if any two are met) a. All non-agricultural consumers in the discoms' areas of supply are metered. b. There is 90% AMI/AMR feeder metering in the areas of supply of assessed discoms. c. At least 70% of all distribution transformers are metered. d. There is periodic reporting of consumer-level metering status in the public domain.	• Consumer and interface metering are crucial to understanding demand trends and planning investment and loss-reduction action.

E10.5 **Price signals exist to encourage shifting of load for better RE integration.**

(Yes, if any two are met)

a. Time-of-day tariffs are applicable for consumers who have connected load as low as 10 kW and also for consumers with kW-scale grid-interactive RE systems.

b. The time-of-day tariff design approved by the SERC encourages consumption during solar hours and high wind periods and disincentivises consumption during stress periods.

c. Time-of-day tariffs vary on a seasonal basis.

d. Incentives and disincentives in time-of-day pricing are significant enough to encourage shift in load (at least 15% penalty/rebate of the applicable tariff for the category).

- A threshold of 10 kW will cover most low-tension consumers, exempting only small enterprises. With metering costs being low, the move would not require significant additional cost.
- With increasing penetration of RE in the system, incentives to shift load need to be provided with price signals that vary with RE availability. Having a widely applicable and dynamic time-of-day regime is an important part of that.

INDICATOR E11 :

Regulatory governance and processes

Given the techno-economic considerations of the energy transition, the role of regulatory agencies will be of crucial importance. The SERCs not only will have to tackle the persistent legacy issues, but also newer issues that are bound to crop up because of the transition. They will have to deal with the emergence of new technologies and make pragmatic choices as to which ones to actively promote. Therefore, the onus of ensuring that the transition happens in a balanced, just, and equitable manner could predominantly fall on the SERCs. Strengthening the regulatory framework, holding deliberations with various stakeholders, and ensuring prompt and agile decision-making will be even more important going forward.

As transition-related challenges will be multi-dimensional, it is also critical that there is a wide level of experience and expertise within the commission. At the bare minimum, the commission should operate without vacancies and members of the commission should be selected from a wider pool of candidates than those with backgrounds in the state government bureaucracy or from the regulated utilities. This would help achieve the commission's autonomy in decision-making and informed deliberation, benefitting from the diverse experiences and expertise within the commission.

Further, decision-making will remain informed if wider public participation is encouraged, not just with respect to tariff determination, but other critical issues that will arise with the transition. This is possible only if the public has easy and transparent access to the regulatory process. Groups which represent consumer interests have an integral role to play to voice a diverse set of consumer concerns. Here, the indicator, using the criteria in Table 12, checks whether such groups are accorded meaningful representation for crucial proceedings before the commission.

Beyond this, the indicator also tracks whether the SERC has taken proactive and timely steps to ensure discoms are held to account, especially in addressing performance-related issues and whether the sector remains forward-looking in its approach to tackling the challenges that will arise during the energy transition.

Table 12: Regulatory governance and processes

S. No	Attribute (Score: Yes=1, No=0)	Remark
E11.1	**Regulatory processes are transparent and easy to access.** (Yes, if both are met) a. All petitions and submissions by licensees are publicly available on the commission's website. b. Charges for individuals or consumer organisations to apply for a petition are not more than ₹5,000.	• For the transition to happen in a just and equitable manner, regulatory processes must remain transparent (e.g., ability to partake in commission hearings, publication of all petitions of licensees) and accessible (e.g., demystification of technical orders/regulations for the public, non-prohibitive charges to approach the commission).

S. No	Attribute (Score: Yes=1, No=0)	Remark
E11.2	**The SERC encourages wider participation in decision-making processes.** (Yes, if any two are met) a. Consumer representatives are appointed for the assessed year as prescribed under Section 94 (3) of the Electricity Act of 2003, and they are a party to crucial proceedings before the commission. b. The State Advisory Committee has non-governmental representatives from all major consumer categories and has convened at least four meetings in the past two years. c. The commission has conducted public hearings for not just the latest tariff determination but other crucial matters which impact costs, supply, and tariffs for consumers. d. Hearings before the commission are live-streamed or available on the SERC website for the public.	• Section 94 (3) of the Electricity Act of 2003 encourages SERCs to authorise people to represent the interests of consumers in the proceedings before them. Many states have still not made these appointments. • To ensure a balance of perspectives, it is imperative that the State Advisory Committee has not only governmental representatives, but, more importantly, non-governmental representatives from major consumer categories. • Public hearings should occur at least at each discom headquarters in cases where a state has multiple discoms.
E11.3	**The commission members are appointed on a timely basis from a diverse pool of candidates.** (Yes, if both are met) a. In the past 60 months, the commission has been functioning without any vacancies for at least 54 months. b. Among working commission members in the past 60 months, at least one non-legal member was appointed from outside of senior state bureaucracy or regulated utilities in the assessed state.	• Commission members are appointed for a term of five years (60 months). To function optimally, it is essential to not have any vacancies for more than 6 months. • A diverse pool of candidates within the commission ensures independence and breadth of relevant knowledge. • When assessing appointments, the backgrounds of only the chairperson, technical/finance member, and secretary are considered. Legal members are excluded from this process as there is clarity and certainty on their background.
E11.4	**The commission takes steps to ensure accountability of utilities.** (Yes, if both are met) a. The commission has gathered and published data on crucial financial and performance parameters of the utilities on an annual basis for the assessment period, irrespective of whether a tariff order was issued that year. b. There was no delay in filing of the last tariff and true-up petitions. Alternatively, in cases where there is a delay of more than five months, the commission had initiated a suo moto process for tariff determination and true-up instead of condoning the delay.	• It is essential that the commission publish crucial data every year to get a sense of the financial and technical performance of utilities, especially in cases where no tariff petitions are filed that year or if, under the multi-year framework, petitions are filed every other year. • A suo moto process would be in line with the Appellate Tribunal for Electricity's direction in OP No. 1 of 2011.

S. No	Attribute (Score: Yes=1, No=0)	Remark
E11.5	**The commission has taken proactive, timely actions to address critical challenges and developments facing the state sector. There has been regulatory action on the following issues in the past two years:** (Yes, if any two are met) a. The commission has conducted a detailed review and evaluation of how central and state government schemes have been implemented. b. A regulatory framework for roll-out, cost-benefit assessment, and cost sharing of smart meters has been provided. c. Measures to address cumulative revenue gaps or a growing working capital requirement for discoms are under assessment. d. Studies on various forward-looking, transition-oriented issues and challenges have been commissioned or published.	• Borrowings are strictly not tracked while determining tariffs as the interest costs are not fully passed onto consumers. However, significant borrowings could affect the discoms' financial situation. • Transition-oriented issues include studies on the techno-economic case for various storage applications, load shifting, demand-side management measures, network planning, and cost assessments for grid services provided by discoms for rooftop solar consumers, among others.

TRANSPORT INDICATORS

The transport sector indicators track states' efforts to transition to cleaner and more efficient modes of transport.

India's transport sector is the second-largest energy user after industry, accounting for about one-fifth of total final energy use. The sector is also among the largest consumers of primary energy, accounting for a major share of crude oil demand in India. Transport alone consumes more than 3.6 million tonnes of oil equivalent (MTOE) of natural gas and 43.4 MTOE of oil products each year, accounting for 12.5 percent of the country's total energy consumption (NITI Aayog 2019). Most of this energy demand comes from road transport. Over the past two decades, India has witnessed rapid urbanisation and motorisation. Between 2001 and 2019, total registered motor vehicles grew at a compound annual growth rate of 9.8 percent (MoRTH 2018; 2019). Consequently, transport sector energy demand and emissions have increased accordingly, making it the third-largest contributor to carbon dioxide (CO2) emissions in India. Road transport accounts for about half this energy demand and nearly 87 percent of total transport emissions, and is a significant contributor to local air pollution (UNFCC n.d.). [vi]

Over the next two decades, the International Energy Agency estimates that the energy demand for road transport could more than double, with oil demand increasing twofold from around 1.9 million barrels per day (mb/d) in 2022 to 3.8 mb/d by 2040 (IEA 2021b). Another modelling-based study projects that transport is the sector with the highest growth rate (5.3 percent per year) of end-use energy demand sectors, reflected in the high demand growth rates of motor spirit, aviation turbine fuel, and electricity for transport just within the decade, with electricity demand growing the fastest among fuels at a 16–20 percent CAGR (PEG 2021b). Considering these trends and projections, decarbonisation of the transport sector is critical and consequential to India's energy transition as well as for meeting its climate commitments, addressing local air pollution, and managing energy import dependency (MoPNG 2021).

The transport sector in India has experienced one of the fastest increases in per capita consumption, with a compound annual growth rate of 3.0 percent from 1970 to 2005 and 4.2 percent from 2005 to 2019. In developing countries, economic development is the main driver of per capita energy consumption. The transport sector in India varies by geography and mode as well as how it's governed. Aviation, commercial freight mobility, and rail, among others, are not under the purview of state governments in India but rather the central government. Therefore, for an exercise like ETPI, there are challenges in 'assessing' plans, actions, and governance of the sector as a whole. Consequently, in this exercise, to highlight areas of actions for states, only the road and passenger segments of the transport sector are evaluated.

While it is evident that several urban transportation projects are executed by the municipal corporation or city-level transport agencies, presently, many of these are launched

and funded by the state government. Therefore, in this sectoral indicator set, we focus on road transport that is by and large governed by state- and city-level agencies.

Given the disproportionate concentration of road transport networks and vehicles in urban centres, many of the attributes and sub-attributes in this indicator set have an urban focus. An added benefit of this scoping is that the maximum potential for the energy transition would be in urban mobility, thus covering actions that can greatly contribute to energy transitions at the state level. However, to include rural mobility aspects to the greatest extent possible, we made an effort to capture the opportunities and initiatives on rural connectivity and access to transport services.

A sustainable energy transition in the transport sector will require a mix of pathways, ranging from greater use of non-motorised and public transport modes to the adoption of clean fuels. It will also require complementary transitions in the urban planning and energy sectors, toward more dense and walkable urban areas and the use of more renewables in the energy mix, respectively. Importantly, it will also require an integrated approach to policymaking and governance. States are primarily responsible for road transportation, vehicle governance, and inter- and intra-city transport services.

The five indicators for the transport sector for the state-level energy transition framework are as follows

T1. Accessibility of transport networks

T2. Development and performance of public transportation

T3. Transport electrification

T4. Sustainable vehicular growth and road safety

T5. Integrated policy and governance of transport sector

INDICATOR T1:

Accessibility of transport networks

Accessibility refers to people's overall ability to reach desired services and activities (together called 'opportunities') and, therefore, the time and money that people and businesses must devote to transportation (Litman 2017). For there to be inclusive and prosperous communities, transport must be accessible to all. Accessibility is a central tenet of equitable and efficient transport systems. Equitable transport systems ensure comparable accessibility regardless of location—urban or rural—which can be distinguished by the reach and quality of road infrastructure and transport systems. In terms of efficiency, accessibility minimises the time required to reach daily activities.

Several factors affect accessibility:

1. **Ease of mobility:** This refers to the ease of physical movement and, thereby, the quality (e.g., availability, frequency, speed, comfort) of travel modes (e.g., walking, cycling, public transport, intermediate public transport).

2. **Transport system connectivity:** This includes density of footpaths, cycling tracks, public transport network and road network and integration of different modes.

3. **Geographic proximity:** This refers to land use development which affects the distance between origin and destination of a users.

4. **Affordability:** This refers to the financial cost of travel relative to users' income.

From the perspective of equitable development, the accessibility indicator focuses on ensuring connectivity and access to opportunity in urban as well as rural areas. For the energy transition, accessibility largely focuses on urban areas, with aspects such as compact land use planning policies which minimise the distance between two activities and thereby the need for motorised travel, which in turn improves proximity to transit networks from residences or commercial establishments. It also encompasses a commitment to infrastructure that enables zero-energy modes of transport (i.e., walking and cycling). Policies and investments that promote walking, cycling, and using public transport can significantly reduce energy consumption.

While the ease of mobility and connectivity are widely represented in this indicator, it is important to note that geographic proximity has been assessed through the presence of mechanisms promoting densification. This is mainly because the assessment of proximity requires detailed Geographic Information System (GIS)–based analysis which may require a significant amount of time considering the scale of the ETPI assessment. However, it is important to acknowledge that GIS-based analysis of the geographic proximity to bus or metro stops and other infrastructure to promote non-motorised modes of transport provides the most accurate assessment. Thus, the assessment of accessibility from the perspective of geographic proximity needs to be considered as a part of a separate case study in further research activities.

Additionally, some aspects of accessibility, such as the affordability of transportation services and planned development, have been represented under other indicators like public transportation

and integrated policymaking and governance. Tracking accessibility at the state level through indicators is a good way to assess the state's commitment to energy efficiency and whether the transport sector is developing in an equitable manner. Transport network accessibility can be tracked using the criteria included in Table 13.

Table 13: Accessibility of transport networks

S. No	Attribute (Score: Yes=1, No=0)	Remark
T1.1	**The state has implemented regulatory and financial interventions to promote non-motorised transport (NMT).** (Yes, if both are met) a. The state has notified a policy or development plans with explicit focus on developing non-motorised transport (pedestrian and/or bicycling infrastructure). b. The state or the municipal corporations in the three most-populous cities have allocated dedicated funding for the development of NMT infrastructure or there is a dedicated allocation for this in the state's annual budget.	• This attribute establishes the presence of a policy and/ or budget allocations toward the development of accessible and connected pedestrian and cycling networks in urban areas, with a view to promoting sustainable urban mobility. The policy sub-attribute will be satisfied by a strong, implementable focus on NMT infrastructure in state transport policies, or a dedicated NMT policy, such as the Active Mobility Bill in Karnataka. • Karnataka is the first state in the country to introduce a draft Active Mobility Bill (currently in the public domain for feedback) that safeguards the rights of pedestrians and cyclists to safe, accessible, and connected pedestrian and cycling networks in urban areas, with a view to promoting sustainable urban mobility. More states may follow suit in developing something like this and it might make sense to continue to evaluate states on this even through it might mean setting a higher bar.
T1.2	**The state has invested in efforts to grow NMT networks.** (Yes, if either is met) a. At least one major city in the state has implemented the provision of NMT lanes in its urban planning strategy. b. All new road construction and major renovation projects of existing roads in the three most-populous cities in the state are equipped with usable pedestrian sidewalks and road crossings.	• This attribute assesses the development and implementation of NMT networks beyond policies and budget allocations, with on-ground infrastructure development. • In terms of measuring the usability of pedestrian sidewalks and road crossings, data on the condition of this infrastructure are extremely limited. This point will thus be covered in the case studies that will be done as a part of this project.
T1.3	**The state has invested in the construction and maintenance of urban road networks.** (Yes, if either is met) a. Urban road availability in the state (measured in kilometres per 100 square kilometres, or km/100 km2) is higher than the urban road availability at the national	• This attribute measures the growth and maintenance of urban road networks, with a focus on ensuring good-quality roads and a proportional expansion of road networks in line with urban population growth.

S. No	Attribute (Score: Yes=1, No=0)	Remark
	level, and is higher than the previous year's value for the state (based on the average annual rate of urbanisation in the state) but is lower than that of Delhi. b. Appropriate government agencies in at least one of the three most-populous cities have executed annual road maintenance contracts for the road network within their jurisdiction or have a dedicated annual budget for road maintenance.	• While the increase in road space beyond a specific limit does result in increased congestion, several Indian states do not have enough roads to enable access to more sustainable modes such as public transport buses. • The sub-attribute on an increased road network includes a cap on the road density that cities and/or states should target using Delhi as a threshold. This is because the city has been found to have reached the upper limit on road density and is a prominent example of how congestion continues to increase beyond a certain threshold of road capacity increase[vii] • An urban road network is generally reported on the website of the state's transport department and information on maintenance contracts will be available on state tendering portals.
T1.4	**The state has implemented efforts to construct and maintain rural road networks.** (Yes, if either is met) a. All villages in the state are connected by all-weather roads. [viii] b. The state has executed zonal maintenance contracts for all Pradhan Mantri Gram Sadak Yojana (PMGSY) [ix] roads that are older than five years, as per the programme guidelines of the scheme.	• This attribute focuses on improving rural accessibility across the state, via construction and maintenance of rural road networks through the PMGSY. [x] • State-level information on rural road connectivity and maintenance is available on the PMGSY portal.
T1.5	**Multi-modal integration is ensured for improved access to transportation options.** (Yes, if both are met) a. There is a state-level guideline or at least two major cities have a strategy to ensure that mass transit networks have last-mile connectivity options. b. The state government has drafted or notified policies or regulations promoting densification in cities in its town-planning and land-pooling schemes in at least one urban centre, specifically along transit corridors.	• Accessibility is affected by the quality of system integration and the proximity of public transit services. The ease of transferring among modes plays a key role in enabling the use of high-efficiency and occupancy modes such as public bus or metro services. Densification of cities will also enable easy access to public transit networks. • For the sub-attributes, researchers may check for any last-mile connectivity services established at or around metro or bus stations. Additionally, as densification is one of the main attributes of a town-planning and land-pooling scheme, researchers may look for the presence of these in the cities being assessed.

INDICATOR T2:

Development and performance of public transportation

Indian cities are currently witnessing increasing ownership of private vehicles and decreasing use of public and non-motorised transport. These trends have implications for India's energy consumption, energy security and economy (FE 2016), pollution, congestion, health, and safety. Growth in vehicle ownership and demand for transportation is also leading to higher congestion in urban centres. Private vehicles have grown exponentially in India, causing a rapid increase in carbon emissions, fossil fuel consumption, air pollution, and traffic congestion and a decrease in road safety. These externalities have a huge economic impact which will increase further with growth in passenger traffic—estimated to grow 16 times from 10,375 billion passenger kilometres (bpkm) in 2011–12 to 168,875 bpkm in 2031–32 (NTDPC 2014). The cost of congestion is estimated to be ₹1.47 trillion annually in Delhi, Mumbai, Kolkata, and Bangalore (BCG 2021), and vehicle emission rates are increasing (IEA 2021a), with negative implications for human health and the environment (NIE 2018).

A quick and cost-effective mechanism to minimise fossil fuel consumption and transition to more efficient modes of transport is the improvement and scaling of public transport systems. Buses are cheaper to deploy, flexible to operate, space-efficient, safer, and have low gestation periods compared with other modes. Using the criteria in Table 14, this indicator tracks states' efforts to efficiently plan, operate, and upgrade safe and accessible public transport service for all.

Table 14: Development and performance of public transportation

S. No	Attribute (Score: Yes=1, No=0)	Remark
T2.1	**The state transport agency has implemented efforts to regulate and operate adequate, affordable, accessible, and good-quality public transport.** (Yes, if any two are met) a. The state government or the most recent Comprehensive Mobility Plan (CMP) of the two most-populous cities in the state mention a target for the mode share of public transport. b. The state government has set up a dedicated fund to support the development and improvement of public transport either state-wide or for the two most-populous cities in the state. c. The state's public bus agency operates (owned and contracted under a public-private partnership, or PPP) at least 32 buses per 100,000 people (MoRTH 2017).[xi] d. Metro rail systems in cities have established last-mile connectivity services or have a strategy to develop these around their stations.	• While public transit services have been operational in several cities across the country, reliance on these systems is limited by their capacity and the areas they cover. This attribute tracks the level of service offered by public transit systems to ensure both adequacy of service and extent of coverage. • Notes: Researchers may look for a dedicated public transport fund or for the presence of an allocation within the state Urban Transport Fund for public transport. • Data on the total number of public transport buses in the state will be available on the website of the respective State Transport Undertakings or the Dynamic Packet Transport for the mass transit network, or the Comprehensive Mobility Plan for the city being assessed will have information on last-mile connectivity.

S. No	Attribute (Score: Yes=1, No=0)	Remark
T2.2	**The state transport agency has implemented efforts to ensure equitable access to public transport.** (Yes, if both are met) a. All assessed cities have an established public bus system, either operated by the government or contracted to a private operator under a PPP, and all towns and cities and villages in the state are connected by public transport service. b. Vulnerable groups are offered concessional fares for both tickets and/or passes used for bus-based public transport operated by the state.	• Accessibility is recognised as a key element of a high-quality, efficient, and sustainable transport system. A fundamental part of a person's mobility is their interaction with the mode of transport available and the environment. With increasing urbanisation, and the associated demand for transportation, access to efficient and reliable public transport systems not only ensures access to livelihood, education, health care, and entertainment, but also limits people's reliance on relatively fossil fuel–intensive private modes of transport. For this attribute, we refer to concessions for vulnerable communities. These include people living below the poverty line, women, the elderly, children, and people with disabilities, among others that may be mentioned in policies or regulations on concessions for public transport as part of state regulations. • Information on concessional fares for vulnerable groups will be present in the annual reports or the website of the State Transport Undertakings.
T2.3	**The state transport agency has implemented efforts to monitor and maintain public transport performance.** (Yes, if any two are met) a. Public transport buses in the state have an average age not greater than eight years or one million kilometres, whichever data point is tracked by the agency. [xii] b. At least 85% [xii] of fleet utilisation is maintained on average for all public bus services. c. The bus trip cancellation rate or cancelled kilometres of the public bus system is maintained below 10% to ensure reliable service. [xii] d. Public transport buses are operated at an average occupancy ratio or load factor of 60% in cities and towns with established public transport systems. [xii]	• Similar to the service-level attribute, the performance of a public transit system plays a key role in ensuring continued reliance on the system. This attribute tracks the energy efficiency, reliability, and uptake of public transit systems. • For these sub-attributes, the average age of the fleet and the average occupancy ratio may be calculated as a weighted average of the age of the entire fleet operated and the average occupancy of all the bus trips that are completed by the fleet. Additionally, the fleet utilisation rate is the average number of buses that are operated daily considering the buses that are off road for maintenance and other issues. • Notes: Data to assess this attribute will be available in the annual report of the State Transport Undertakings. • To assess this attribute, researchers should consider the value of the parameter as the average of the past five years. This has been added to avoid misrepresentation due to the lack of operational services during the COVID-19 lockdown imposed by the government.

T2.4	**Public transport systems are upgraded by adopting improved technology and cleaner fuels.** (Yes, if any two are met) a. Public transit systems have adopted or have a plan to adopt new technologies such as automatic ticketing systems and GPS devices to enable high-quality and reliable passenger information systems. b. The public transit system has adopted or has a plan to adopt an intelligent transportation system to ensure improved planning and operation. c. All public transport buses are BS4 standard and above. d. States have already begun to or have a plan to on-board low- or zero-emission buses into the public transport fleet.	• With improvements in transportation technology and service provision, the mobility sector in India has seen the influx of several high-tech transportation solutions that offer improved access and customer experience. These attributes of the system have begun to shift people's choices to more reliable, comfortable, and accessible modes of on-demand transportation. • Additionally, improvements in technology have also enabled improvements in fuel efficiency and for transportation with a potential to significantly reduce reliance on highly polluting and expensive fossil fuels. • This attribute tracks states' efforts to leverage these technologies to upgrade the quality of service, promoting greater uptake and a transition to cleaner and more efficient fuel technologies. • Here, an intelligent transportation system includes technologies that enable transit agencies and operators to collect real-time digitised data on vehicle position, ticketing, fuel efficiency, and engine condition, among others, that can be analysed and used for more accurate decision-making. • Details on the State Transport Undertaking's (STU's) plans to upgrade technology are generally published in articles, press releases, or memos hosted on the STU's website. Information on the status of these can also be found in the STU's annual reports.
T2.5	**Public transport systems have sufficient uptake in states.** (Yes, if either is met) a. Public transport buses service (including Bus Rapid Transit System and PPP services) at least 345 passenger trips per bus per day (MoRTH 2017). [xiii] b. Metro rail with established networks has a daily ridership which is at least 75% of that projected in the detailed project report (DPR) for that specific metro system.	• This attribute tracks the uptake of public transport as a result of all the states' efforts put into the system. • A logical choice for one of the sub-attributes to assess the uptake of public transport would be to track mode share. However, as mode share is not tracked by the government on an annual basis (rather mode share is generally captured only by large-scale surveys conducted by private or public sector entities), this study has not considered mode share as an output indicator. • Note: Data on bus and metro ridership will be available in the annual reports of the State Transport Undertaking and the respective metro agency. Additionally, the planned metro ridership will be available in the metro's DPR.

INDICATOR T3:

Transport electrification

Despite rapid urbanisation and motorisation, motor vehicle ownership in India remains relatively low, at about 225 vehicles per 1,000 persons, including motorised two-wheelers (as of 2019). With the projected growth in India's GDP and per capita income, the number of private motor vehicles is expected to increase threefold by 2050. The number of cars per 1,000 persons is likely to grow even more rapidly, from 22 in 2018 to 175 in 2040 (IEA 2015). This offers India an opportunity to transition to a cleaner, more sustainable transport sector.

The transition to electric vehicles (EVs), which are powered by electricity rather than fossil fuels and emit zero tailpipe emissions, is an important pathway for sustainable and clean transport systems. Coupled with India's push to increase the share of renewable energy in the country's electricity generation, a transition to electric mobility will further catalyse decarbonisation of the transport sector.

Recognising the opportunity, India has embarked on an ambitious plan to electrify its transport sector. As one of the 14 signatories of the global EV30@30 campaign (CEM n.d.), India has pledged to achieve a 30 percent share of electric vehicles among all new vehicle sales by 2030. In turn, the government is providing significant fiscal and policy support to the EV transition with the deployment of the FAME scheme (Faster Adoption and Manufacturing of Electric and Hybrid Vehicles) by the Ministry of Heavy Industries, and with various supporting guidelines and policy notifications by the Ministry of Power (MoP), the Ministry of Road Transport and Highways (MoRTH), and the Ministry of Housing and Urban Affairs (MoHUA).

However, the implementation of policies and interventions for the electric mobility (e-mobility) transition needs to take place at the state and local levels. Moreover, several states have already enacted their own policies and targets. Therefore, state action will be critical to ensuring that India achieves its ambitious transport electrification targets and remains an automotive leader in a rapidly electrifying global transport sector. These actions by the states can be tracked using criteria in Table 15.

Table 15. Transport electrification

S. No	Attribute (Score: Yes=1, No=0)	Remark
T3.1	**The state has indicated its intention and has set up processes to develop the e-mobility ecosystem.** (Yes, if any two are met) a. The state has notified an EV policy to promote development of the e-mobility ecosystem. b. The state has constituted a steering or high-powered committee to oversee governance of e-mobility development. c. The state has undertaken EV-related awareness campaigns and programmes in the assessment period or within the previous three years.	• The EV transition is in its nascency and requires robust government support. This attribute assesses the seriousness of state intent to promote e-mobility through a range of policy, governance, and financing mechanisms. • To assess the presence or completion of EV-related awareness campaigns, researchers may need to check for awareness campaigns three years before the current assessment period as executed awareness campaigns may not be repeated on a yearly basis.

S. No	Attribute (Score: Yes=1, No=0)	Remark
	d. The state has established a dedicated fund that can be used for incentivising EV adoption and developing supporting infrastructure in the state	• The website of the state's transport department or the EV cell of the state, if present, will have all the information needed to assess this attribute.
T3.2	**The state has offered purchase incentives for EVs.** (Yes, if any two are met) a. The state provides purchase subsidies for at least two electric vehicle modes. b. The state provides a reduction in or exemption from road tax, permit exemptions, priority permits, reduced or free parking, and toll waivers, among others, for EVs. c. The state provides scrapping incentives for replacing internal combustion engine (ICE) transport vehicles with EV variants. d. The state provides access to concessional financing in the form of interest subventions or a first loss default guarantee or other schemes for purchase of EVs.	• A primary barrier to the uptake of electric vehicles is their higher upfront cost compared with that of ICE vehicles. Governments across the world, including the government of India through the FAME scheme, are providing subsidies on the capital cost of EVs to incentivise their purchase. • This attribute highlights various measures that state governments can deploy to reduce the upfront cost of EVs and provide access to EV financing. While road tax exemptions are an effective state-level instrument to reduce the on-road cost of the vehicle, states may also provide add-on purchase subsidies or scrapping incentives to incentivise the switch to electric. • The state's EV policy or motor vehicle rules, or the website of the transport department, will provide the data needed to assess this attribute.
T3.3	**The state has invested resources to develop EV infrastructure, adoption plans, and supporting regulations.** (Yes, if any four are met) a. The state's urban development department has added to or revised its building bylaws to include a provision for EV charging infrastructure. b. A single-window mechanism is operated by a state discom or the State Nodal Agency for processing permissions and approvals related to installing charging infrastructure. c. At least one public EV charging station has been commissioned in the state, with concessional access to land for EV charging. d. The SERC has notified a concessional electricity tariff or tariff category for EV charging, in line with MoP guidelines. e. At least one state discom has undertaken an assessment of the DT-level grid impact of EV charging loads in its service area. f. The SERC has implemented a time-of-day tariff structure for EV connections.	• Range anxiety and low availability of charging infrastructure are two other key barriers to the EV transition. EV charging facilities are a type of hybrid infrastructure that must be planned according to existing transport and electricity grid networks. A holistic approach to EV charging must also ensure its availability in public and private locations. This requires coordination among various government departments and a streamlined process for customers. • This attribute offers a checklist of different planning and regulatory measures that state departments or state-led agencies may take to enable greater provision and availability of charging infrastructure, which in turn is expected to accelerate EV adoption.

S. No	Attribute (Score: Yes=1, No=0)	Remark
T3.4	**The state has taken steps to support EV sector innovation and employment generation.** (Yes, if both are met) a. The state promotes innovation in the EV sector through incentives or initiatives such as a research and development programme focused on e-mobility or the establishment of an innovation fund to support EV start-ups. b. The state skill development mission offers at least two courses that focus on preparing workers for the EV workforce and/or provides incentives or initiatives for the inclusion of women, low-income communities, and/or other marginalised groups in the electric mobility workforce.	• Apart from environmental benefits, the EV transition offers states the opportunity for economic growth and employment creation due to the disruption it brings to the established automotive industry. This attribute tracks how states are leveraging the EV transition to attract industry and businesses to set up base in their regions, and to create more green and inclusive jobs not just for the existing workforce but also for underrepresented groups. • The state's EV policy or the websites of the transport department, the Department of Higher Education and Skill Development, or the National Skill Development Corporation will provide the data needed to assess this attribute.
T3.5	**The state has helped foster the growth of an EV ecosystem.** (Yes, if any two are met) a. The cumulative market share of EVs at the state level, measured as the percent of EVs in new motor vehicle registrations annually, is equivalent to or exceeds the cumulative national EV registration percentage share. b. The public charging infrastructure provision in the three biggest municipal corporations equals or exceeds the MoP target of one charging station for every 3x3 km area (MoP 2022). c. Public charging infrastructure on all national and state highways equals or exceeds the MoP target of one charging station every 25 km, on either side of the road (MoP 2022). d. The percentage of government electric vehicles during the assessment year is higher than the percentage of government electric vehicles in the previous year.	• This attribute measures the outcomes of state action for e-mobility, with a focus on EV adoption and infrastructure development. • Data on the total number of registered EVs in the state can be obtained through the Vahan ('Vehicles') portal or on the website of the state's transport department. • Information on charging infrastructure can be obtained from the municipal corporation, the city's discom, the transport department, or the Ministry of Heavy Industries.

INDICATOR T4:

Sustainable vehicle growth and road safety

Rapid urbanisation and motor vehicle growth has imposed a serious effect on human life and the environment in recent years. Motor vehicles significantly contribute to the increasing dependence on fossil fuels and are a major source of air pollution. The growth in personal and freight vehicles, and the corresponding surge in fuel use, is expected to continue for the next several decades as increased mobility provides enhanced economic opportunities for all sectors of society. While the energy transition aims to decouple fossil fuel use from access to mobility, there is a need to regulate the growth of motor vehicles (of which more than 90 percent are personal vehicles) and their movement in a manner that minimises their negative externalities such as road accidents, traffic congestion, and the myriad health impacts associated with air pollution.

Road crashes and fatalities are a by-product of the growing dependence on motor vehicles and poor traffic management. While India accounts for only 1 percent of motor vehicles globally, it is home to more than 10 percent of the world's road traffic deaths (World Bank 2021). India loses 3 percent of its GDP to road accidents (UNESCAP 2013) as most accidents involve adults that are active in the country's workforce. To address this issue, the Motor Vehicles (Amendment) Act of 2019 strengthened penalties for traffic and safety violations on roads.

The attributes in Table 16 help evaluate the states' efforts to regulate the growth of ICE motor vehicles and mandate measures to improve road safety, thus ensuring safer and improved access to opportunity, education, and health care and, therefore, an improved quality of life for all residents.

Table 16: Sustainable vehicle growth and road safety

S. No	Attribute (Score: Yes=1, No=0)	Remark
T4.1	**The state has implemented measures to control vehicle growth.** (Yes, if both are met) a. The highest road tax issued on purchase of an ICE passenger car in the state is at least 12%, or the registration of a second car is taxed at a higher rate than the first car. b. The state has amended appropriate rules or regulations to adhere to the national Vehicle Scrappage Policy and has undertaken measures for its execution (e.g., issuance of SoP for establishing Vehicle Scrappage Facilities, issuance of mandates on retirement age of vehicles)	• This attribute measures the states' efforts to control motor vehicle growth. High road taxes, especially on more expensive vehicles, and progressive tax regimes, such as higher taxes on second cars, can curb the growth of, and dependence on, motor vehicles. • At the same time, older vehicles need to be retired at a regular rate to ensure that the operational motor vehicle fleet is modern and equipped with the latest technologies for more efficient energy use. The notification of the national Vehicle Scrappage Policy at the central government level opens the door for state governments to adopt and implement more stringent regulations and processes to incentivise the scrapping of old vehicles. • The website of the state's transport department, the motor vehicle rules, or (if available) the dedicated scrappage policy of the state will provide data to assess this indicator.

S. No	Attribute (Score: Yes=1, No=0)	Remark
T4.2	**The state has implemented measures to control vehicle pollution.** (Yes, if both are met) a. The state has enforced the requirement for Pollution under Control (PUC) centres to upload emission test data electronically to the Vahan database to support the operationalisation of the MoRTH amendment to the Central Motor Vehicle Rules requiring PUC certificates to be linked with the Vahan database. b. The state imposes penalties per the Motor Vehicles (Amendment) Act of 2019 to vehicle owners using their vehicles without a valid PUC certificate.	• This indicator measures the efficacy of state action on curbing pollution from vehicle tailpipe emissions through a robust regime of well-regulated PUC certification centres and the imposition of hefty penalties for non-compliance.
T4.3	**The state has implemented measures to improve road safety.** (Yes, if both are met) a. The state government has notified a dedicated road safety policy as per the requirements of the Motor Vehicles (Amendment) Act of 2019. b. The state government has set up a dedicated committee for road safety to periodically review road safety in the state and designated a lead agency with the resources and authority to implement measures.	• State governments have set up road safety committees that bring together representatives from various departments including the local police to ensure steps are taken to improve road safety. This attribute focuses on assessing a state's efforts to prioritise road safety by the formation of these committees or the establishment of dedicated road safety action plans in which the roles and responsibilities of various stakeholders are clearly described. • Information on the road safety policy or the road safety committee will be available on the website of the state's transport department.
T4.4	**The state has set up mechanisms to enforce traffic and safety.** (Yes, if both are met) a. The state has notified all penalties for traffic and road safety violations as per the Motor Vehicles (Amendment) Act of 2019 in the state's motor vehicle rules. b. The traffic police have adopted intelligent traffic management systems in at least one of the three most-populous cities to identify and enforce traffic and road safety violations.	• To improve road safety and limit the number of road fatalities, the central government amended the Motor Vehicles Act in 2019 to include several penalties for non-compliance with road safety measures. This attribute evaluates a state's alignment with the act and the state's efforts to adopt intelligent transportation technologies to enforce these rules. • Information on the adoption of new technologies for traffic and transport management will be available in articles, press notes, or memos published on the website of the transport department, city police, or municipal corporation.

S. No	Attribute (Score: Yes=1, No=0)	Remark
T4.5	**The state's vehicle growth and road fatality rates are below the national averages.** (Yes, if both are met) a. The annual cumulative motor vehicle growth rate in the state is less than the national average, and/or has decreased in absolute value from the previous year's growth rate. b. The number of road fatalities per one million inhabitants in the state is less than the national average and shows improvement from the state's performance in the previous year.	• This attribute measures the impact of the states' efforts to manage vehicle growth and ensure road safety. The majority of the information required for this attribute will be available in the annual report of the transport department or any dedicated reports that it publishes. • Researchers shall consider the population projection presented on the 2011 Census website and the vehicle registration data provided in the Vahan database for any calculations required for assessing this attribute.

INDICATOR T5:

Integrated policy and governance of the transport sector

An energy transition in the transport sector comprises a range of potential pathways, including reduced transport demand and the use of efficient transport modes and clean transport technologies as seen in previous indicators. However, an integrated approach to policymaking and governance in the transport sector is essential to ensuring that the overarching vision is toward clean and environmentally sustainable transportation networks (UNESCAP 2015).

Nurturing integration within the transport sector is an organisational process that can be delivered by bringing planning and delivery of various elements of the transport system together across modes, sectors, operators, and institutions to increase the net environmental and societal benefits. A fragmented, multi-level governance structure for transportation results in development policies and programmes that may not be ambitious enough or may even be at cross-purposes with one another. For instance, the promotion of electric mobility without an adequate focus on public transportation and non-motorised transport modes will result in a sub-optimal energy transition, as will electrifying transport without ensuring that the energy mix for electricity generation becomes cleaner. Similarly, sprawling urban development will limit the gains of cleaner and more efficient transport modes by increasing transport demand and deprioritizing non-motorised transport (Kakar and Prasad 2020).

This indicator assesses the state's intent and implementation capacity for an energy transition that will ensure the sustainability of the transport sector, from the lenses of both policymaking and governance. The presence of alternate decarbonisation policy pathways and the integration of transport policies, both within the sector and externally with relevant climate change and urbanisation frameworks, demonstrates the holistic vision for a successful transition. In terms of governance, the integration, inclusivity, transparency, and participatory nature of institutions and processes in the transport sector can be assessed using the criteria in Table 17.

Table 17: Integrated policy and governance of the transport sector

S. No	Attribute (Score: Yes=1, No=0)	Remark
T5.1	**Alternate transport decarbonisation pathways are clearly defined in state policies.** (Yes, if either is met) a. The state has a notified policy or has provided pilot support to test electric vehicle variants of medium- and/or heavy-duty vehicles or the use of alternative clean fuels for those vehicles. b. The state has a notified policy or regulatory framework for urban shared mobility operators, defined as private transport or mass mobility operators or aggregators of passenger transport fleets enabled by technology interfaces (not including inter-city passenger transport).	• This attribute measures the state government's intent and capacity to provide guidance and direction for transport decarbonisation by leveraging the potential of alternative technologies and service models, such as hydrogen fuel and bio-fuel use in transport, and the development of on-demand shared mobility services which have evolved as a substitute for personal vehicles in urban centres. • Given that the net impact of on-demand shared mobility services (such as those offered by Uber and Ola) may also be negative, the sub-attribute on policy and regulatory frameworks for shared mobility

S. No	Attribute (Score: Yes=1, No=0)	Remark
		• services should comprise balanced guidance and direction for such services so that they are equitable, accessible, and complementary to public transport networks.
T5.2	**The transport sector is integrated in the state's overall decarbonisation and sustainability planning.** (Yes, if either is met) a. Transport sector targets are included in the State Action Plans on Climate Change (SAPCC). b. The state Pollution Control Board has allocated National Clean Air Programme funds (provided for non-attainment cities for air pollution mitigation) for sustainable and clean transport projects.	• This attribute measures the integration of the transport sector with external sustainability frameworks given that the transport sector has significant negative externalities for air pollution and climate change. The alignment of transport sector outcomes with climate adaptation and mitigation frameworks at the state level indicates a recognition of the sector's importance to reducing greenhouse gas emissions. Similarly, the allocation of clean air funds to transport sector projects highlights the important role of transportation in air pollution emissions, especially in urban centres.
T5.3	**Transport sector planning and institutional frameworks follow the integrated transport approach.** (Yes, if any two are met) a. The state has a transport policy for an integrated approach to regional or urban transport networks. b. The state has at least one empowered Unified Metropolitan Transport Authority with project approval authority and an established budget among its cities with populations of over one million inhabitants, as recommended by the National Urban Transport Policy. c. The development authorities or municipal bodies in at least two of the most-populous cities in the state have an updated CMP, from 2015 or later, to inform future planning and development of passenger and sustainable freight movement in the cities. d. The development authorities or municipal bodies in the three most-populous cities in the state have an updated master plan, from 2015 or later, with the inclusion of a well-detailed transport infrastructure development plan.	• This attribute determines the capacity for integrated policymaking and governance of transport at the state level. • Integrated transport involves enabling the combined use of modes of transport to maximise ease and efficiency for the user in terms of time, cost, comfort, safety, accessibility, and convenience. • Integrated policies and institutions for transportation are important to counter the fragmentation of the sector. • The attribute also assesses the state and local focus on the planned development of transport networks, especially in urban centres, which are growing rapidly and often without adequate planning.

S. No	Attribute (Score: Yes=1, No=0)	Remark
T5.4	**The state has implemented efforts to ensure transparency and public participation in transport sector planning and governance.** (Yes, if any two are met) a. The state regularly publishes transport data (at least once every two years) on vehicle registrations, public transport fleets, road safety, and other topics used to develop transport department annual reports, master plans, and comprehensive mobility plans that are published on official state or national portals. b. The state regularly undertakes public consultations for proposals (not limited to environmental impact assessment/social impact assessment processes) of transport infrastructure projects of greater than ₹10 billion in value (for at least 75% of relevant projects). c. The state (or the largest municipal corporation in the state) has a defined process by which citizens may submit requests or grievances regarding transport infrastructure and services. d. State residents can perform routine tasks like registering a vehicle, paying a fine, or submitting a data request (such as for copies of a driver's license or registration certificate) through dedicated single-window portals, which may be online or offline.	• While the collection and use of data are important in transport planning and development, an open and transparent approach to data availability for the public ensures greater accountability of government measures and promotes greater participation from the private sector and civil society. This attribute measures the transparency, responsiveness, and participatory nature of state transport governance. • This includes the sub-attribute on publication of various transport data, which citizens may use to provide input into the planning process and to hold their representatives accountable. This indicator also includes sub-attributes on the institutionalisation of public participation and feedback as inputs into the planning process, which are crucial for the development of safe and people-oriented transport infrastructure for all citizens. • Information on the mechanism for grievance redress will be available on the website of the transport department, municipal corporation, or STU.
T5.5	**The state has invested in efforts to ensure inclusion and socio-economic development.** (Yes, if either is met) a. The state provides improved education and/or skilling opportunities, or other indirect benefits, to women, low-income citizens, and/or marginalised demographic groups through social welfare schemes (for subsidised vehicle financing or other schemes). b. The state, or public sector undertakings in the state, has reserved jobs for women, low-income communities, and/or other marginalised demographic groups.	• This attribute assesses state performance on distributing the benefits of transport sector jobs to low-income, marginalised, and/or under-represented groups. • Information on skilling programmes or jobs for marginalised groups will be available on the website of the transport department, STU, National Skill Development Corporation, or the Department of Higher Education and Skill Development.


T-1
T6

BUILDINGS INDICATORS

The indicators track subnational participation in policies and programs for energy efficiency and clean energy integration in building sector.

Urban areas are characterised by buildings, both residential and commercial, and high population density. Buildings are energy guzzlers due to heating or cooling requirements. The sector was responsible for approximately 40 percent of global energy consumption and 38 percent of greenhouse gas emissions in 2019 (Tricoire 2021; Steinemann and Kessler 2021). In India, 35 percent of total electricity consumption is attributed to buildings and this percentage is growing at a rate of 8 percent annually; buildings are the second-largest emitter of greenhouse gases (BEE n.d.). The Energy Conservation Act of 2001 was enacted to reduce energy intensity and promote energy efficiency and energy conservation across sectors including buildings. Subsequently, the Bureau of Energy Efficiency (BEE) was established in 2002 as the nodal agency for coordinating efforts for energy efficiency across the energy sector.

Out of total electricity consumption by buildings in India, approximately 75 percent is used by residential buildings (BEE 2018). Also, the residential sector accounts for 25 percent of current energy usage which will increase to 39 percent by 2047 (BEE 2021). Thus, similar to the Energy Conservation Building Code (ECBC) for commercial buildings, an ECBC for residential buildings has been developed, known as Eco Niwas Samhita (ENS).

India has set an ambitious target for renewable energy generation to enable energy access, energy security, climate change mitigation, and other environmental benefits. Apart from large RE power plants, this also includes grid-connected on-site RE—namely rooftop solar PV integration with buildings in cities. This is supported by favourable policies such as capital subsidies, accelerated depreciation, and most recently net/gross metering, while also being encouraged through infrastructure development programmes such as Smart Grids and Smart Cities Mission. Commercial, institutional, and residential consumers are an integral target audience for uptake of rooftop PV.

However, currently, RE deployment policies for buildings are not in sync with building energy policies, which recommend RE integration (as in the case of ECBC and ENS) only after achieving a reduction in energy demand through appropriate design and employing efficient technologies. Builders have no incentive to invest more in energy efficiency or renewable energy in buildings because they are not the ultimate user. Hence, regulation is needed. Incorporating RE to reduce the carbon content of the energy supply is recommended as a final step to meeting this optimal demand. As a principle, this is true for both—retrofitting of existing buildings and for new building design and construction; however, in India, building energy policies are currently applicable to only new buildings. The need for energy efficiency is not being considered and is being questioned as RE is expected to become cheaper. While this is true for larger solar power

plants, at the building level, RE costs continue to be significant.

Energy efficiency measures can be seen as a possible enabler of less RE and less storage, or 'freeing up' of more electricity units to export to the grid, if innovatively integrated, hence improving the economics of RE deployment in buildings. This also has additional benefits in terms of reducing the resources needed for manufacture of RE technologies, including PV panels and supporting infrastructure. The economic and carbon costs related to resource use are not frequently discussed as RE technology benefits are seen to largely outweigh the resource implications. Energy efficiency integration is likely to reduce demand for these resources and remains a crucial strategy for mitigating climate change. Energy efficiency as a resource also has the potential to integrate with other electricity sector 'disruptions' like digitalisation. Digitalisation enables energy efficiency and flexibility in building energy consumption, especially smart buildings installed with advanced sensors, control system integration, and data optimisation to reduce energy usage. Along with decreasing energy usage, it can improve health, comfort, and productivity of the occupant and other such benefits (Nesler et al. 2021). Smart and energy-efficient buildings are an important linkage between the smart grid infrastructure and management of the energy load through various demand-side management interventions.

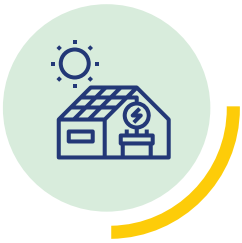
However, the buildings sector in India may not be prepared for these needed large-scale transformations due to governance challenges. If done well, buildings sector interventions can be an enabler of the clean energy transition. Fundamentally, a clean energy transition and energy efficiency should go hand-in-hand. In India, where demand and consumption are still increasing in the buildings sector, reducing the rate of growth in energy demand through efficiency is required if the share of RE in the energy mix is to be increased. Otherwise, RE growth will be chasing an ever-increasing target.

In these contexts, the proposed indicator set tracks the ambition and outlook of state decision-makers and the commitment capacity and preparedness of state-level agencies to support the transformation of the buildings sector and strengthen its contribution to the overall energy transition through energy efficiency and renewables integration. The indicator set is based on current and expected policy and programme developments in the sector and assesses the

actions of state governments to enable outcomes intended from selected policies, schemes, and programmes. The indicators also assess measures undertaken to streamline processes, compliance with directives, investments in institutional capacity, and progress toward aspirational actions needed.

The five indicators for assessing the buildings sector are the following:

B1. Energy Conservation Building Code compliance and Eco Niwas Samhita preparedness in the buildings sector



B2. Promotion of grid-connected rooftop solar photovoltaic and solar water heaters in urban buildings

B3. Promotion of energy-efficient appliances and equipment in buildings

B4.Energy efficiency and clean energy considerations in public buildings

B5.Energy efficiency and clean energy considerations in affordable housing projects

INDICATOR B1:

Energy Conservation Building Code compliance and Eco Niwas Samhita preparedness

India's buildings sector is responsible for a third of electricity consumption (MOSPI 2021). The floor area for commercial buildings is expected to grow 2.7 times, from 1.60 billion square metres (m^2) in 2017–18 to 3 billion m2 in 2037–38. At the same time, the floor area for residential buildings is expected to grow 1.6 times, from 15.34 billion m^2 to 28.44 billion m^2.

To avoid locking in inefficient building stock and decarbonise the buildings sector, in 2007, the Bureau of Energy Efficiency launched the Energy Conservation Building Code which stipulates minimum [xiv] energy efficiency requirements for building envelopes; mechanical systems; and equipment, including heating, ventilation, and air conditioning (HVAC) and service hot water heating; interior and exterior lighting; electrical power and motors; and renewable energy systems in new commercial buildings. The BEE updated the ECBC in 2017 (BEE 2017). The update primarily covers new buildings with a connected load of 100 kW or more or contract demand of 120 kilovolt-amperes (kVA) or more and buildings undergoing additions or alterations which result in a connected load of 100 kW or more or contract demand of 120 kVA or more.

In 2018, an ECBC for new residential buildings was launched—called Eco Niwas Samhita (ENS)—part of which specifies building envelope design requirements for thermally comfortable residential buildings. This was followed by the release of the second part of ENS in 2021, which describes provisions for energy efficiency in building services, indoor electrical end uses, and compliance requirements for renewable energy systems. Both ECBC and ENS are examples of building energy codes that integrate energy efficiency and renewable energy in buildings.

Though the codes were developed by BEE, its adoption and implementation are the responsibility of state governments and their urban local bodies. States also have the flexibility to adapt the codes to suit their local circumstances (e.g., the scope of the codes).

BEE notified ECBC in 2017 but as of March 2020, only 12 Indian states and union territories have notified ECBC rules. Only some states have been proactive in their application of the code.

The process of complying with ECBC is as follows:

a. Amendment of ECBC to suit local conditions

b. ECBC notification by states

c. Incorporation of the code in relevant bylaws

d. Notification of the code at the municipal level

e. Enforcement to approve and certify buildings

This indicator also includes the above-mentioned steps to understand the intent, processes, and enforcement involved in achieving ECBC compliance in commercial buildings as well as preparedness for ENS in a state. Assessment criteria for this indicator are in Table 18.

Table 18: Energy Conservation Building Code compliance and Eco Niwas Samhita preparedness

S. No	Attribute (Score: Yes=1, No=0)	Remark
B1.1	**The state intends to adopt the ECBC.** (Yes, if both are met) a. The state has notified ECBC 2017 in the state gazette. b. The state has incorporated ECBC 2017 in its Model Building Bye-Laws or unified building bylaws or development control rule.	• The ECBC sets minimum energy efficiency standards for commercial buildings. Therefore, notification of ECBC by states and incorporating it in their model bylaws are the initial steps toward operationalising, enforcing, and achieving improved energy efficiency in commercial buildings. The Energy Conservation Building Code Rules of 2018 are the primary central government policies that inform sub-national actions on energy efficiency in commercial establishments
B1.2	**The urban local government has adopted energy efficiency provisions for buildings.** (Yes, if both are met) a. The municipal or local government provides incentives for energy-efficient/green building–compliant constructions (e.g., through a subsidy, tax incentive, fast-track clearance). b. Municipalities in the three most-populous cities in the state have included or revised bylaws to incorporate ECBC 2017 provisions.	• After notification of ECBC by states, they need to incorporate them into the Model Building Bye-Laws. Then, the code is adopted in the bylaws of large cities. Adopting the code demonstrates the state's seriousness and sets expectations for smaller cities.
B1.3	**States have simplified the process for complying with ECBC.** (Yes, if any two are met) a. The state has notified ECBC rules, laying out the process of enforcement and compliance with a clear description of roles and responsibilities of different institutions and agencies along the approval chain. b. The state has created a panel of ECBC professionals consisting of energy auditors, architects, and simulation experts. c. The top three most-populous cities in the state have an online single-window clearance process in place for approving buildings that comply with the code. d. The state or government agencies provide training on online tools or simulation software for users to demonstrate ECBC compliance.	• Compliance simplification is one way to facilitate ECBC adoption. • To simplify the process, some actions need to be taken by local bodies—these include having a step-by-step process in place, a portal for approving ECBC compliance, and a panel of ECBC professionals to check for compliance. • Based on a favourable review by the energy auditor on the panel, the requisite authority will provide the owner with an occupancy certificate. A building approval or occupancy certificate will not be provided when ECBC is not complied with. • There is software like eQuest and Simergy, as mentioned in the ECBC 2017 document, to create building simulations for energy modelling.

B1.4	**States have processes in place for implementing ECBC provisions and a framework for assessing them.** (Yes, if both are met) a. All new commercial buildings under the purview of ECBC are ECBC-compliant if they have been provided with an occupancy certificate in a municipal area in one of the three most-populous cities in the state, where ECBC has been adopted in municipal bylaws. b. All existing buildings in the municipal areas of the three most-populous cities are ECBC compliant for buildings that have undergone alterations or additions which increased their connected load above 100 kW or contract demand above 120 kVA, or as per the applicability criteria defined under the respective state or local ECBC.	• This is also an aspirational attribute. For states that have set up mechanisms for checking and verifying ECBC compliance, data on whether all commercial buildings within the ambit of the code are compliant is likely to be missing. SDAs do annually report to BEE the number of ECBC-compliant buildings in the state. We would like to see the sector develop better mechanisms for building stock record-keeping.
B1.5	**The state is prepared to implement ENS.** (Yes, if both are met) a. The state has demonstrated policy intent to adopt ENS by organising consultations and training workshops, among other efforts, to train relevant stakeholders on code provisions and tools. b. The state has completed one or more demonstration projects on ENS.	• Since ENS is currently voluntary (until official amendments made in the Energy Conservation Act make it mandatory), some states are taking a proactive approach, driven by bilateral assistance and support from BEE, to demonstrate preparedness to adopt ENS. Recent examples of policy intent to voluntarily adopt ECBC are demonstrated through affordable housing schemes meeting ENS mandates in Andhra Pradesh. Demonstration projects include those on government housing.

INDICATOR B2:

Promotion of grid-connected rooftop solar photovoltaic and solar water heaters in urban buildings

Using rooftop solar PV is a significant way to decarbonise the buildings sector while achieving the consumer-side renewable energy targets. These are laid out in states' energy or solar policies, which are in turn informed by the policies and targets set by the central government. India set a target of achieving 40 GW of grid-connected rooftop solar capacity by the end of 2022 under Rooftop Solar Programme Phase-II (PIB 2019), which it failed to achieve. However, the target deadline has been extended for another four years (MoNRE 2022) and implementation will continue through discoms with central financial assistance. The discoms have been allocated target capacities for rooftop solar projects and the Ministry of New and Renewable Energy (MoNRE) has launched an online platform for grid-connected rooftop solar PV for all states. In addition to this, many states have solar policies and have launched programmes to promote grid-connected rooftop solar to achieve the targets set by the central government. Phase two of the programme aims to reduce 45.6 tonnes of CO_2 per year.

Solar water heating has been identified as one of the most promising decentralised solar applications. Replacing an electric geyser with a solar water heater can significantly reduce energy consumption as well as emissions. Model Building Bye-Laws of the Ministry of Housing and Urban Affairs have provisions for solar water heating and these bylaws have been adopted by many states and urban local bodies.

On-site electricity generation is a more efficient method of meeting electricity demand (PEG 2012). The effectiveness of rooftop solar uptake is also determined by the regulatory support that the buildings sector can provide to promote on-site installation. More recently, we have also witnessed a revival of MoNRE's solar cities programme (the first version was launched in 2015), which aims to provide the policy fillip for the rooftop solar sector—electricity generation as well as water heating. This indicator covers all building typologies and consumer tariff categories in the state.

This indicator, using the criteria in Table 19, assesses plans, actions, incentives, achievements, and outcomes of the states regarding rooftop solar and solar water heaters.

Table 19: Promotion of grid-connected rooftop solar photovoltaic and solar water heaters in urban buildings

S. No	Attribute (Score: Yes=1, No=0)	Remark
B2.1	**There is a plan to develop rooftop solar installations.** (Yes, if both are met) a. The state has notified a solar policy in the last five years with specific targets for grid-connected rooftop solar (RTS) and/or behind-the-meter RTS solutions supported by battery energy storage systems and/or a policy for solar water heaters. b. Municipalities in the three most-populous cities or assessed discoms of the state have clear development guidelines, plans, and targets that encourage RTS installation and/or solar water heater installation.	• This indicator pertains to existing and new commercial, residential, and public buildings. • Since our objective is to focus on end-use efficiency, this indicator will include rooftop solar as well as solar water heaters. • Policy emphasis on RTS and solar water heaters includes a description of plans, targets/goals, incentives, schemes, and mandates to promote these solar technologies across building typologies.

S. No	Attribute (Score: Yes=1, No=0)	Remark
		• The Model Building Bye-Laws of 2016 stipulate RTS generation requirement of minimum 20 W per square foot or 5% of connected load, whichever is lower, to obtain an occupancy certificate. Here, we have kept roof space reservation requirements open-ended to account for geographic differences in the thresholds. Examples of development guidelines encouraging RTS and solar water heaters include the following: structural integrity guidelines for RTS, included in documents such as the Model Building Bye-Laws and Building Rules. We have assessed discoms with a total share of sales in the state of more than 15%. The list of assessed discoms is attached in annexure.
B2.2	**There are incentives for rooftop solar installation.** (Yes, if both are met) a. The state promotes RTS installation through incentive schemes and tariff nudges, in addition to central financial assistance. b. The regulator has created a regulatory environment supporting RTS by notifying net metering regulations with maximum allowed capacity of 100% of sanctioned load or contracted demand.	• In addition to central schemes to promote rooftop solar, various states have been implementing schemes such as Soura Gruha Yojane (Karnataka) and Surya Gujarat (Gujarat). This indicator assesses if the state also has its own programme and is promoting such a programme. • 'Incentive' is an overarching term which can include any monetary nudge for changing behaviour toward rooftop installation. • This indicator assesses a provision by the regulator to create a uniform regulatory environment for RTS which can help promote RTS installations.
B2.3	**Discoms have taken action to implement grid-connected RTS under the MoNRE RTS programme.** (Yes, if both are met) a. The assessed discom has created an RTS cell and designated a nodal officer at the division or sub-division level to implement an RTS project. b. The assessed discom or state agency has created an online portal to ensure a transparent, time-bound process for consumers by providing information about policies, incentives, and exemptions, among other topics, and allowing consumers to submit and track applications for grid-connected RTS.	• The government's grid-connected rooftop solar programme requires discoms to appoint nodal officers to implement RTS projects in their areas of supply. This indicator verifies if such officers have been appointed. • A single window mechanism can help consumers gain all relevant information in one place along with submitting an application for installing RTS. This indicator tracks whether the states have such mechanisms.

S. No	Attribute (Score: Yes=1, No=0)	Remark
B2.4	**The state has operational metrics for its RTS programme.** (Yes, if either is met) a. Assessed discoms publish data about the timeline for closing each RTS installation application and 90% of cases close within the timeline specified by the respective discom. b. Assessed discoms publish data about payouts to net- /gross-metered consumers regularly, and over 90% of the time, non-disputed payments are made on time and in full.	• This attribute tracks the operational parameters for rooftop solar—especially the touchpoints between the consumers and discoms—at the approval and payment stages. The payouts are the amounts paid by discoms to the consumer for supplying excess electricity to the grid. Here, we track if the discoms publish data on this and if payouts are made on time.
B2.5	**Discoms are achieving RTS targets.** (Yes, if either is met) a. Assessed discoms in the state have achieved the target capacity allocated to them under a grid-connected rooftop programme. b. Assessed discoms in the state have achieved targets set under their own RTS programmes.	• This attribute tracks whether the state has achieved outcomes under the national or state programme.

INDICATOR B3:

Promotion of energy-efficient appliances and equipment in buildings

Since the 1970s, energy performance standards and labels have been used by governments globally as policy instruments to steadily improve the average efficiency of appliances and equipment sold in the market. Launched by BEE in 2006, the Standards and Labelling (S&L) programme was the first programme in India to achieve two objectives:

1. Remove inefficient and the worst energy-performing products from the market

2. Provide consumers with the information needed to purchase energy-efficient products

To help achieve the first objective, as of January 2022, the mandatory Minimum Energy Performance Standard (MEPS) covered 10 products and 16 others under the voluntary scheme. To achieve the second objective, MEPS is accompanied by 'star labels', which enable comparisons of energy efficiency based on the number of stars given (there are endorsement labels for two product categories).

The Energy Conservation Act empowers state governments to enforce certain provisions for energy efficiency and energy conservation. This includes creating awareness on the importance of using energy-efficient appliances, building staff capacity on how to use energy efficiently and conserve energy, and providing incentives for using efficient appliances or equipment. States are expected to designate an agency to coordinate, regulate, and enforce provisions of the Energy Conservation Act. There are 36 State Designated Agencies, of which 16 are Renewable Energy Development Agencies, five are state government power departments, seven are electrical inspectorates, six are electricity distribution companies, and two (in Kerala and Andhra Pradesh) are stand-alone SDAs. BEE believes that not having exclusive/stand-alone agencies to implement energy efficiency programmes has been the reason behind delays in implementing central schemes and policies (BEE 2022). States have also been asked to establish a State Energy Conservation Fund (SECF), with BEE matching the contribution of the state government. However, the financial contributions of many states to SECFs has been stagnant over the last three years.[xv]

State governments can undertake initiatives on their own to increase the average efficiency of products sold, demonstrating their intent and seriousness about efficiency. The long-term market transformation toward higher-efficiency products is a continuous process of the BEE improving performance standards and the state engaging in activities at the local level to

1. build consumer awareness;

2. grow trust in the label; and

3. make the efficient alternative affordable and accessible to all.

Tracking state performance in delivering these activities can be a good starting point to assess the states' commitment and action to promote energy-efficient appliances. Table 20 includes criteria that can be used to track state performance.

Table 20: Promotion of energy-efficient appliances and equipment in buildings

S. No	Attribute (Score: Yes=1, No=0)	Remark
B3.1	**The state promotes energy-efficient appliances.** (Yes, if both are met) a. All assessed distribution utilities in the state are running programmes and schemes to promote energy-efficient four- and five-star labelled appliances and equipment in residential buildings such as lights, fans, air conditioners, and geysers. b. All assessed utilities in the major cities promote and support the adoption of energy-efficient equipment in commercial buildings such as energy-efficient HVAC, thermal energy storage, pumping systems, and motors.	• Discoms can take a programmatic view of promoting energy-efficient appliances with support from SERCs which can require that discoms allocate DSM or other budgetary funds to promote the uptake of energy-efficient appliances (e.g., running appliance rebate programmes). These could include an LED (light-emitting diode) programme. Other examples include appliance rebates and energy-efficient ceiling fans, transformers, and motor schemes. • For example, 'Filament Free Kerala' is one of the projects envisaged for the Urja Kerala Mission announced by the government of Kerala. Discom KSEB and the SDA EMC Kerala are implementing the project, which encourages consumers to switch from using incandescent lamps and compact fluorescent lights to energy-efficient LED bulbs. • Tata Power and Brihanmumbai Electricity Supply and Transport (Mumbai) have thermal energy storage/energy-efficient HVAC as part of DSM activities for commercial and industrial consumers.
B3.2	**The state or a state agency supports energy conservation and energy efficiency in buildings by promoting energy-efficient appliances.** (Yes, if either is met) a. State public procurement rules and/or budgeting guidelines have been amended so that public agencies purchase only BEE four- and five-star appliances and equipment. b. The SDA provides an incentive such as soft loans or subsidies to residential consumers to purchase four- and five-star appliances.	• At present, SECFs are largely funded by the central government, which is not ideal. The SECF can be used to meet all Energy Conservation Act 2001 provisions including promoting and increasing public awareness of energy-efficient appliances covered under BEE's S&L programme.
B3.3	**The SDA helps ensure compliance and conducts market surveillance.** (Yes, if both are met) a. The SDA has appointed inspecting officers to ensure compliance with S&L procedures and that labels are appropriately displayed in the state's appliance market. b. The SDA conducts market surveillance and maintains a list of non-complying appliances/equipment under S&L programme and submits quarterly reports on the outcome of market surveillance to the bureau	• It is the responsibility of the respective SDA to ensure compliance with S&L provisions by appointing inspecting officers, conducting market surveillance, maintaining a list of non-complying entities, and reporting data to BEE (DISHA initiative). This attribute assesses how well SDAs are fulfilling their mandate.

S. No	Attribute (Score: Yes=1, No=0)	Remark
B3.4	**The state facilitates public participation and promotes the use of energy-efficient appliances.** (Yes, if either is met) a. The state or SDA participates with CSOs, resident welfare associations, and educational institutions on an annual basis to create awareness among and engage the public on the importance of using energy-efficient appliances. b. The state, SDA, or discom conducts or participates in awareness campaigns for consumers and retailers and wholesalers on energy-efficient appliances and equipment.	• CSOs are integral to engaging the public and creating awareness. This attribute tracks if the state or SDA engages with CSOs or directly with consumers and retailers to generate awareness on the importance of energy-efficient appliances. • Creating awareness includes regularly publishing information in newspapers, on electricity bills, and through government offices, and engaging local officials with the public, among others.
B3.5	**State efforts to promote energy-efficient appliances are having a sufficient impact.** (Yes, if met) a. At least 50% of all appliances (mandatory appliances) sold in the state are four- or five-star labelled in accordance with the S&L programme.	• The attribute tracks the outcome of the S&L programme in the state. It is also an aspirational attribute, as tracking appliance sales at the state level is not the norm, though we hope it will become an important market transformation tracking mechanism. The threshold of at least 50% is to ensure that most appliances meet this goal.

INDICATOR B4:

Energy efficiency and clean energy considerations in public buildings

Public buildings are those that are accessible to the public and whose construction is funded by public sources. There are three categories of public buildings (Ranganathan 1988):

1. Those that are owned by the central or a state government

2. Those that are taken on lease or requisitioned by the central or a state government

3. Buildings owned or leased by or on behalf of any local authority or any public sector corporation

Consequently, public buildings cover a wide range of types including government offices (all); educational institutions; hospitals and health facilities; certain types of housing; [xvi] and places of religious, social, and cultural significance.

As per the sixth economic census, almost 16 percent of all establishments in the country that were employing people were owned by government agencies and public sector undertaking agencies. [xvii] Other than this data point, estimates on public building stock in literature are non-existent. In a study by Lawrence Berkeley National Laboratory (Iyer and Sathaye 2012), energy data from 130 public buildings showed that the energy use intensity in these buildings ranged from 20 to 500 kWh/m^2. State government agencies and entities can demonstrate leadership in accelerating energy-efficient buildings by

1. retrofitting old buildings;

2. mandating energy performance requirements for new buildings;

3. reforming public procurement policies and budgeting to allow for construction and occupancy of more efficient buildings;

4. setting building-level or portfolio-wide energy savings targets; and

5. conducting periodic energy audits.

These can be done by contracting Energy Service Companies (ESCOs) or other types of energy efficiency service providers. Table 21 provides criteria to assess energy efficiency and clean energy considerations in public buildings.

Table 21: Energy efficiency and clean energy considerations in public buildings

S. No	Attribute (Score: Yes=1, No=0)	Remark
B4.1	**The state mandates the use of energy star ratings and energy-efficient appliances in public buildings.** (Yes, if both are met) a. The state has made it mandatory for all public buildings to comply with Green Rating for Integrated Habitat Assessment (GRIHA), Indian Green Building Council (IGBC), Leadership in Energy and Environmental Design (LEED), or BEE star ratings through a gazette notification and an office memo or order to ensure compliance by state departments and agencies.	• The state's notification of ECBC applies to public buildings but more needs to be done to ensure compliance. This is also determined to some extent by participation from the state Public Works Department (PWD). For example, in Karnataka, the state PWD has been constructing ECBC-compliant government buildings, which was facilitated through two measures: a memo from KREDL (the SDA) to government departments on ECBC compliance; and bypassing local municipality approval for construction of public buildings.

S. No	Attribute (Score: Yes=1, No=0)	Remark
	b. State agencies have executed contracts with ESCOs/Renewable Energy Service Companies for implementation of energy efficiency/solar rooftop projects in public buildings in the last five years.	• State procurement guidelines are critical and must be changed to ensure procurement of only energy-efficient equipment and appliances. This attribute tracks whether this is done.
B4.2	**There is an inter-departmental committee to ensure energy efficiency in public buildings.** (Yes, if either is met) a. The state has constituted inter-departmental committees, missions, or programmes dedicated to implementing energy efficiency and energy conservation in public buildings. b. The municipalities of the three most-populous cities in the state have constituted inter-departmental committees, missions, or programmes dedicated to implementing energy efficiency and energy conservation in public buildings.	• Public bodies like state or local governments can constitute a committee to ensure that energy efficiency or energy conservation initiatives are implemented across their various departments. For example, in Surat, the Surat Municipal Corporation has an energy efficiency and energy conservation cell for promoting and implementing energy efficiency measures and use of renewables in the corporation's buildings and services. • This attribute tracks whether these bodies have appointed any such committees.
B4.3	**The use of renewable energy and energy efficiency in public buildings is promoted and periodic audits are conducted.** (Yes, if all are met) a. An energy management information system is used as per ECBC/ENS norms in all eligible public buildings. b. The state/municipality has mandated or has a scheme for promoting rooftop solar and/or solar water heaters in public buildings. c. The state/municipality has mandated that public buildings conduct energy audits once every three years and follow audit recommendations.	• Periodic energy audits can help track energy usage and how interventions can help in energy conservation/efficiency measures. This attribute tracks action taken by the state to promote the use of renewables and energy efficiency and undertake periodic energy audits. • Public buildings under the jurisdiction of a municipality include, for example, its offices, schools, hospital and health centres, and fire department.
B4.4	**The state PWD or other responsible authority has made a detailed design and requirements for energy-efficient buildings.** (Yes, if all are met) a. The PWD or any state construction agency has a maintenance plan which orients the buildings toward energy efficiency through retrofitting with energy-efficient technologies.	• The state PWD or any other responsible body for making and releasing building templates and guidelines are uniquely placed to ensure ECBC compliance. This attribute helps us track these actions by relevant authorities.

S. No	Attribute (Score: Yes=1, No=0)	Remark
	b. The state PWD or other agencies have amended their specifications to include solar PV rooftop plants for all new constructions. c. The state PWD, housing corporation, or any other agency has revised the schedule of rates (SOR) document for both electrical and civil works to include energy-efficient materials and equipment with BEE four- or five-star labels.	• ECBC cells created by BEE in different states are required to work with state PWDs to create enabling conditions for new public buildings to be ECBC compliant. These include making revisions to the SOR. BEE has identified these revisions as an important ECBC enforcement step at the state level.
B4.5	**Energy efficiency and renewable energy compliance are tracked for public buildings.** (Yes, if both are met) a. All new public buildings, under the scope of ECBC, in the three most-populous cities of the state constructed after 2020 are ECBC compliant/green buildings. b. All existing public buildings in the three most-populous cities of the state have undergone retrofitting in the last five years to achieve green building standards.	• This indicator tracks if the public buildings, both new and existing (which have undergone additions/alterations), are ECBC compliant.

INDICATOR B5:

Energy efficiency and clean energy considerations in affordable housing projects

An efficient building envelope must incorporate efficient building practices as well as passive design factors that are incorporated to make the dwelling less dependent on energy for lighting and cooling/thermal comfort requirements.

As per the India Cooling Action Plan (ICAP), prioritising thermal comfort in low-income households is necessary and aligns with the goal of achieving sustainable and thermal comfort for all of ICAP. By emphasising energy-efficient affordable housing, we are providing low-income populations an opportunity to access affordable cooling. As Telangana's draft Cool Roof Policy from 2019 states—'Slum communities are one of the groups that are the most susceptible to extreme heat because of the lack of access to cooling and that slum housing is often made of heat-trapping materials such as tin sheets, cement sheet (asbestos), plastic and tarpaulin without sufficient ventilation' (GoT 2019). As part of this policy, it identifies cool roofing for all low-income housing in Greater Hyderabad Municipal Corporation's heat action plan.

The programme PM Housing for All–Urban (Pradhan Mantri Awas Yojana–Urban, or PMAY-U) had a target of providing 12 million affordable homes by 2022, which has since been extended to December 2024 as the target was not met. While MoHUA, the central ministry responsible for this scheme, has made efforts to partially address the carbon/energy and resource footprint of PMAY-U housing construction through different initiatives (most notably a housing technology challenge), efficient construction and thermally comfortable affordable housing is dependent on states' willingness to act since states implement the programme.

Complementary to this, in the context of building efficiency, the Ministry of Environment, Forest and Climate Change's India Cooling Action Plan aims to ensure sustainable access to cooling for all. Focused specifically on the end use of cooling, and the expected rise in energy demand and emissions from this end use across sectors, the plan describes short-, medium-, and long-term recommendations to mitigate energy and emissions rise from cooling. Inclusive access to cooling is an explicit goal of the plan. While clear guidance is absent, states will be expected to eventually implement the plan.

This indicator uses the two above-mentioned policies to understand how states can ensure that beneficiaries of affordable housing projects can benefit from the clean energy transition and be provided thermally comfortable houses. This indicator uses criteria in Table 22 to assess states' statuses.

Table 22: Energy efficiency and clean energy considerations in affordable housing projects

S. No	Attribute (Score: Yes=1, No=0)	Remark
B5.1	**Energy efficiency is included in the affordable housing policy of the state.** (Yes, if either is met) a. The state's affordable housing policy or scheme describes the intent [xviii] to incorporate energy efficiency and thermal comfort considerations in the design and planning of buildings (such as innovative technologies,	• Historically, some states have incorporated green (also referred to as 'eco-friendly' or 'energy-efficient') housing considerations in their scheme guidelines. Examples of home design and construction with energy efficiency and thermal comfort considerations include shading, an efficient building envelope,

S. No	Attribute (Score: Yes=1, No=0)	Remark
	green materials, energy-efficient technologies, and incorporating ENS provisions in the scheme guidelines). b. The state has mandated ECBC-Residential, GRIHA, IGBC, or BEE rating certification for houses built under an affordable housing scheme.	passive cooling, natural lighting, and cross ventilation. • In addition to PMAY-U–allocated targets, states have their own schemes and programmes on affordable housing. Unless explicitly mentioned in the scheme guidelines or through a policy document, affordable housing, which typically is based on cost and speed considerations, will not have energy efficiency or green construction requirements for dwelling units. There have been recent examples of states adopting ENS voluntarily for their affordable housing projects. • This attribute tracks states' intent to incorporate energy efficiency considerations in their affordable housing policies or mandated certifications for energy efficiency for these houses.
B5.2	**There is financing available for energy-efficient affordable housing projects.** (Yes, if either is met) a. The state has allocated financial resources or identified funding sources for meeting any incremental costs to increase the number of energy-efficient affordable houses. b. The state provides an upfront subsidy or interest subsidy on loans for energy-efficient affordable houses.	• Financing is critical for energy-efficient households as these interventions are cost-intensive; to keep houses affordable, developers might compromise by using unsustainable materials. State governments, in addition to providing subsidies for housing, can also make an investment or divert a part of the subsidy to finance energy-efficient households through a subsidy on procuring material, equipment, and appliances. This is an aspirational indicator; while no states may be doing this at this time, the indicator can create awareness about this idea among the public.
B5.3	**States are implementing energy efficiency measures in affordable housing.** (Yes, if either is met) a. The state has issued technical guidelines for developers to incorporate energy efficiency considerations in affordable housing projects. This could include incorporating ENS provisions in the scheme's technical guidelines. b. The state makes it mandatory for DPRs submitted for approval by affordable housing developers/builders to describe design and material considerations for thermal comfort.	• The State-Level Empowered Committee for Affordable Housing can develop manuals of locally relevant architectural designs and material and technology options to guide private developers on design and construction practices to be followed for affordable housing projects. • In the case of PMAY-U, there are State-Level Sanctioning and Monitoring Committees (SLSMCs) headed by the chief secretary which can enforce guidelines for construction of projects under the scheme. There is also a State-Level Appraisal Committee for the techno-economic appraisal of DPRs. It can raise concerns with the SLSMC and prevent

S. No	Attribute (Score: Yes=1, No=0)	Remark
		non-compliant projects from proceeding. Similar committees can be established for non-PMAY-U affordable housing projects. • States have fixed benchmark costs for constructing affordable housing projects that are lower than market rates. To meet these low construction costs, builders may compromise on material selection. This attribute tracks the actions of states in this regard.
B5.4	**Solar energy is used in affordable housing projects.** (Yes, if met) a. Affordable housing policy mandates that rooftop solar PV or a solar water heater is used to meet common-area energy needs in mass affordable housing projects or for water heating purposes.	• Solar energy is a form of clean and affordable energy. It can offset the cost of electricity in affordable houses through net metering and can cut down on the cost to heat water by using solar heaters. This attribute tracks actions to ensure that solar energy provisions are made for affordable housing projects.
B5.5	**The state enforces compliance with these measures.** (Yes, if either is met) a. At least 50% of affordable housing projects in the three most-populous cities in the state meet energy efficiency guidelines including ENS provisions. b. The state has constituted committees to impose penalties on public agencies and developers not meeting requirements or guidelines.	• This aspirational attribute checks affordable housing policies to see if they include ENS provisions. It also helps assess whether the state has constituted a committee to ensure compliance and issued penalties for non-compliance. • We have chosen 50% as the threshold to ensure that the majority of projects comply with these guidelines. • The impact of ENS is predominantly important for energy-intensive urban buildings. Starting with implementation in the three most-populous cities could inspire other cities to adopt these measures. The three most-populous cities will constitute the bulk of energy consumption and have the most resources to implement this.

CROSSCUTTING INDICATORS

While energy transition is driven by sectoral actions and outcomes, these indicators capture some cross-cutting aspects relevant across the selected sectors.

The indicators in this section explore crosscutting aspects relevant to energy transition preparedness across the three selected sectors. These indicators track and analyse state-level planning by looking at frontline capacity, institutional coordination, and the approach to a just transition. India's energy transition is driven by a complex set of development imperatives, technology cost considerations, and climate mitigation considerations. Moreover, a significant part of India's decarbonisation and climate action commitments depend on its energy transition. Thus, state-level low-carbon development plans and climate strategies become critical to understanding state preparedness for the energy transition. Considering the interlinked nature of challenges and opportunities in the energy transition, institutional coordination across sectors is critical for a smooth transition. The decentralised and diffused nature of energy transition actions, involving planning and action at multiple levels, will require local and frontline capacity-building in the states. Finally, a disruptive, technology-driven energy transition could reinforce and exacerbate existing patterns of inequity and injustice and thus create resistance to the transition. Conscious state efforts to manage these disruptions and minimise losses are critical for a smooth energy transition. These crosscutting indicators were designed to draw indicative insights about the level of progress and preparedness on these fronts across the states studied.

The three crosscutting indicators include the following:

C1. Comprehensive state-level low-carbon development strategy

C2. Local and frontline capacity in the states

C3. Articulation of a just energy transition at the state level

INDICATOR C1:

Comprehensive state-level low-carbon development strategy

As the energy transition is a critical aspect of India's decarbonisation and climate pledges, we include an indicator to evaluate state-level low-carbon development (LCD) strategies to assess state intent and plans. Following the National Action Plan on Climate Change, states were required to prepare State Action Plans on Climate Change consistent with the strategy outlined in the national plan. While all states have complied with the requirement, few have taken independent initiatives to prepare updated climate change strategies and/or low-carbon development strategies. A second round of state climate action plans are being developed as mandated by the central government.

Considering the broad nature of these plans, and the way they are designed and developed, their thrust and coverage are not only indicative of state-level planning and processes, but also likely to be consequential to the energy transition trajectory. While it is important to track their implementation and progress, it is beyond the scope of ETPI to track all the intervention areas. Sectoral indicators capture implementation and outcomes in three sectors critical to the energy transition.

Through this indicator, we seek to understand if these strategies are updated to reflect changing dynamics and emerging risks and opportunities—an indication of states' commitment to decarbonisation and climate action. Do these strategies seek convergence between climate action, and developmental and environmental imperatives? Are these strategies developed through an inclusive and participatory process, reflecting the science and technical expertise as well as stakeholder perspectives? Do these strategies identify fiscal needs and opportunities? Are these planned actions environmentally beneficial, seeking to minimise local environmental and ecological pressures?

Table 23: Comprehensive state-level low-carbon development strategy

S. No	Attribute (Score: Yes=1, No=0)	Remark
C1.1	**There is a state-level low-carbon development plan or strategy.** (Yes, if both are met) a. The plan or strategy was approved by the state cabinet or government. b. The plan or strategy was developed or updated in the last five years.	• Our objective here is to assess the state's intent and articulation of a low-carbon development strategy. We emphasise a timely revision of these plans/strategies for continuity in planning and calibration with sectoral planning. • States are required to prepare State Action Plans on Climate Change and update them periodically. Some states have developed LCD or climate strategies through independent state-level processes. Researchers will score based on whether the strategy is available as a public document and has been approved by the state government/cabinet. • Score NO if the document has expired (or has a vision/target expiring) by the assessment year, even if the document was developed, revised, or approved in the last five years.

C1.2	**The state plan/strategy includes a sector-specific framework and targets.** (Yes, if both are met) a. The plan/strategy has sector-specific targets and a framework with a long-term horizon. b. The plan/strategy has an estimation of investment requirements for these interventions.	• Our intent is to examine if the states see decarbonisation/LCD as a sectoral goal and to measure the significance of the three sectors in the state-level LCD strategy. • A climate or LCD plan may cover various sectors. Our focus is on electricity, buildings, and transport. Score YES if at least these three sectors are covered. 'Targets' imply quantifiable targets and 'plans' imply sectoral vision of actions. Long term refers to 7 to 10 years, or the year 2030.
C1.3	**The development of the LCD/climate plan/ strategy is/was inclusive.** (Yes, if both are met) a. The plan/strategy was developed and updated through a process requiring inputs from and engagement with technical experts, sectoral departments/ministries, and CSO representatives. b. The development and revision of the plan/ strategy was based on public consultation.	• Our intent is to examine if such a plan/ strategy is based on local thinking, and thus incorporates state-specific considerations, as opposed to transplanting a broad vision. • Possible trajectory: The plan/strategy was developed/revised in consultation with a core group or committee that was composed of technical experts, representatives from government departments/ministries, and civil society members representing stakeholders and the public interest. The draft plan/strategy was published for public input/comments before finalisation.
C1.4	**There is a mechanism for monitoring and reporting progress on the plan/strategy.** (Yes, if both are met) a. The plan/strategy has a provision for periodic monitoring and reporting of progress and identifies an agency for that purpose. b. There is a provision for a digital platform to report annual progress that is accessible to the public.	• The states recognise the importance of monitoring and reporting for sustained low-carbon development. At this phase, we focus on intent and plan to track progress at a later phase. • Periodic refers to a specific time interval, which could be annual, biennial, or once every five years. The digital platform could be a dedicated web platform or an online repository on an existing website.
C1.5	**The state has an institutional setup to over-see progress and coordination on the plan/ strategy.** (Yes, if any two are met) a. The state has constituted an agency to oversee implementation of the plan/ strategy. b. The agency has identified nodal officers from departments (sectoral representatives) for coordination and accountability. c. The agency convenes periodic review meetings with sectoral and other representatives. d. The agency has avenues for collaboration and engagement with CSOs.	• The objective here is to see that the states have established an institutional setup for implementation of the LCD plan/strategy and coordination across concerned departments. • The last three sub-attributes are conditional on compliance with the first sub-attribute. Score YES if the state has complied with the first sub-attribute and at least one of the following sub-attributes. • This institutional setup could be broad-based, focused on climate mitigation and adaptation, or at least cover the energy transition across the assessed sectors.

INDICATOR C2:

Local and frontline capacity in the states

The decentralised and diffuse nature of the energy transition as well as LCD interventions will require capacity building at different tiers within the states. Dealing with localised challenges and opportunities would require bottom-up planning, execution, and proactive management of interventions. Thus, the capacity of frontline agencies and actors will be critical in state-level preparedness. While there has been some effort from the central government to engage and inform the district administrators seeking to build their capacities as part of some centrally sponsored schemes, state-level efforts are scarce and varied.

In this indicator, we focus on state-level efforts on local and frontline capacity building. Delegation of responsibilities to the local level is an important step toward preparing the frontline agencies. Do the state policies and legislations make provisions for city- and district-level infrastructure planning? Have the states issued guidelines on incorporating the energy transition and LCD goals into local development plans? Do the states provide fiscal support for such local climate and energy interventions? Are there state-level initiatives on capacity building of frontline staff on climate strategy and the energy transition? Are there avenues for civil society participation in the design and implementation of local interventions?

Frontline agencies and workers typically mean public servants and agencies within essential service sectors that directly engage with the service users, i.e., citizens and businesses. However, in this indicator, we focus on a subset of this—city and district administrations—for the assessment using the criteria in Table 24. It is beyond the scope of ETPI to cover plans and processes at all levels of local governance. We propose covering the three most-populous districts and/or cities in each state.

Table 24: Local and frontline capacity in the states

S. No	Attribute (Score: Yes=1, No=0)	Remark
C2.1	**The state has city- or district-level LCD/ climate plans.** (Yes, if any two are met) a. Municipal cities/districts in the state have prepared LCD/climate strategies. b. The strategy was developed through a process requiring input from and engagement with district/city administration. c. The strategy was developed through public consultation. d. There are sector-specific action plans focusing on goals, actions, and implementation.	• City/district plans signify mainstreaming of climate/LCD considerations at the local level. • Score YES if the state has such plans for at least the three most-populous municipal cities or districts. • Examples of city/district climate/LCD plan processes can be found in Times of India (2022).

S. No	Attribute (Score: Yes=1, No=0)	Remark
C2.2	**The state has policies creating scope for district- and/or city-level infrastructure planning (with a particular focus on the three assessed sectors).** (Yes, if either is met) a. The state LCD/climate strategy identifies the role of district- and/or city-level bodies in implementing identified actions. b. Sectoral policies identify the role of district- and/or city-level bodies in implementing identified actions within each sector.	• Our intent is to recognise city and district administrations as important agencies for implementing LCD and climate interventions and, thus, building frontline capacity. • State legislation or policies make provisions for the district and/or city administrations to plan for electricity, transport, and building infrastructure, with reference to LCD and energy transition goals.
C2.3	**The state has commissioned studies on local (regional/district/city) variations in climate impacts and opportunities for LCD interventions.** (Yes, if either is met) a. The state has commissioned a comprehensive and comparative assessment at the state level. b. City and/or district administrations have prepared assessment reports.	• Knowledge creation is important in assessing the capacity requirement, and thus, to capacity building. • Such an assessment may be published independently or as part of the LCD/climate plans. But these need to be comprehensive, capture regional diversity, and cover at least the three assessed sectors.
C2.4	**There are state-level efforts on capacity building for frontline staff on LCD, the climate strategy, and the energy transition.** (Yes, if either is met) a. There are initiatives for furthering knowledge and training of frontline staff. b. There are institutions set up for training/capacity building of frontline staff.	• Our objective is to map the state-level efforts to train frontline staff as a complement to the central government interventions. • Look for orientation sessions and workshops on climate change for government officials to better understand climate change dynamics and impacts, along with opportunities and issues related to adaptation and mitigation. • Study work done by field-level institutions, strategic partners, and research centres for sub-attribute b.
C2.5	**There are avenues for CSO participation in the design and implementation of LCD/climate interventions.** (Yes, if met) a. CSOs are recognised and included in the committees responsible for developing such plans/strategies.	• Our objective is to recognise CSOs as important stakeholders in LCD and the energy transition. Building on stakeholders' perspectives in LCD and energy transition plans is important for implementation. • CSOs include consumer groups, trade associations, citizen groups, universities, and local leaders, among others.

INDICATOR C3:

Articulation of a just energy transition at the state level

A technology-driven energy transition is likely to be disruptive. Such disruptions have the potential to affect the existing order and exacerbate social and economic inequalities. Consequently, the economic losers would create barriers to the transition. An effective and smooth energy transition would require minimising the disruptions and losses and maximising the opportunities and gains. A just transition is a framing and development approach that seeks to maximise the social and economic opportunities of LCD and climate actions, while minimising and managing the losses incurred. In the Indian context, a just transition approach also involves addressing the chronic inequities and unjust practices in energy access and dependencies.

Just transition is a relatively new concept in the Indian context. However, it is being widely discussed in the policy discourse and there is an emerging consensus on mainstreaming justice as part of low-carbon development. While a 'just transition' approach is critical to sustaining the energy transition toward full decarbonisation, we also recognise the embryonic state of this framing. This indicator seeks to assess states' articulation of just transition and multiple aspects of justice as part of low-carbon development interventions. The indicator also captures four aspects of justice that have a direct and immediate bearing on the state and society. The indicator assessments can be done using the attributes and sub-attributes as indicated in Table 25 to understand just energy considerations in the energy transition.

Table 25: Articulation of a just energy transition at the state level

S. No	Attribute (Score: Yes=1, No=0)	Remark
C3.1	**The LCD strategy or sectoral policies in the state have some articulation of a just transition approach.** (Yes, if met) a. As part of the assessed sectoral and LCD/climate policies/plans, the state has articulated justice considerations.	• Our intent is to capture the state's intent to engage with a just transition approach and mainstream justice concerns as part of LCD/climate/energy transition interventions. • Look for any articulation of 'justice' or 'just transition' in the sectoral policies (all three sectors) and LCD strategy. Score YES if found in either. Our objectives are to see if states think of justice beyond the conventional approach to providing compensation for direct loss and if they see just transition as a development approach. The latter would particularly include explicit considerations for consequential effects of low-carbon interventions. Articulation could be seeking to find evidence through assessments, targeted interventions, or building institutional capacity.
C3.2	**The state policies on LCD/ energy transition identify the communities that are affected by these interventions.** (Yes, if both are met)	• Our intent is to ensure that states place communities and people at the centre of the LCD and energy transition.

S. No	Attribute (Score: Yes=1, No=0)	Remark
	a. The policies identify the communities/population affected and make provisions for compensation. b. The policies identify the communities/population for targeted benefit delivery.	• Focus only on the policies in the assessed sectors (all three) and state-level LCD/climate plan. Score YES if found in either. • Communities could imply certain occupational categories or income groups. • For example, the states should consider the consequences of acquiring farmland to convert to solar parks while planning for the energy transition.
C3.3	**The state policies on LCD/the energy transition identify the impacts on jobs and livelihoods.** (Yes, if both are met) a. The policies identify the loss of jobs and livelihoods. b. The policies identify job and livelihood opportunities.	• Our objective is to ensure that job and livelihood creation is treated as a co-benefit of LCD and the energy transition and adequate attention is paid to job and livelihood losses as a consequence of the transition. • Quantify job and livelihood loss and creation as part of LCD and energy transition interventions. Score YES if the state has estimated numbers for the three assessed sectors or at the state level. • For example, displacement of ICE vehicles with EVs will impact the livelihoods of mechanics. EV expansion will also create new jobs.
C3.4	**The state policies on LCD/ the energy transition identify ecological impacts (with a focus on land, water, and air).** (Yes, if both are met) a. The policies identify ecological impacts (losses and gains). b. The policies include measures to address/minimise the losses.	• Our intent is to measure whether states recognise LCD and the energy transition as instruments to ensure ecological justice. • Assessed policies identify the stresses on natural resources (particularly land, water, and air) and opportunities for gains, and propose measures to minimise these stresses. • It is important that each of the sectoral policies has addressed ecological justice. However, score YES if the assessed policies collectively meet both sub-attributes. • Ideally, the impacts can be quantified. In this phase, we will explore if the states recognise these impacts and opportunities.
C3.5	**The state policies on LCD/ the energy transition identify macro-economic challenges and opportunities.** (Yes, if either is met) a. The policies estimate investment opportunities and public investment. b. The policies estimate the impact on public finance (loss of tax revenue).	• Our intent is to ensure that states are cognisant of the macro-economic challenges and opportunities. • Sub-attribute a seeks to ensure that states have estimated the investment potential for the state, for at least the three sectors or at the state level, and that they also have an amount of public investment committed. • Sub-attribute b seeks to determine if the states have an estimation of loss to fossil taxes (petroleum and coal) as an outcome of the energy transition.

CONCLUSION

The energy transition in India must meet multiple competing priorities including improving energy access, increasing energy security and self-reliance, meeting demand growth for economic development, and undergoing decarbonisation to mitigate climate change. India is poised to embark on this transition path with ambitious targets for renewable energy, energy intensity reduction, electrification of transportation, and sustainable buildings. Achievement of these targets, the pace of this transition, and its consequences will be shaped by the plans, actions, and governance processes at the state level.

These transition preparedness indicators are meant to help researchers understand and analyse the energy transition plans, actions, governance processes, and outcomes in Indian states. The findings from this indicator-based assessment will fill the information gap and enable cross-state learning by complementing available techno-economic analyses. The assessment will be supplemented with a set of case studies on new initiatives and emerging trends to provide a complete picture of energy transition preparedness in Indian states. Through this assessment, ETPI aims to build evidence around critical governance and political-economy aspects of the transition as a necessary complement to the techno-economic discourse. With assessments across states and over time, ETPI will track progress, highlight good practices, and underscore lessons learned from variegated transition trajectories in the states.

This guidebook is a compendium of the indicators, provides guidelines for researchers, and justifies the normative framework. The indicators were designed as a composite set, together covering policy intent, effectiveness of processes, institutional capacity, and outcomes across various drivers and enablers of the transition. The intent is to establish a framework to track transition-related changes which is specific and tangible but not prescriptive.

These indicators and the guidebook were developed for the first phase of ETPI, which will include two annual assessments. In the current version, the guidebook and containing indicators cover three sectors—electricity, buildings, and transport—that are critical to the energy transition. Moreover, considering the dynamic nature of the transition, over time, we plan to revise the indicators and update the guidebook to capture new trends and developments in the assessed sectors as well as raise the thresholds to match progress in the states.

Finally, these indicators and the guidebook will be used by the consortium partners—CPR, PEG, and WRI India—to assess energy transition preparedness in 10 states that together account for about 63 percent of India's energy demand. Going forward, in the next phases, ETPI assessments may be expanded to cover other states.

LIST OF ABBREVIATIONS

AMI: Advanced Metering Infrastructure

AMR: Automatic Meter Reading

BEE: Bureau of Energy Efficiency

BPL: below poverty line

CERC: Central Electricity Regulatory Commission

CMP: Comprehensive Mobility Plan

CSO: civil society organisation

discom: distribution companies

DPR: detailed project report

DSM: demand-side management

DT: distribution transformer

ECBC: Energy Conservation Building Code

EE: energy efficiency

ENS: Eco Niwas Samhita

ESCO: Energy Service Company

ETPI: Energy Transition Preparedness Initiative

EV: electric vehicle

FAME: Faster Adoption and Manufacturing of Electric Vehicles

FY: fiscal year

GDP: gross domestic product

GIS: Geographic Information System

GRIHA: Green Rating for Integrated Habitat Assessment

GW: gigawatt

ICAP: India Cooling Action Plan

ICE: internal combustion engine

IGBC: Indian Green Building Council

IRP: integrated resource planning

LCD: low-carbon development

LEED: Leadership in Energy and Environmental Design

LT: low tension

MoHUA: Ministry of Housing and Urban Affairs

MoP: Ministry of Power

MoRTH: Ministry of Road Transport and Highways

MTOE: million tonnes oil equivalent

MYT: multi-year tariff

NMT: non-motorised transport

PMAY-U: Pradhan Mantri Awas Yojana–Urban

PMGSY: Pradhan Mantri Gram Sadak Yojana

PPA: power purchase agreement

PPP: public-private partnership

PV: photovoltaic

PWD: Public Works Department

RE: renewable energy

RPO: renewable purchase obligation

RTS: rooftop solar

SDA: State Designated Agency

SECF: State Energy Conservation Fund

SERC: State Electricity Regulatory Commission

STU: State Transport Undertaking

UDAY: Ujwal Discom Assurance Yojana

END NOTE

i. Identification and mitigation of socio-environmental impacts of RE capacity addition is important but there is limited development on the legislative, policy, and regulatory fronts toward this end. Given the limitation of information, this indicator does not focus on socio-environmental impacts.

ii. The Central Electricity Authority (CEA) carries out an Electric Power Survey every five years in consultation with the states and utilities and forecasts year-by-year electricity demand, by state and region, for the next 10 years and for the 15th and 20th years. The CEA also prepares a National Electricity Plan once every five years, with a short-term (five-year) framework and long-term (15-year) perspective.

iii. Some such schemes are 'PM-KUSUM' for solarisation of agricultural pump sets and 'DDUGJY' for feeder separation.

iv. Based on the work we have done with states, most consumers that are metered do not have functional meters.

v. Based on PEG's analysis, which is based on data sourced from the CEA annual general review, additional surcharge petitions, tariff petitions, and orders of various states.

vi. As indicated in India's Biennial Update Reports to the United Nations Framework Convention on Climate Change (UNFCC n.d.).

vii. Inferred from ETPI pilot assessments.

viiii. PMGSY Dashboard and annual reports are possible data sources.

ix. PMGSY aims to provide good all-weather road connectivity to unconnected villages.

x. PMGSY programme guidelines ensure participatory planning through transect walks.

xi. Assessed based on the national average of the number of buses per 100,000 people operated by the state transport undertaking in India.

xii. Based on practices of major STUs in India.

xiii. Assessed based on the national average of the number of buses per 100,000 people operated by the state transport undertaking in India.

xiv. There are ECBC+ and ECBC++ certifications available as well. For our indicator, we will maintain ECBC as our benchmark to evaluate states.

xv. Funding was ₹40 million in 2017–18, ₹60 million in 2018–19, and ₹60 million in 2019–2020.

xvi. National Building Code 2016 has a category on group housing which includes housing that is built on land owned by public agencies such as housing authorities and boards and construction is undertaken by one agency.

xvii. The economic census classifies the establishments by 'activity group'—40.96 percent of establishments were engaged in activity group 'education', followed by 'public administration and defence: compulsory social security' (20.18 percent). These were the two most significant activity groups, which, taken together, constitute 61.14 percent of the total non-agricultural establishments with hired workers under 'Govt. & PSUs'.

xvii. Or, for ease of use, we can identify certain keywords, such as 'thermal comfort' and 'natural light/ventilation', that must be present in the policy or scheme document.


VIPER
FIREFOX
Shimano

REFERENCES

BCG (Boston Consulting Group). 2021. Unlocking Cities: The Impact of Ridesharing across India. Boston: BCG Global. https://www.bcg.com/unlocking-cities-the-impact-of-ridesharing-across-india.

BEE (Bureau of Energy Efficiency, Ministry of Power, Government of India). n.d. "Energy Benchmark for Commercial Buildings." New Delhi: Bureau of Energy Efficiency. https://www.beeindia.gov.in/sites/default/files/Flyer_22nd%20Jan.pdf. Accessed March 10, 2023.

BEE. 2017. Energy Conservation Building Code, 2017. New Delhi: Bureau of Energy Efficiency. https://beeindia.gov.in/sites/default/files/BEE_ECBC%202017.pdf.

BEE. 2018. Eco-Niwas Samhita 2018, Part 1: Building Envelope. New Delhi: Bureau of Energy Efficiency. https://www.beeindia.gov.in/sites/default/files/ECBC_BOOK_Web.pdf.

BEE. 2021. Eco-Niwas Samhita 2021, Part 2: Electro Mechanical and Renewable Energy Systems. New Delhi: Bureau of Energy Efficiency. https://beeindia.gov.in/sites/default/files/ENS%202021.pdf.

BEE. 2022. "Promoting Energy Efficiency Activities in Different Sectors: Scheme for Strengthening of SDAs (Operational Guidelines)." New Delhi: Bureau of Energy Efficiency. https://beeindia.gov.in/sites/default/files/Guidelines%20SDA%20Book%20PRINTED%20ONE_0.pdf.

CEA (Central Electricity Authority, Ministry of Power, Government of India). 2022. "Executive Summary on Power Sector April 2022." New Delhi: Central Electricity Authority.

CEM (Clean Energy Ministerial). n.d. "UK and Seven Major Companies Join EV30@30 Campaign." Clean Energy Ministerial. https://www.cleanenergyministerial.org/uk-and-seven-major-companies-join-ev3030-campaign/. Accessed October 6, 2022.

FE (Financial Express). 2016. "India's Crude Oil Import Bill Halves to $64 Bn in 2015–16." Financial Express, April 20. https://www.financialexpress.com/economy/indias-crude-oil-import-bill-halves-to-64-bn-in-2015-16/240446/.

GoT (Government of Telangana, India). 2019. Making Telangana a Cool State: State Wide Cool Roofs Program. Telangana, India: Government of Telangana). https://tsredco.telangana.gov.in/PDFs/Telangana_Cool_Roofs_Policy_for_Public_Comments.pdf.

IEA (International Energy Agency). 2015. Energy and Climate Change: World Energy Outlook Special Report. Paris: International Energy Agency.

IEA. 2021a. "Greenhouse Gas Emissions from Energy Data Explorer." Paris: International Energy Agency. https://www.iea.org/data-and-statistics/data-tools/greenhouse-gas-emissions-from-energy-data-explorer.

IEA. 2021b. India Energy Outlook 2021. Paris: International Energy Agency.

Iyer, M., and J. Sathaye. 2012. Market Assessment of Public Sector Energy Efficiency Potential in India. Berkeley, CA: Lawrence Berkeley National Laboratory.

Kakar, K.A., and C.S.R.K. Prasad. 2020. "Impact of Urban Sprawl on Travel Demand for Public Transport, Private Transport and Walking." Transportation Research Procedia 48: 1881–92.

Litman, T. 2017. Evaluating Accessibility for Transport Planning. Victoria, BC: Victoria Transport Policy Institute.

MoNRE (Ministry of New and Renewable Energy, Government of India). 2022. Extension of Phase 2 of Grid Connected Rooftop Solar Programme. New Delhi: Ministry of New and Renewable Energy.

MoSPI. (2021). Energy Statistics 2021.

MoP (Ministry of Power, Government of India). n.d. "State of Overdues to Genos by Discoms." http://praapti.in/. Accessed October 17.

MoP. 2018. "Long Term Growth Trajectory of Renewable Purchase Obligation for Solar and Non solar for Period of 3 years i.e. 2019-20 to 2021-22." New Delhi: Ministry of Power, June 14.

MoP. 2020. "Presentation at the Conference of Power Ministers by the Ministry of Power." New Delhi: Ministry of Power.

MoP. 2021. "All India Electricity Statistics: General Review 2021." New Delhi: Ministry of Power.

MoP. 2022. "Renewable Purchase Obligation and Energy Storage Obligation Trajectory till 2029–30." New Delhi: Ministry of Power, July 22.

MoPNG (Ministry of Petroleum and Natural Gas, Government of India). 2021. "India Imports More than 85% of Its Oil Demand." New Delhi: Ministry of Petroleum and Natural Gas, Lok Sabha Unstarred Question No. 1076, February 8.

MoRTH (Ministry of Road Transport and Highways, Government of India). 2017. Review of the Performance of State Road Transport Undertakings. New Delhi: Ministry of Road Transport and Highways.

MoRTH. 2018. Road Transport Yearbook 2017–18. New Delhi: Ministry of Road Transport and Highways.

MoRTH. 2019. Road Transport Yearbook 2018–19. New Delhi: Ministry of Road Transport and Highways.

Nesler, C., K. Poh Lam, and B. Lasternas. 2021. "How to Build Smart, Zero Carbon Buildings—and Why It Matters." World Economic Forum, September. https://www.weforum.org/agenda/2021/09/how-to-build-zero-carbon-buildings/.

NIE (New Indian Express). 2018. "14 out of World's 20 Most Polluted Cities in India: WHO." New Indian Express, May 2. https://www.newindianexpress.com/nation/2018/may/02/14-out-of-worlds-20-most-polluted-cities-in-india-who-1809107.html.

NITI Aayog (NITI Aayog, Government of India). 2019. "Energy Balances for 2019." Energy Dashboards by NITI Aayog. https://niti.gov.in/edm/#balance.

NTDPC (National Transport Development Policy Committee, Government of India). 2014. India Transport Report, Moving India to 2031. Vol 1. New Delhi: National Transport Development Policy Committee.

PEG (Prayas (Energy Group)). 2012. Solar Rooftop PV in India. Prayas (Energy Group).

PEG. 2016. Renewable Energy Data Portal, November 25. https://energy.prayaspune.org/renewable-energy-data-portal/prices.

PEG. 2018a. "Many Sparks but Little Light: The Rhetoric and Practice of Electricity Sector Reforms in India." Pune, India: Prayas (Energy Group), January 24. https://energy.prayaspune.org/our-work/policy-regulatory-engagements/many-sparks-but-little-light-the-rhetoric-and-practice-of-electricity-sector-reforms-in-india.

PEG. 2018b. Electricity Distribution Companies in India: Preparing for an Uncertain Future. Pune, India: Prayas (Energy Group). https://energy.prayaspune.org/our-work/policy-regulatory-engagement/research-report/electricity-distribution-companies-in-india-preparing-for-an-uncertain-future.

PEG. 2018c. Understanding the Electricity, Water, Agriculture Linkages, Volume 2. Pune, India: Prayas (Energy Group). https://energy.prayaspune.org/images/pdf/electricity-water-agri-vol-2-electricity_supply_challenges.pdf.

PEG. 2019. The Percentage Problem: A Commentary on the Methodologies for Estimating Transmission and Distribution Loss in Indian Regulatory Practice. Pune, India: Prayas (Energy Group). https://energy.prayaspune.org/our-work/research-report/the-percentage-problem.

PEG. 2021a. Maharashtra's Electricity Supply Mix by 2030: Cost and Reliability Insights from a GridPath Production Cost Modelling Exercise. Pune, India: Prayas (Energy Group).

PEG. 2021b. PIER: Modelling the Indian Energy System through the 2020s. Pune, India: Prayas (Energy Group). https://energy.prayaspune.org/our-work/research-report/pier-modelling-the-indian-energy-system-through-the-2020s.

PEG. 2021c. "Additional Surcharge on Captive: Bold Move, but Still Is Anybody's Game." Pune, India: Prayas (Energy Group), November 10. https://energy.prayaspune.org/power-perspectives/additional-surcharge-on-captive-bold-move-but-still-is-anybodys-game?filter_.

PFC, GoI. 2022. "Report on Performance of Power Utilities 2020 21

PIB (Press Information Bureau, Government of India). 2019. "Cabinet Approves Phase-II of Grid Connected Rooftop Solar Programme for Achieving Cumulative Capacity of 40,000 MW from Rooftop Solar Projects by the Year 2022." Press Information Bureau, February 19. https://pib.gov.in/Pressreleaseshare.aspx?PRID=1565282.

PPAC (Petroleum Planning & Analysis Cell, Ministry of Petroleum & Natural Gas, Government of India). 2023. "Historical Data on Consumption of Petroleum Products." https://ppac.gov.in/consumption/products-wise.

Ranganathan, S. 1988. "State of U.P.& Another vs Malik Zarid Khalid AIR." Supreme Court of India.

Steinemann, M., and S. Kessler. 2021. "Decarbonizing the Building Sector." Nairobi: United Nations Environment Programme. https://globalabc.org/sites/default/files/2021-07/Decarbonizing%20the%20building%20sector.pdf.

Singh, D., and A.K. Swain. 2018. Fixated on Megawatts: Urgent Need to Improve Power Procurement and Resource Planning by Distribution Companies in India. New Delhi: Centre for Policy Research.

Times of India. 2022. "Dist Climate Action Plan in the Works: Bengal Minister." Times of India, June 22. https://timesofindia.indiatimes.com/city/kolkata/dist-climate-action-plan-in-the-works-bengal-minister/articleshow/92375740.cms.

Tricoire, J.-P. 2021. “Buildings Are the Foundation of Our Energy-Efficient Future.” World Economic Forum, February 22. https://www.weforum.org/agenda/2021/02/why-the-buildings-of-the-future-are-key-to-an-efficient-energy-ecosystem/.

UNESCAP (United Nations Economic and Social Commission for Asia and the Pacific). 2013. Transport and Communications Bulletin for Asia and the Pacific. No. 83. Bangkok: United Nations Economic and Social Commission for Asia and the Pacific. Microsoft Word - bulletin83_Cover page (unescap.org).

UNESCAP. 2015. “Integrated National Transport Planning and Policy Formulation.” Bhutan: UNESCAP Capacity Building Workshop. 07 Integrated transport planning and Policy Formulation.pdf (unescap.org).

UNFCCC (United Nations Framework Convention on Climate Change). n.d. Biennial Update Report Submissions from Non-Annex I Parties. United Nations Framework Convention on Climate Change. https://unfccc.int/BURs.

World Bank. 2021. Traffic Crash Injuries and Disabilities: The Burden on Indian Society. Washington, DC: World Bank.

ACKNOWLEDGEMENTS

The authors are grateful to the following peer reviewers for their valuable comments: Kanagaraj Ganesan and Rajkumar Balasubramanian (Integrative Design Solutions); Amit Bhatt (International Council on Clean Transportation); Sophie Boehm, Katrina McLaughlin, and Davida Wood (WRI); Daljit Singh (Centre for Social and Economic Progress); Satish Kumar and Sangeeta Mathew (Alliance for an Energy Efficient Economy); Deepak Krishnan (WRI India); Sreekumar Nhalur (PEG); Sudhir Chella Rajan (Indian Institute of Technology Madras); Thomas Spencer (International Energy Agency); and Shivanand Swamy (CEPT Research and Development Foundation).

We also thank colleagues Namrata Ginoya, Mehul Garg, Kanika Gounder Shilpa Kharwal, Vaisakh Kumar, Chaitanya Kanuri, Sandra Kamar, Uttara Narayan, Yash Singh Rawat Anirudh Ray and Dhilon Subramanian from WRI India for their support and contributions to this guidebook.

Photo Credits:
Page 106: Ashwini Kumar
All other Image used under license from
Shutterstock.com.

Designed by:
Poorva Kelkar
Gati Narvekar

Disclaimer: The guidebook represents analysis and views of the authors alone, who also are responsible for accuracy and interpretation.

ENERGY TRANSITION PREPAREDNESS INITIATIVE

Energy Transition Preparedness Initiative (ETPI) is a consortium of Centre for Policy Research, Prayas (Energy Group) and World Resources Institute, India.

CENTRE FOR POLICY RESEARCH

Prayas (Energy Group)

WRI INDIA