

Environmental Sustainability in India: Challenges, Policies, Progress and Future Directions

Submitted by

Rohit Antil

Roll No.: 22041504056

Department of Commerce

Maharaja Agrasen College

University of Delhi

(May, 2026)

ABSTRACT

Environmental sustainability remains one of the most pressing policy challenges for India, a nation balancing rapid economic growth, high population density, and acute climate vulnerability. This study critically examines the issues, policies, developments, and prospects of environmental sustainability in India from the launch of the National Action Plan on Climate Change (NAPCC) in 2008 to the latest available data (2025–2026). Drawing on government reports (Economic Survey, India State of Forest Report, SDG India Index, CPCB), peer-reviewed literature, and international assessments (IPCC, IEA, UNFCCC), the research provides an updated, integrative synthesis. It highlights notable achievements, including the early attainment of the 50% non-fossil fuel power capacity target, significant growth in renewable energy (solar and wind additions), reduction in emissions intensity of GDP, and incremental gains in forest and tree cover. These advances align with key Sustainable Development Goals, particularly SDG 7 (Affordable and Clean Energy). However, persistent and interconnected challenges undermine overall progress. Air pollution continues as a severe public health crisis, with many cities recording PM_{2.5} levels far exceeding WHO guidelines. Water stress and pollution affect hundreds of river stretches, while groundwater over-exploitation and gaps in sewage treatment persist. Land degradation, biodiversity loss, and uneven policy implementation—particularly at subnational levels—further compound vulnerabilities. Structural issues such as coal dependency, institutional fragmentation, fiscal constraints, and enforcement gaps limit effectiveness despite ambitious frameworks like updated NDCs, Mission LiFE, and NCAP. Employing a descriptive-analytical approach with thematic document analysis and quantitative trend examination of key indicators (renewable capacity, forest cover, SDG scores, pollution levels), this study assesses progress, identifies implementation gaps, and offers evidence-based policy recommendations. It underscores that sustainability is not an optional add-on but a prerequisite for India's long-term growth, equity, and resilience in the face of climate risks.

CHAPTER 1:

INTRODUCTION

1.1 Background and Context

The issue of environmental sustainability has become one of the most significant policy challenges that confronts India in the twenty-first century. India is a country of immense population, and the fifth largest economy by the nominal Gross Domestic Product (GDP) in the world, hence the country is in a position of immense developmental aspiration

and ecological constraint (Ministry of Finance, 2025). It is home to about 17.8% of the world's population in a mere 2.4% of its landmass, putting significant strain on forests, freshwater, soils and air (MoEFCC, 2024a). India, on the other hand, is a developing country, and its projected growth, urbanization and increase in energy demand will significantly affect the world's capacity to stay within the Paris Agreement (UNFCCC) temperature limits (United Nations Framework Convention on Climate Change [UNFCCC], 2022).

The concept of environmental sustainability in India dates back to the Stockholm Conference (1972) and the Brundtland Commission's definition of 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (World Commission on Environment and Development [WCED], 1987, p. 43). In India, this normative regime has been increasingly codified into law and obligations, under, Article 48A of the Indian Constitution; the Water (Prevention and Control of Pollution) Act, 1974; the Air (Prevention and Control of Pollution) Act, 1981; the Environment (Protection) Act, 1986 and, more recently, the National Action Plan on Climate Change (NAPCC) of 2008 (Prime Minister's Council on Climate Change, 2008). This layered environmental governance structure is aimed at achieving a balance between development and ecological wisdom.

But the institutional setting in which policy is made in India is still tough. Per capita income has been growing, but remains substantially lower than the world average, and almost two-thirds of the population rely, directly or indirectly, on the climate-sensitive sectors – agriculture, forestry and fisheries (Ministry of Finance, 2025). According to International Energy Agency (IEA, 2024), India's energy demand is expected to rise at a faster rate than that in any other major economy in the next 10 years. Although there has been a spectacular growth in renewable energy capacity (Central Electricity Authority [CEA], 2025; Ministry of Statistics and Programme Implementation [MoSPI], 2025), coal continues to supply around 74–76% of the electricity generated from the utility sector. The challenge of reconciling the fast pace of socio-economic change with planetary boundaries is thus a central challenge of the public policy of the day in India.

1.2 Linkage with the Sustainable Development Goals

The 2030 Agenda for Sustainable Development adopted by all the Member States of the United Nations in 2015, now forms the wider international framework for measuring India's environmental performance (United Nations [UN], 2015). India's environmental performance now is measured within a wider international framework, the 2030 Agenda for Sustainable Development, agreed by United Nations Member States in 2015. Out of the total seventeen Sustainable Development Goals (SDGs), some address the issue of environmental sustainability explicitly and are of special relevance to the situation in India. SDG 6 (Clean Water and Sanitation) addresses the chronic problem of water quality and access with 296 polluted stretches of rivers in 271 rivers still needing to be restored, as per Central Pollution Control Board ([CPCB], 2022). The SDG 7 (Affordable and Clean Energy) aligns with India's vision of renewable energy and the recently reached milestone of 50% of installed power capacity from non-fossil sources (Ministry of New and Renewable Energy [MNRE], 2025). Air pollution is highlighted as one concern for SDG 11 (Sustainable Cities and Communities) and several cities in India are among the most polluted cities in the world (Centre for Science and Environment [CSE] 2025). SDG 12 (Responsible Consumption and Production) is being implemented by Mission LiFE (Lifestyle for Environment) and the Extended Producer Responsibility regulations on plastic waste (MoEFCC, 2022b). SDG 13 (Climate Action) is supported by the India's Updated First Nationally Determined Contribution (UNFCCC, 2022) and the Long-Term Low-Carbon Development Strategy submitted in 2022 (MoEFCC, 2022a). The National Mission for a Green India and the expanded Protected Area network are being pursued to achieve SDG 14 (Life Below Water) and SDG 15 (Life on Land). Forest and tree cover is now being estimated at 25.17% of geographical area according to the eighteenth India State of Forest Report Forest Survey of India [FSI] (2024).

As per NITI Aayog SDG India Index 2023–24, the country's overall SDG score rose from 57 in 2018 to 71 in 2023–24, indicating the country is making incremental and uneven progress towards achieving SDGs (NITI Aayog, 2024). Importantly, environment-related goals have demonstrated mixed progress, with indicators in the area of clean water, sustainable cities, and climate action, illustrating slower or stagnating progress, and those on the affordable and clean energy goal showing more significant improvement (MoSPI, 2024). The disparity highlights the importance of a comprehensive and analytical study of environmental sustainability in India that transcends the mere composite of the scores.

1.3 Importance for India as a Developing Economy with High Climate Vulnerability

The vulnerability of the climate in India is of special concern. South Asia has been identified as a global hotspot of climate-induced risk in the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) due to intensified heatwaves, monsoon variations, melting of glaciers in the Hindu Kush–Himalayas, sea-level rise along the long Indian coastline, and an increase in the frequency of tropical cyclones (TCs). Based on the district-level analyses of recent years, it has been found that more than 80% of the population of India resides in districts that are highly vulnerable to one or more hydrometeorological hazards (Mohanty & Wadhawan, 2021). The Economic survey of 2024 also highlights the fact that climate change is increasingly a near reality and has become a growing constraint to development, including on agriculture, urban infrastructure, public health, and water security, with associated costs (Ministry of Finance, 2024).

Indigenous structural characteristics of Indian economy worsen these vulnerabilities. Some 42-46% of the workforce is still working in agriculture, and significant portions of this are rain-fed and vulnerable to climatic shocks (MoSPI, 2025). The informal urban settlement area, where significant proportion of urban dwellers reside, is very vulnerable to urban heat islands and to flooding from extreme precipitation events. The fiscal costs of adaptation are correspondingly significant, and the Economic Survey 2024–25 indicates that India needs continued and predictable funding from the international community to address its adaptation needs, and also highlights the continued mismatch between estimated funding needs and flows (United Nations Environment Programme [UNEP], 2024; Ministry of Finance, 2025). Therefore, sustainability is not an add-on or 'post-developmental' issue in India but rather one of the necessary pre-conditions for stable growth, social equity and intergenerational welfare.

1.4 Aim of the Study

In this context, the present study seeks to critically examine the issues, policy, developments and prospects in environmental sustainability in India. The study will rely upon government reports, policy documents, peer-reviewed academic literature and reliable international assessments. The study aims to develop an updated and balanced synthesis that captures, on one hand the achievements of the last few years, such as the renewable energy transition and the early achievement of the 50% non-fossil installed power capacity target (MNRE, 2025), and on the other hand the persistent areas of weakness, such as tackling air and water pollution, solid waste management, biodiversity loss, and the weak enforcement of environmental statutes.

1.5 Objectives

The study is guided by five specific objectives:

1. To recognize the key environmental issues that India is currently facing.
2. To review the principle national and international policy frameworks that guide India's environmental governance.
3. To measure the progress observed using secondary indicators.
4. To assess the gaps and weaknesses in policy implementation.
5. To recommend future actions and policy recommendations based on evidence.

1.6 Significance of the Study

The significance of this study lies in three principal contributions. First, this is a revised synthesis that incorporates the latest secondary data available as of the time of the writing of this document (2025-26), which also includes the Economic Survey 2024-25 and the 18th India State of Forest Report (ISFR 2023), the SDG India Index 2023-24, the Energy Statistics India 2025 release, and new data available on India's Second NDC and on renewable energy additions for calendar year 2025 (MNRE, 2025; FSI, 2024; NITI Aayog, 2024; MoSPI, 2025). These data sources capture inflection points such as the early achievement of the 50% non-fossil power capacity target which were only anticipated in previous evaluations.

Second, the study has a deliberately critical and integrative approach. It does not look at individual environmental sectors alone, but at how advances in one area (e.g., the fast growth of solar and wind capacity) exist alongside advances in other areas (e.g., reduced ambient particulate matter) or declines in others (e.g., stagnation of PM river stretches). This comparison highlights the structural challenges, including coal dependency, fiscal federalism, differences in technology adoption, and capacity of subnational pollution boards, which account for the uneven performance of India's environmental regulators (Pillai et al., 2021; Dubash et al., 2018).

Third, the study will aim to be public-policy literate. The study collates and combines information from various official Indian portals (MoEFCC, MNRE, NITI Aayog, MoSPI, CPCB and FSI) as well as peer-reviewed scholarship and international assessments (such as the IPCC AR6 and UNEP Adaptation Gap reports and the Climate Action Tracker), producing a detailed, reference document with citations that can be used by students, researchers and policy practitioners.

1.7 Scope of the Study

The timeframe of the study is from 2008, when India's NAPCC was launched, to the latest available data (2025–2026) when climate policy was formalized in India. This era includes the 12th Five-Year Plan, the transition to the post-Paris-Agreement era and the consolidation of India's renewable energy and net zero goals. The geographical coverage is national, with some subnational illustrations selected wherever they further illustrate implementation challenges, such as in the context of National Clean Air Programme (NCAP) and City level air-quality interventions through the State Action Plans on Climate change (SAPCCs).

The study looks at issues of terrestrial and atmospheric environment relevant to Indian policy and most directly impacted by it: climate change mitigation and adaptation, energy transition, air and water pollution, waste management, forest and biodiversity protection. While marine ecosystems and oceanic governance are part of SDG 14, they are not discussed in the context of marine and coastal zone vulnerability and India's blue-economy strategies.

1.8 Limitations of the Study

Several limitations should be acknowledged at the outset. The study is based primarily on secondary data and no primary surveys, interviews or even field measurements have been conducted. This also allows for a general analysis, but it is subject to the limitations of the sources, such as delays in reporting, uneven coverage (especially in rural areas where air quality monitoring is less dense), and changes in methodology to successive editions of the source documents (Greenstone et al., 2022). Secondly, the official statistics on which the study is based are authoritative, but sometimes do not agree with independent estimates. It engages with both the overall climate target's ambition and policy commitment for India and considers the efforts to be 'Highly Insufficient', while Indian government statements focus on its ambitions to meet the milestones of the NDC targets early; it does not resolve the ambivalence of the two. Thirdly, the study does not engage in advanced econometric or modelling analysis. Its analytical approach is a synthesis of the literature on themes and a descriptive analysis of the trends of quantitative indicators. Third, some of the numbers and policy statements mentioned here may be updated with future official announcements (UNFCCC, 2026), especially the policies in India's Second NDC submitted to the UNFCCC in 2026 and the ongoing work on elaborating the policy in the LTCDS. Finally, the study cannot be exhaustive; with a country as vast as India, environmental issues are many and the ones that are included will be further treated at a depth which is more conducive to the availability of both official and academic data.

CHAPTER 2:

REVIEW OF LITERATURE

2.1 Introduction

The existing literature on environmental sustainability in India is critically analysed and is reviewed in a thematic manner in this chapter. The review is based on four types of source material: (a) peer-reviewed academic literature indexed in Google Scholar and other databases; (b) Government of India publications, with particular focus on the Economic Survey, the India State of Forest Report, the SDG India Index, the National Indicator Framework Progress Reports, and the reports of the Central Pollution Control Board; (c) policy documents and submissions to the UNFCCC, such as the National Communications, Biennial Update Reports, successive NDCs, and other policy documents; and (d) international assessments published by the IPCC, UNEP, IEA, World Bank, and independent monitoring initiatives like the Climate Action Tracker. The literature is broken down into four interrelated themes:

environmental challenges, policy frameworks, observed progress and current critiques and gaps; these themes are discussed in the sections that follow.

2.2 Environmental Challenges

2.2.1 Air Pollution

Air pollution has always been cited as one of the most serious environmental and public health problems in India. Delhi's annual ambient PM_{2.5} levels increased for the second year in 2024, as the Centre for Science and Environment (CSE, 2025) indicated that structural sources like transport, industry, and household combustion are still a major issue. Independent assessments in the National Clean Air Programme (NCAP) by Lal & Nagpure (2026) reveal that just seven out of the twenty-nine cities for which comparable PM_{2.5} information is available for 2017 and 2024 have achieved the original 20% reduction goal, indicating a significant implementation gap. Energy and Clean Air programme has also highlighted that although the number of Continuous Ambient Air Quality Monitoring Stations (CAAQMS) has increased significantly, from the targeted number of 150 stations to more than 530 by 2024, the rate of monitoring transition to emission reduction has been slow (Dahiya et al., 2024).

2.2.2 Water Pollution and Stress

Indian fresh water system is over stressed and polluted. Based on the latest evaluation of the polluted stretches of rivers by the Central Pollution Control Board (CPCB), a total of 296 stretches are polluted in 271 rivers in 32 States and Union Territories (UTs) (CPCB, 2022). Although the Ganga river system has been a subject of a concerted intervention in the form of Namami Gange Programme, it does continue to exhibit poor water quality in many stretches that do not meet the stipulated bathing standard (National Mission for Clean Ganga [NMCG] 2024). From about 17% in August 2019 to more than 78% in late 2024, the Jal Jeevan Mission has successfully increased coverage for access to household tap water in rural areas, but quality assurance and source sustainability have not been consistently covered (Department of Drinking Water and Sanitation, 2024). Various academic research has pointed to the fragmented institutional responsibilities, misaligned irrigation pricing and lack of management at the aquifer level leading to the problem of scarcity and contamination (Cullet, 2009).

2.2.3 Solid and Plastic Waste

As urbanization and shift in consumption patterns has increased, so has the generation of solid waste. Though waste management in urban India shows significant improvement as reflected in Swachh Survekshan reports but a persistent gap remains between waste generated and waste scientifically treated (Ministry of Housing and Urban Affairs [MoHUA], 2025). Regarding plastic wastes, India's policy is a phased ban on single-use plastics and notification of Plastic Waste Management Rules with the Extended Producer Responsibility (EPR) provisions (MoEFCC, 2022b). However, according to the academic and civil-society evaluations, the informal sector still continues to manage a significant portion of plastic waste and the flows of plastic waste in rural areas are not well measured and are poorly managed (Kumar et al., 2017; Indian Development Review, 2024).

2.2.4 Forest, Biodiversity, and Land Degradation

According to the 18th India State of Forest Report, the forest and tree cover in India is 8,27,357 km² or 25.17 % of the geographical area and increased by 1,445 km² from the previous assessment (FSI, 2024). The estimated forest carbon stock is 7,285.5 million tonnes, which showed a growth of 81.5 million tonnes from 2021 (FSI, 2024). Meanwhile, criticisms have been voiced about methodologies that incorporate commercial plantations and non-forest tree cover in the overall estimate, thereby obscuring qualitative degradation of natural forests (Reddy et al., 2015; Puyravaud et al., 2010). India has operationalized 12 NBTs under Aichi framework in its National Biodiversity Action Plan, however, progress on habitat connectivity and on threatened species is still incomplete as highlighted in Convention on Biological Diversity (CBD) Sixth National Report and literature (CBD, 2018).

2.2.5 Climate Change and Climate-Induced Risks

India is identified as one of the most vulnerable regions by the IPCC AR6 Working Group II report and the report projects possibility of increased heat wave, compound flood-drought events, glacial melt and sea-level rise in India and South Asia as a whole with high certainty. The Council on Energy, Environment and Water (CEEW) has mapped

the spatial distribution of heat wave risk and identified some of the districts with greater exposure in India, which are primarily located in the Indo-Gangetic plain and central peninsular regions of the country (Pillai et al., 2023). The Fourth Biennial Update Report to the UNFCCC shows that overall emissions intensity of GDP has decreased by 36% from 2005 to 2020, demonstrating decoupling of growth and emissions in India, while absolute emissions increase (MoEFCC, 2024b).

2.3 Policy Frameworks: From NAPCC to NDCs and Mission LiFE

2.3.1 The National Action Plan on Climate Change (2008)

The National Action Plan on Climate Change (NAPCC), published in 2008 by the Prime Minister's Council on Climate Change (PCC), is the backbone of the national climate change policy. It emphasises eight National Missions: National Solar Mission, National Mission on Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission on Sustaining the Himalayan Ecosystem, National Mission for Green India, National Mission on Sustainable Agriculture and National Mission on Strategic Knowledge for Climate Change (PMCCC, 2008). The literature is generally laudatory of the contribution of NAPCC to institutionalizing climate concerns into Indian policy and that the missions are under-resourced and unevenly implemented (Dubash & Joseph, 2016; Atteridge et al., 2012).

2.3.2 State Action Plans and Federal Coordination

After the NAPCC, all the States and UTs were asked to prepare the State Action Plans on Climate Change (SAPCC) as per their ecological and developmental settings. This experiment has been critically assessed by Pillai et al. (2021) and Dubash et al. (2018), who have found that most SAPCCs were essentially compilation exercises of various schemes already in place in the departments without creating substantive additionality or adequate sources of funding. The literature highlights the continuing impact of subnational fiscal disparities and a lack of technical capacity at the state level on effective subnational climate action (Observer Research Foundation [ORF] 2023).

2.3.3 India's Nationally Determined Contributions

India has communicated its Intended Nationally Determined Contribution (INDC) to the UNFCCC in 2015 and the Updated First NDC (FNDC) in August 2022. The new NDC sets India's ambition to achieve 50% of cumulative electric power installed capacity from non-fossil-fuel-based energy resources by 2030; to create an additional carbon sink of 2.5 to 3 billion tonnes of CO₂-equivalent through additional forest and tree cover by 2030, and to reduce the emissions intensity of its GDP by 45% by 2030 from the 2005 baseline (UNFCCC, 2022). The country has announced the Target of 2070 towards achieving Net Zero, through the Long-Term Low-Carbon Development Strategy submitted to the UNFCCC at COP27 (MoEFCC 2022a). India's latest pledge is in its second NDC, which was submitted in 2026, which calls for further increases in ambition, including a 47% reduction in emissions intensity by 2035 and 60% non-fossil installed capacity (UNFCCC, 2026).

2.3.4 Mission LiFE and the Green Credit Programme

The India-proposed Mission LiFE (Lifestyle for Environment) which was formally started in 2022, aims at mobilizing behavior change for climate action. Mission LiFE is a 'global mass movement' aimed at conscious individual and collective change in favor of the environment, according to the MoEFCC (2022c). Under Mission LiFE, the Green Credit Programme is an instrument that encourages voluntary environmental efforts, in this instance tree plantation on forest land, through the provision of tradable green credits, which serve as an incentive to promote them in the market (MoEFCC, 2023). Independent commentary has enthusiastically embraced the goal of extending environmental liability beyond the state, and voiced concerns regarding additionality, monitoring and the possibility of the commodification of ecosystem services (Council on Energy, Environment and Water [CEEW], 2024).

2.3.5 Sectoral Programmes: NCAP, Namami Gange, FAME, PAT, and PLI

In addition to sectoral programmes, there is a framework of instruments that drive India's environmental trajectory, which are not specific to climate. The NCAP (2019) was originally developed with the objective to cut down the concentration of PM₁₀ and PM_{2.5} in 131 non-attainment cities by 2024 by 20–30%, which was later increased to 40% by 2026 (MoEFCC, 2019). The Namami Gange Programme has incorporated the three pillars of sewage treatment,

riverfront development and afforestation under the Ganga basin (NMCG, 2024). The Faster Adoption and Manufacturing of Electric Vehicles (FAME) scheme, Phase II, facilitated the sale of 1.67 million EVs up to March 2024 (Ministry of Heavy Industries, 2024). The Perform, Achieve and Trade (PAT) scheme implemented by the Bureau of Energy Efficiency is specifically designed for the energy intensive sector, with energy tradable for overperformance, and there is academic evidence of energy intensity reduction among covered companies, albeit not large enough for a statistical significance of the outcome (Chauhan & Mohanasundari, 2025). The production-linked incentive (PLI) schemes for solar modules and advanced chemistry cell batteries are changing the manufacturing landscape for the energy transition, with India's solar module manufacturing capacity reportedly increasing almost by 200% from 38 GW in March 2024 to approximately 74 GW in March 2025 (Press Information Bureau [PIB], 2025).

2.4 Observed Progress: A Critical Reading of Indicators

The literature agrees on three main directions in which India's environmental sustainability is clearly visible. First, the transition to renewable energy has been an important and swift move. As of mid-2025, around 50% of India's installed power generation capacity was from non-fossil fuels, well ahead of the 2030 target agreed to in NDCs (MNRE 2025). During 2025, an estimated 48,436 MW of renewable capacity—37,945 MW solar and 6,347 MW wind—was added to the grid (PIB, 2025). As of November 2025, the total installed power capacity in India is around 500 GW, with the renewable capacity accounting for ~254 GW (CEA, 2025; Enerdata, 2025). Second, it has clearly reduced the emissions intensity of GDP by more than four-fifths of the 45% by 2030 goal already, as the emissions intensity of GDP has been reduced by 36% between 2005 and 2020 (MoEFCC, 2024b). Thirdly, forest and tree cover has been increasing at the national level, with the last ISFR indicating a positive trend in carbon stock (FSI, 2024).

But it is also clear from the literature that progress is not uniform across sectors. The progress on SDG 7 indicators have been quite fast, whereas SDG 6 (clean water and sanitation) and SDG 11 (sustainable cities) indicators have seen partial or slow progress, while SDG 13 (climate action) outcomes are contested when evaluated against a 1.5 °C-aligned trajectory (NITI Aayog, 2024; Climate Action Tracker, 2024). Coal is continuing to be the backbone of the country's electricity generation, and its share of electricity generation has declined by around 3% in 2025, the second decrease in half a century (Centre for Research on Energy and Clean Air [CREA] 2026).

2.5 Existing Critiques and Identified Gaps

The literature is rich in several structural gaps cited. Both Singh & Dewan (2022) and CSE (2025) conclude that although monitoring data are growing, it is not yet used to inform source apportioned policy decisions in most non-attainment cities. Iyer (2003) and Cullet (2009) point to the problem of deep institutional disintegration in water governance, especially between the groundwater and the surface-water regulators. Pillai et al. (2021) highlight the constraints of the SAPCC paradigm, and call for a more true-to-form federal climate financing system. Reddy et al. (2015) highlight the methodological differences and problems between forest assessment methods, while Puyravaud et al. (2010) point out that traditional indicators might overestimate the ecological value of forest spread. India's stated ambition is found by various international assessments including Climate Action Tracker (2024) to be incompatible with a 1.5 °C pathway without extra measures, especially in the area of coal phase-down. The UNEP Adaptation Gap Report Reports 2024 and 2025 (UNEP 2024, 2025) also underscores the persistent gap in the global adaptation financing for climate vulnerable countries, such as India.

2.6 Synthesis: Need for an Updated Integrated Review

This thematic review has three observations. Firstly, there is a vast body of literature, but it is quite dispersed and lacks of integrated coverage of climate, energy, air, water, forests, and waste. Second, there has been significant revision of the most policy-relevant data, especially regarding renewable energy additions, NDC trajectories, and SDG performance, in the 2024-2026 period, which means that many of the previous analytical frameworks are partially outdated. Third, there is a need for an integrative reading of progress and gaps in order to avoid the two extremes: celebratory narratives (only on the progress of renewables) or unduly pessimistic (only on the level of pollution). Thus, the current project is a critical, evidence-driven, currency-sensitive synthesis which triangulates official Indian sources, peer-reviewed scholarship and credible international assessments to fill these gaps.

CHAPTER 3:**METHODOLOGY****3.1 Research Design**

The research method used in this study is descriptive-analytical research with a secondary data analysis approach. The research question is interpretive and synthetic; a descriptive-analytical design is appropriate as it aims at describing the condition of environmental sustainability in India, analysing the policy instruments that influence it and assessing the progress made towards the stated policy objectives. The design is not experimental, or hypothesis testing by inferential statistics; it involves qualitative thematic analysis with descriptive quantitative trend analysis (Bowen, 2009).

The study uses two complementary methods in this overall design. Document analysis is the first approach which involves systematically analyzing available documents, reports, policy documents, and academic research to identify themes, claims, and evidence (Bowen, 2009). The second is descriptive trend analysis on quantitative indicators (installed renewable energy capacity, the emissions intensity of GDP, forest cover, SDG composite scores, ambient PM2.5 levels) for the time period 2008-2026, presented in simple tables and charts in Microsoft Excel

3.2 Time Frame

The timeframe of the analysis is started in 2008, the year when the NAPCC was initiated and institutionalisation of climate-environmental policy in India was done. It covers the latest data available as of the date of this report, such as the Economic Survey 2024–25, eighteenth ISFR (2023), SDG India Index 2023–24, Energy Statistics India 2025 release and the latest press releases from the Ministry of New and Renewable Energy (MoNRE) and the Press Information Bureau (PIB) on the addition of capacity during calendar year 2025 (Ministry of Finance, 2025; FSI, 2024; NITI Aayog, 2024; MoNRE, 2025; PIB, 2025). If the UNFCCC and Second NDC and government submissions are referred to then they are included in the text (UNFCCC, 2026).

3.3 Data Sources

Three types of secondary sources have been used. Government of India publications and official portals are the first and foremost ones. These include the Economic Survey of India 2023–24 and 2024–25, chapters on climate and environment (Ministry of Finance, 2024, 2025); the National Action Plan on Climate Change, Long-Term Low-Carbon Development Strategy, XVIIIth India State of Forest Report, notifications on Plastic Waste Management Rules, and the Green Credit Programme (MoEFCC, 2008, 2022a, 2022b, 2023, 2024b); the status reports and press releases by the Ministry of Statistics and Programme Implementation on

The second are international assessments and reports to multilateral organizations. The key international references are the India's Updated First NDC (UNFCCC, 2022), the IPCC Sixth Assessment Report Working Group II chapter on Asia, the IEA World Energy Outlook 2024 and India country profile (IEA, 2024; IEA, 2025), the UNEP Adaptation Gap Reports 2024 and 2025 (UNEP, 2024; UNEP, 2025), and Climate Action Tracker country assessment for India (Climate Action Tracker, 2024).

The third category is peer-reviewed academic literature that was identified via Google Scholar search from January to April 2026. The combinations of keywords included in search terms were phrases like 'India,' 'environmental sustainability,' 'NAPCC,' 'SAPCC,' 'NDC,' 'renewable energy,' 'air pollution,' 'forest cover,' 'climate vulnerability,' and 'biodiversity. Publications in indexed journal; publications by recognized policy research institutions (Centre for Policy Research, CEEW, ORF, etc.) and the latest scholarly work among different comparable studies were given priority.

3.4 Analytical Approach

A combination of two analytical strategies. A thematic analysis of the literature was initially performed according to the method presented by Braun and Clarke (2006). The four themes outlined in Chapter 2—environmental challenges, policy frameworks, observed progress, and existing critiques—were used to code the sources. Codes were then aggregated into a number of sub-themes, such as 'air pollution—NCAP performance', 'water—polluted river stretches', and 'climate—NDC architecture', with divergent results from the codes kept for explicit discussion, but not simply averaged away. The approach eschewed a focus on individual performance gaps and sought to uncover structural issues that contributed to the disparities in progress—federalism, finance, technology, coal dependence, and enforcement gaps.

Second, a series of quantitative indicators were selected for descriptive trend analysis. These indicators are: total installed renewable energy capacity (GW) and the share of TIRC in total installed capacity (2008-25); emissions intensity of GDP as compared to 2005 base line; total forest and tree cover and forest carbon stock as reported in ISFRs (2013-14, 2017-18); SDG India Index composite score and goal-wise scores for SDGs 6, 7, 11, 12, 13, 14 and 15; and annual ambient PM_{2.5} concentration in selected cities. The data is shown in simple line and bar charts using Microsoft Excel and each chart had a source attributed to it.

3.5 Reliability of Sources and Steps to Ensure Objectivity

To improve reliability and objectivity of the analysis, three procedural steps were taken. First, government sources of India were deemed as official in matters like installed capacity, forest cover etc., and also triangulated, if available, with independent assessments. For instance, data on renewable energy capacity was verified using country statistics from MNRE and from IEA and the annual country review of the power sector from CREA (2026; 2025). Second, divergent interpretations, such as the government's assessment of significant climate progress and Climate Action Tracker's rating of 'Highly Insufficient', were left side by side, and the reasons behind the different methodology explained (Climate Action Tracker, 2024).

Thirdly, for each source, the latest version was used wherever possible, to ensure that the sources used were not superseded. For instance, ISFR 2022-23 has been used instead of ISFR 2021-22; the SDG India Index 2024-25 has been used instead of its predecessor SDG India Index 2020-21; and the Economic Survey 2024-25 instead of its predecessor Economic Survey 2023-24. Older editions were used only for time-series construction, and explicitly referenced in a comparative context when it was necessary to refer to them over time, as with trends in renewable energy or emissions intensity, rather than to characterize the most current situation.

3.6 Ethical Considerations

Since the study is done entirely with secondary open public data, it has no need of ethics clearance within traditional research ethics procedures. Use of personal data, human or animal subjects, and proprietary data sets has been avoided. All sources have been cited in full and have been paraphrased, and claims have been attributed to the sources cited. If direct quotes are used, the page numbers are included.

3.7 Limitations of the Methodology

There are a number of methodological limitations to be noted. No primary data means that the study does not have the capacity to independently measure the numbers and verify with the numbers published by the officials, but it can compare the numbers from the data sources. Emissions inventories are especially important because the inventory data for the reference year is released several years later, as reported in India's Fourth Biennial Update Report (MoEFCC, 2024b). There is considerable geographic disaggregation with some indicators available at the state level and others only at the national or broad regional level (e.g. installed renewable capacity and forest carbon stock). Lastly, the study's focus on document analysis also implies that the institutional dynamics that are not explicitly stated in documents, like inter-ministerial bargaining or informal regulatory practices, are inferred. However, these are only limitations and the methodology is suitable for the descriptive-analytical research needs of the present study and also in accordance with the norms of an academic review of literature on environmental policy in India (Dubash & Joseph, 2016; Pillai et al., 2021).

CHAPTER 4:

CHALLENGES

4.1 Introduction

This chapter engages in a critical assessment of the major ecological challenges facing India in the mid-2020s, as the conceptual, statutory and methodological foundations of studying environmental sustainability in India have been set in earlier chapters. The challenges outlined here are not standalone issues, but are inter-dependant and linked to structural drivers including rapid urbanization, demographic momentum, industrial growth, continued reliance on coal, and the under-enforcement of environmental laws (Ministry of Finance, 2025; IPCC, 2023). The paradox in India is that despite the country making substantial investments in renewable energy, forest cover and clean cooking, it still has some of the world's most polluted cities and most stressed river basins (Greenpeace & IQAir, 2025; Central Pollution Control Board [CPCB], 2025a). This chapter therefore employs a critical-analytical perspective, analysing the depth, distribution and drivers of five interconnected challenges: (i) air pollution, (ii) water pollution and water stress, (iii) deforestation, land degradation, and biodiversity loss, (iv) waste management, and (v) climate vulnerability, using a combination of government reports, peer-reviewed scholarship and intergovernmental data.

4.2 Air Pollution: The Persistent Public Health Emergency

The level of ambient air pollution continues to be the most visible and most politically intractable environmental problem in India. In the IQAir World Air Quality Report 2024, India had a population-weighted PM_{2.5} concentration of 50.6 micrograms per cubic metre ($\mu\text{g}/\text{m}^3$), which dropped by just seven percent from 54.4 $\mu\text{g}/\text{m}^3$ in 2023, but remains over ten times the revised annual WHO guideline of 5 $\mu\text{g}/\text{m}^3$ (Greenpeace & IQAir, 2025). In 2024, the country was the fifth most polluted country in the world and 35 percent of the Indian cities had a PM_{2.5} concentration above the WHO guideline. The Indo-Gangetic Plain is of particular concern as daily peak PM_{2.5} levels remain above 300 micrograms per cubic metre in Delhi, Lucknow, Patna and a few smaller cities during the winter.

There are many factors behind this crisis, and they are subject to seasonal changes as well as being multi-sectoral. The source apportionment studies carried out by the Council on Energy, Environment and Water and Indian Institute of Technology (IIT) Kanpur have consistently identified the major sources as vehicular exhaust, thermal power generation by coal fired stations, household biomass burning, brick kilns, construction dust and open burning of agricultural residues in Punjab, Haryana, and western Uttar Pradesh (MoEFCC, 2024; Guo et al., 2017). According to the Global Burden of Disease 2021 (GBD 2021), around 1.67 million premature deaths in India in 2019 were caused by ambient and household air pollution (HAP), which accounted for almost 18 percent of all annual deaths (Pandey et al., 2021). Newer econometric studies by Singh & Dewan (2022) indicate that average Indian could lose 5.3 years of life if current levels of PM_{2.5} remain, while people in the Indo-Gangetic Plain could lose up to 11.9 years of life.

The National Clean Air Programme (NCAP) was implemented in 2019 to decrease particulate levels by 20-30 percent from 2017 targets in 131 non-attainment cities by 2024 (which has been raised to 40 percent by 2026) with mixed success. Only 51 of 131 cities had a measurable reduction in PM₁₀ and, for Delhi, the annual PM_{2.5} even rose from 2023-2024 (CPCB, 2024; Centre for Research on Energy and Clean Air [CREA], 2024). The implementation gap represents three structural issues: fewer continuous ambient air quality monitoring stations (CAAQMS) in tier-two and tier-three towns; poor co-ordination of the source level governance of pollution sources, which are often transnational in scope; and limited fiscal devolution to urban local bodies responsible for implementing source-level interventions (Thakur & Patel, 2023).

Table 4.1: Top Ten Most Polluted Indian Cities by Annual PM2.5 Concentration, 2024. (Source: Compiled from Greenpeace and IQAir (2025) World Air Quality Report 2024.)

Rank	City	PM2.5 ($\mu\text{g}/\text{m}^3$)	WHO Exceedance ($\times$)
1	Byrnihat (Meghalaya/Assam)	128.2	25.6
2	Delhi	108.3	21.7
3	Mullanpur (Punjab)	102.3	20.5
4	Faridabad (Haryana)	101.2	20.2
5	Loni (UP)	91.7	18.3
6	New Delhi	89.2	17.8
7	Gurugram (Haryana)	84.3	16.9
8	Ganganagar (Rajasthan)	82.3	16.5
9	Greater Noida (UP)	81.8	16.4
10	Bhiwadi (Rajasthan)	81.6	16.3

Air pollution also costs the economy of the country a lot. Based on a Dalberg-CII (2021) assessment, the loss of productivity and health due to air pollution was estimated to be USD 95 billion, or approximately 3 percent of GDP in 2019. The more recent World Bank (2022) modelling suggested that meeting the National Ambient Air Quality Standards by 2030 would result in cumulative economic benefits of about USD 700 billion due to avoided mortality, morbidity and productivity losses. However, implementation is hampered by the political economy of fossil fuel subsidies, the lack of legally binding ambient standards that are compatible with WHO guidelines and the narrow adjudicatory jurisdiction of the National Green Tribunal (Dubash et al., 2018).

4.3 Water Pollution and Water Stress

India's water problem is a double edged sword – the deteriorating quality of surface water and groundwater, and disturbingly disproportionate per capita freshwater availability. Based on the Biochemical Oxygen Demand (BOD) data for 2022 and 2023, the CPCB's 2025 assessment of polluted river stretches revealed 296 polluted stretches in 271 rivers across 32 States and Union Territories, a slight improvement from 311 polluted stretches in 311 rivers across 32 States and UTs reported in the previous round in 2022 (CPCB, 2025a). The Ganga, Yamuna, Sabarmati, Mithi and Cooum are still some of the most polluted rivers with the primary source being untreated municipal sewage or Class V (severe) BOD readings.

According to the CPCB's State of Sewage Treatment Plants Report (2024), about 72,368 million litres per day (MLD) of urban sewage is generated in the country, with an installed treatment capacity of 31,841 MLD, with only about 26,869 MLD being effectively operated, leading to a gap of more than 60 percent. Even though the volume of industrial effluents is far less than domestic sewage, the amount of heavy metals, dyes and pharmaceutical residues released in the effluents is causing significant toxicity (CPCB, 2024).

In terms of quantity, India is regarded as 'water-stressed' with per capita water availability falling from 1,486 cubic metres in 2021 to 1,367 cubic metres in 2031, nearing the threshold of 1,000 m^3 per capita considered 'water-scarcity' (Ministry of Jal Shakti, 2023). More than 60 percent of irrigation water and 85 percent of rural drinking water comes from groundwater, which is being mined at unsustainable rates – 736 out of 6,553 units assessed by the Central Ground Water Board (CGWB) are classified as 'over-exploited' and the extreme depletion is in Punjab, Haryana, western Uttar Pradesh, Rajasthan and parts of Tamil Nadu and Karnataka.

The Jal Jeevan Mission (JJM) has been a delivery success with more than 15.4 crore functional household tap connections (FHTC) provided by the Mission as of late 2024 (15.2 percent) (Ministry of Jal Shakti, 2024). However,

there is a double challenge of sustainable source water and water quality. Cullet (2017) and Saleth and Dinar (2004) have emphasized that the benefits of household connectivity may not lead to long-term water security if it is not coupled with complementary investments in groundwater recharge and demand side management and decentralized wastewater treatment.

Table 4.2: Indicators of Water Stress and Pollution in India, 2024–2025. (Source: Compiled from CPCB (2024, 2025a), CGWB (2024), Ministry of Jal Shakti (2023, 2024)).

Indicator	Value	Source
Polluted river stretches (priority I–V)	296 across 271 rivers	CPCB (2025a)
Urban sewage generated (MLD)	72,368	CPCB (2024)
Installed STP capacity (MLD)	31,841	CPCB (2024)
Operational STP capacity (MLD)	26,869	CPCB (2024)
Per-capita water availability 2021 (m ³ /yr)	1,486	Min. of Jal Shakti (2023)
Projected per-capita availability 2031 (m ³ /yr)	1,367	Min. of Jal Shakti (2023)
Over-exploited groundwater units	736 of 6,553	CGWB (2024)
JJM rural tap-water coverage (Dec 2024)	~78%	Min. of Jal Shakti (2024)

4.4 Deforestation, Land Degradation, and Biodiversity Loss

The India State of Forest Report (ISFR) 2023, released by Forest Survey of India (FSI) in December, 2024 indicates that forest and tree cover in India has increased to 25.17 percent of geographical area, up from 25.16 percent in 2021. Overall, the trend is positive, and India's progress towards achieving an additional carbon-sink target of 2.5–3.0 billion tonnes embedded in the updated Nationally Determined Contribution (NDC) has resulted in an additional carbon sink of ~2.29 billion tonnes of CO₂ equivalent by 2023 (FSI, 2024; Press Information Bureau [PIB], 2024).

But there are three counter-trends when indicators are disaggregated. First, natural forest cover density remained stagnant and the increase was limited in some of the states with high levels of biodiversity, with the increase in the low ecological value open forests and plantations (Reddy et al., 2015). Second, the North-Eastern states (which account for about one-quarter of forest cover) experienced a net loss of 327 km² between 2021 and 2023, mainly due to shifting cultivation cycles and infrastructure development (FSI, 2024). Third, Indian Space Research Organisation (ISRO) reports desertification and land degradation in the country in the range of 30 percent of the geographical area (97.85 million hectares) with the hotspots of land degradation in Rajasthan, Maharashtra, Gujarat, Karnataka and Jharkhand in the Desertification and Land degradation Atlas 2021 (ISRO, 2021).

These stresses are exacerbated by biodiversity loss. According to the Living Planet Report 2024, the average loss of populations of monitored vertebrates has been 73 percent since 1970 throughout the world, with South and Southeast Asia being one of the worst-affected areas (WWF, 2024). In India, there are 73 critically endangered species recorded in the National Wildlife Database and the IUCN Red List highlights habitat fragmentation, linear infrastructure, invasive species and human–wildlife conflict as key drivers (Ministry of Environment, Forest and Climate Change, 2023). While these initiatives were successful in the case of the Cheetah reintroduction at Kuno and the Project Tiger expansion to 58 reserves, the political economy of land acquisition and the watering-down of forest clearance processes under the Forest (Conservation) Amendment Act, 2023 (Boora, 2023) are still constraining landscape-scale conservation efforts.

Table 4.3: Forest and Tree Cover in India, 2013–2023. (Source: Compiled from Forest Survey of India, India State of Forest Report 2013–2023 (FSI, 2024)).

Year (ISFR)	Forest Cover (km ²)	Tree Cover (km ²)	Total (km ²)	% of GA
2013	697,898	91,266	789,164	24.01
2015	701,673	92,572	794,245	24.16
2017	708,273	93,815	802,088	24.39
2019	712,249	95,027	807,276	24.56
2021	713,789	112,014	825,803	25.13
2023	715,343	112,014	827,357	25.17

4.5 Waste Management: Municipal Solid Waste and Plastic Pollution

Solid waste management is one of the least performing sectors of India's environmental management. India is estimated to generate around 1,70,338 tonnes per day (TPD) of municipal solid waste (MSW), with an estimated 50-52 percent of this being scientifically processed and around 91 percent collected, with the remaining fraction being informally dumped or burned (CPCB, 2023). Launched in 2021 with an allocation of ₹ 1.41 lakh crore, the Swachh Bharat Mission 2.0 (SBM-U 2.0) has clearly laid emphasis on 'garbage-free cities' and the clean-up of legacy dumpsites by 2026, but implementation efforts have been weak: as of late 2024, only 19.43 percent of legacy dumpsites had been remediated, and some large metros had not cleared any land from their legacy landfills (MoHUA, 2024).

A highly visible sub-component is plastic pollution. Every year, India produces about 3.9 million tonnes of plastic waste, which works out to nearly 10,689 tonnes of plastic per day, of which an estimated 40 percent is uncollected or washed into rivers, drains and marine ecosystems (CPCB, 2023; CEED, 2024). The Plastic Waste Management Rules, 2016 (amended 2021, 2022), prohibited the use of plastics which are intended to be used just once and imposed an Extended Producer Responsibility (EPR) for plastic packaging. The compliance rate is, however, low, and the redressal rate for the complaints of illegal plastic use through the CPCB's mobile application dropped from about 25 percent in 2023 to 19 percent in May 2024 (Mordor Intelligence, 2024). Gupta & Dash (2023) state that the idea behind the EPR, while sound, has problems with poor penalties, data quality, and a lack of a reverse logistics infrastructure. The Central Pollution Control Board also estimates that if the current per capita waste generation trends continue, the total waste generated would increase from its current 130 million tons a year to 165 million tons a year in 2030, further emphasising the need for source segregation, decentralised composting and circular economy infrastructure (CPCB, 2023).

Table 4.4: Status of Municipal Solid Waste and Plastic Waste Management in India, 2022–2024. (Source: Compiled from CPCB (2023), MoHUA (2024), Mordor Intelligence (2024), and CEED (2024)).

Indicator	Value
MSW generated daily	~1,70,338 TPD
MSW collected	~91%
MSW scientifically processed	~50–52%
MSW landfilled / dumped daily	~25,000–40,000 TPD
Plastic waste generated annually	~3.9 million tonnes
Single-use plastic redressal rate (May 2024)	~19% (down from 25% in 2023)
Legacy dumpsites remediated under SBM-U 2.0	~19.43%
Projected MSW by 2030	~165 million tonnes/yr

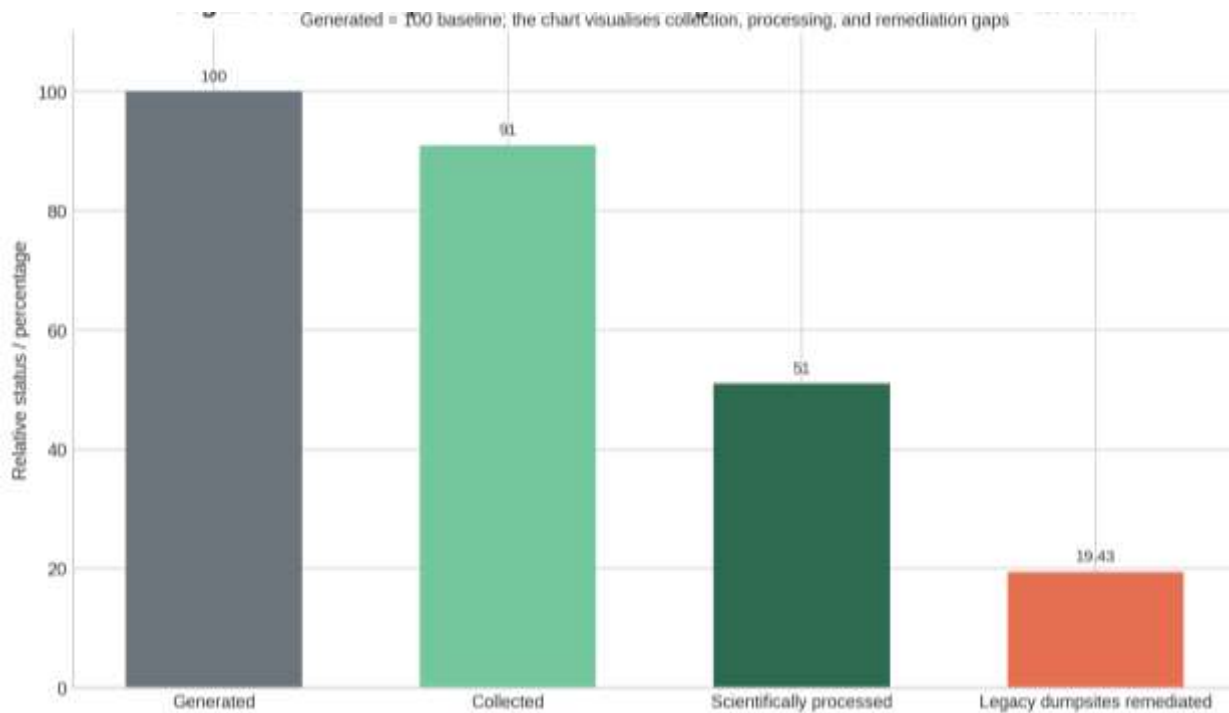


Figure 4.1: Municipal Solid Waste Management Status Indicators in India. (Source: Compiled from CPCB solid waste reports and SBM-U 2.0 status material cited.)

4.6 Climate Vulnerability and Extreme Events

Geographically, India, and demographically, is one of the most vulnerable states in the world to climate change. According to Global Climate Risk Index 2025 (Germanwatch, 2025) India has been ranked as the 7th most affected economy in the last 24 years (2000-2023) in terms of climate-related death and economic losses. South Asia is a region of 'compound risks', where heatwaves, variations in monsoon season, glacial-lake outburst floods, sea level rise and water stress are compounding, and where population density is high and agriculture represents a large share of the workforce (IPCC, 2023). According to the assessment report Climate India 2024 by Centre for Science and Environment (CSE), extreme weather events occurred on 322 out of the first 274 days of the year 2024, killing 3238 people, destroying 235862 houses, and damaging 3.2 million hectares of cropland in the country.

Heatwaves are more frequent, longer and more severe. Overall, 536 heat wave days were observed in the country by the India Meteorological Department (IMD) in April-June 2024, which is the highest in 14 years, with maximum temperatures more than 50°C in parts of Rajasthan and at Mungeshpur in the observatory in Delhi (IMD, 2024). Peer-reviewed literature has shown that during a heatwave, there is increased all-cause mortality due to elevated cardiovascular and renal risk (Mazdiyasn et al., 2017; Vicedo-Cabrera et al., 2021).

Nearly 45 percent of the Indian population is engaged in agriculture and it accounts for around 16 percent of the Gross Value Added (GVA), making it highly climate-sensitive. Under moderate emission scenarios, ICAR modelling indicates that by 2100, yields of rainfed rice may be 10–20 percent lower, while wheat yields may be 6–25 percent lower (ICAR, 2023). The IPCC AR6 estimated that about 14 million Indians may be affected by coastal flooding every year by 2050, under the 0.5 m SLR scenario, which is the minimum possible rise, subject to uncertainties. The IPCC AR6 estimated that about 14 million Indians may be affected by coastal flooding annually by 2050 under the 0.5 m sea-level-rise scenario, which would be the minimum possible sea-level-rise subject to uncertainties. Climate vulnerability is also socially structured with disproportionate exposure compared to adaptive capacity, as women,

Scheduled Castes and Tribes, small and marginal farmers and urban informal workers are exposed to climate change more than their capacity to adjust. Hence, there are high equity concerns in any 'just transition' concept (Roy et al., 2018).

4.6.1 Health, Economic, and Social Impacts of Climate Vulnerability

The overall human-development costs of climate vulnerability should be explored. India has been repeatedly identified as one of the most vulnerable countries to the impacts of heat on labour productivity loss by Lancet Countdown on Health and Climate Change for these losses, the 2023 edition estimated India had lost the equivalent of 167 billion potential labour hours in 2022 from heat exposure, which is equivalent to nearly 6 percent of total annual labour supply in agriculture, construction, and outdoor services (Romanello et al., 2023). As per the International Labour Organisation (2024), India is projected to lose 34 million jobs equating to full-time employment to heat stress by the year 2030, under the business-as-usual scenarios, mainly affecting the unorganised workforce and women workers in rural and peri-urban areas. These losses manifest in tangible macroeconomic costs – Switzerland Re Institute (2021) calculated that if there is no meaningful mitigation, India could lose about one-third of its GDP by mid-century due to severe warming.

Distributional aspects are also a component of climate vulnerability. India has been mentioned by the IPCC Working Group II Sixth Assessment Report as a country where 'observed adverse impacts and related losses and damages have been disproportionately attributable to vulnerable populations' (IPCC, 2023). The Climate Vulnerability Index published by the Department of Science and Technology, 2021, has identified states like Jharkhand, Mizoram, Odisha, Chhattisgarh and Assam as the most vulnerable states within India, due to their combination of high climate vulnerability and low human-development indicators, together with their reliance on rain-fed agriculture (Department of Science and Technology, 2021). Climate vulnerability intersects with informal-sector employment and gender, and with caste, to make the issue of equity a critical one that must be addressed by any sustainability framework (Mehta et al., 2019; Roy et al., 2018).

4.6.2 Compound and Cascading Risks

A new line of climate risk research has been emerging that highlights climate compound and climate cascading risks, which are especially relevant to India. Compound risk situations are a case of multiple hazards, such as a heatwave shortly followed by a monsoon rainfall shortfall and a power-grid stress event, whose effects are so large that infrastructure and institutions cannot cope with them (Zscheischler et al., 2018). The occurrence of the north Indian heatwave during May-June 2024 (when power demand hit 250 GW and drinking water shortage was reported in various metropolitan cities) and the cluster of pre-monsoon thunderstorms in the Indo-Gangetic Plain exemplifies this (IMD, 2024; CEA, 2024). Cascading risks, by contrast, involve the transmission of an initial impact along cascading systems such as an extreme rainfall event in the upper Himalayas may trigger glacial-lake outburst floods (GLOFs) that ultimately lead to damage of hydropower plants, road and bridge construction, downstream agricultural properties, and supply chains, and that can persist for several weeks (Wester et al., 2019). These compound and cascading features highlight the importance of multi-sectoral, multi-disciplinary planning in India's adaptation regime.

4.7 Underlying Drivers: Population, Urbanisation, Coal Dependency, and Economic Pressure

Four interrelated structural drivers reinforce the challenges discussed above. Demographic momentum first is a driver of the growing absolute and per-capita environmental footprint. According to the United Nations Population Division (2024), India is estimated to have a population of 1.45 billion in 2024, which is expected to reach around 1.7 billion in the early 2060s. Second, there is a growing concentration of people in urban areas; the proportion of urban population (currently 36 percent) is expected to surpass 50 percent by 2050, leading to a demand for concentrated housing, transport, water, and energy needs (United Nations Department of Economic and Social Affairs [UN DESA], 2022). Urban 20 framework of the Ministry of Housing and Urban Affairs (MoHUA, 2023) recognizes that Indian cities will be home to an additional 416 million people during the next 30 years (from 2020 to 2050).

Third, there remains a dominant role for coal in the energy system. According to IISD's Mapping India's Energy Policy 2025, in FY 2024, coal accounted for 59 percent of the country's primary energy supply and 74 percent of its total electricity generation, indicating plans to introduce up to 100 GW of new coal-based electricity generation capacity over 2025-2032, even under accelerated renewable scenarios (Centre for Research on Energy and Clean Air, 2025; International Institute for Sustainable Development [IISD], 2025). It is also a source of fiscal revenue for coal-bearing states like Jharkhand, Odisha, Chhattisgarh and West Bengal and direct employment for ~ 0.3 million people, with several million indirect dependents (Bhushan, Banerjee, & Agarwal, 2020). Fourth, India's middle-income status also means continued demand for increased mobility, construction and industrial production, all of which are major contributors to air, water and waste pollution (Ministry of Finance, 2025).

As a whole, the evidence presented in this chapter suggests a picture of sustainability where policies are not a significant absence, but rather a significant asymmetry of progress. India has enacted a remarkable body of laws, plans and missions, yet results are not uniform in pollution fields nor federally. The relatively high growth rates of renewable energy capacity (which are explored in detail in Chapter 6) are distinctly different from the slower trends in reducing PM2.5, restoring rivers and processing waste. It is now being argued that this asymmetry is not just due to low ambition, but it is a result of the “two sides of the technological deployment market”, namely the supply side and the demand side, as behavioural and regulatory change is necessary to drive demand (Dubash, 2019; Thakur & Patel, 2023). The consequences of this asymmetry and the policy context in which it has played out is examined in the next chapter.

CHAPTER 5:

POLICIES AND FRAMEWORKS

5.1 Introduction

With the diagnostic provided in Chapter 4, this chapter critically examines main policy and institutional frameworks governing environmental sustainability in India. It is multi-layered (constitutional, legislation of the central government, sectoral missions, state action plans, and international commitments, such as the United Nations Framework Convention on Climate Change (UNFCCC)). This chapter aims to describe both the content of these frameworks and to question the disconnect between their rhetoric and practice. Dubash (2019) and Singh & Kolluri (2025) argue that the environmental policy regime in India is formally sophisticated, but suffers from some limitations at the subnational level due to federal coordination problems, fiscal asymmetries and subnational administrative limitations.

5.2 National Frameworks

5.2.1 *The National Environment Policy, 2006*

The National Environment Policy (NEP) which was notified by the Ministry of Environment and Forests in May of 2006 is the main document that lays out India's philosophy on the environment. The NEP is based on the principles of intergenerational equity, polluter pays principle and decentralised environmental governance with five priority objectives: conservation of critical environmental resources, livelihood security for the poor, integration of environmental concerns into economic and social development, efficient use of environmental resources and good governance (MoEF, 2006). Over the last two decades, the NEP has not officially been amended, but it is still reflected in the Supreme Court's 'public-trust doctrine' in environmental cases (Sahu, 2014) and in the jurisprudence of the Environment (Protection) Act, 1986.

5.2.2 *The National Action Plan on Climate Change, 2008*

The National Action Plan on Climate Change (NAPCC) was released by the Prime Minister's Council on Climate Change in June 2008, which translates India's climate response into eight National Missions, namely, the National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission on Sustaining the Himalayan Ecosystem, National Mission for Green India, National Mission for Sustainable Agriculture, and National Mission on Strategic Knowledge for Climate Change (Government of India [GoI], 2008). Later, further missions were added to the UNFCCC (coastal, human health and wind).

The emphasis of NAPCC on co-benefits, that is, multiple developmental and climate outcomes – has been cited widely as a good practice example of the integration of climate considerations into development planning. However, there are some missions that have failed to have adequate funding and execution procedures, as indicated by Dubash (2019) and Singh & Kolluri (2025). The most prominent vehicle of delivery for the National Solar Mission has been the solar target of 100 GW by 2022, which was revised in 2015 and established the institutional bedrock for the larger capacity target of 500 GW non-fossil.

5.2.3 *Sectoral Legislation*

In addition to NAPCC, there are various other environmental laws in India such as the Energy Conservation Act, 2001 (amended 2022), the Environment (Protection) Act, 1986, the Air (Prevention and Control of Pollution) Act, 1981, the Water (Prevention and Control of Pollution) Act, 1974, the Forest (Conservation) Act, 1980 (substantial amendment 2023), the Biological Diversity Act, 2002 (amendment 2023), Plastic Waste Management Rules, 2016 (amendment 2021, 2022, 2024) and the National Green Tribunal Act, 2010 (Sahu, 2014). The Energy Conservation (Amendment) Act, 2022, specifically confers powers on the central government to prescribe a scheme for trading carbon credits, to designate consumers to use non-fossil energy and to amend efficiency norms for vehicles, vessels and equipment (Ministry of Power, 2022).

5.2.4 *The National Green Hydrogen Mission, 2023*

The National Green Hydrogen Mission (NGHM) is a flagship initiative for decarbonisation in industry which was approved by the Union Cabinet in January 2023 with an initial budget of ₹ 19,744 crore (about USD 2.4 billion). The Mission aims to achieve at least 5 million metric tonnes (MMT) per annum goal for green hydrogen production capacity by 2030, adding around 60-100 GW of related renewable energy capacity, and eliminating about 50 MMT CO₂-equivalent emissions per year by 2030 (Ministry of New and Renewable Energy [MNRE], 2023; PIB, 2024). As of 2024, tenders for the production of 4.12 lakh tonnes per annum (TPA) green hydrogen and manufacturing capacity of 1,500 MW per annum (MPA) electrolyser had been awarded under the sub-component, 'Strategic Interventions for Green Hydrogen Transition' (Ministry of Finance, 2025). The Mission will be a conceptually important one, given that it combines competitiveness in industry with decarbonisation, yet the realisation of these targets will depend on the continued reduction in the cost of electrolysers and the creation of driver-side policies in the steel, fertiliser and refining sectors.

5.2.5 Mission LiFE and Demand-Side Sustainability

Mission LiFE, which aims to address seven areas of lifestyle: Energy, Water, Food, Waste, Mobility, Single Use Plastics, Sustainable Consumption, was introduced at COP27 (2022) and was operationalised through the Lifestyle for Environment (LiFE) National Action Plan (NAT), 2023 (NITI Aayog, 2023). Though it is hard to quantify its impact on decarbonisation, the Mission qualifies as a conceptual leap forward towards demand side decarbonisation and will supplement supply-side missions like NGHM and Solar Mission. It is pointed out that voluntary behavioral approaches need to be complemented by price signals, urban planning changes, and alternatives that are available in this country, such as transport and consumption (Anable et al., 2011).

5.3 State Action Plans on Climate Change

In India, since 2009, the central government has encouraged state governments to prepare State Action Plans on Climate Change (SAPCCs) that take into account the different climate impacts and potentials for mitigation across the country's ecologically and economically varied states. The first generation of the SAPCC has been prepared in all 28 states and 8 union territories, and several (including Bihar, Punjab, Madhya Pradesh, Tamil Nadu, Maharashtra, Uttar Pradesh and Odisha) have redone them based on the new NDC and SDG framework (MoEFCC, 2024).

Comparative analyses suggest that SAPCCs have increased the salience of climate concerns in the state level planning process and have emerged as avenues for international climate finance, especially the Green Climate Fund and Adaptation Fund. However, Jogesh and Dubash (2015) and Khosla and Bhardwaj (2019) discovered that early SAPCCs were not of uniform technical quality, were poorly incorporated into departmental budgets, and were rarely formally monitored. Recent revisions are now making steps to respond to these criticisms by incorporating vulnerability assessments by sectors, climate-budget tagging, and climate indicators associated with the SDG and the National Adaptation Communication. Despite this, there is no national level law that obligates the States to transition towards carbon neutrality, unlike the United Kingdom's Climate Change Act 2008 and the European Climate Law 2021 (Rajamani & Ghosh, 2024).

5.4 International Commitments

5.4.1 The Paris Agreement and the 2022 Updated NDC

In October 2016, India was among the 195 countries to ratify the Paris Agreement and made three quantitative pledges in its first NDC submitted in 2015: reduce the emissions intensity of the GDP by 33–35 percent by 2030 from 2005 level; increase the proportion of cumulative installed electric power capacity from non-fossil-fuel-based sources to 40 percent by 2030; and establish an additional cumulative carbon sink of 2.5–3.0 billion tonnes of CO₂ equivalent through additional forest and tree cover (UNFCCC, 2015). The COP26 Glasgow announcement of the 'Panchamrit' commitments led to India submitting an updated NDC in August 2022 which included a strengthening of two of the COP26 commitments: reduction in emissions intensity of GDP by 45 percent from 2005 levels by 2030 and 50 percent share of non-fossil-fuel installed electric power capacity by 2030 (UNFCCC, 2022).

5.4.2 The Long-Term Low Emission Development Strategy and Net-Zero by 2070

India submitted its Long-Term Low-Emission Development Strategy (LT-LEDS) to the UNFCCC at COP27 in November 2022, which outlines a pathway towards a net-zero GHG emission scenario by 2070. The strategy highlights 7 transitions: low carbon electricity; transport-system electrification and modal shift; urbanisation patterns that enable low carbon development; industrial decarbonisation; decarbonising buildings and appliances; low carbon agriculture and land use; sustainable lifestyles in line with Mission LiFE (Government of India, 2022). In accordance with the principle of common but differentiated responsibilities and respective capabilities (CBDR-RC), LT-LEDS puts the net-zero target as contingent on the timely provision of fair climate finance and technology transfer.

5.4.3 The 2026 Updated NDC: 47 Percent and 60 Percent by 2035

In March 2026, India presented its new NDC to the UNFCCC that extends its NDC commitment to 2031-2035, where the level of ambition has been increased in two ways: first, emissions intensity of GDP has been reduced to 47 percent by 2035, compared to 2005 levels, while 36 percent was achieved by 2020 and the current 45 percent has already been committed; second, the share of non-fossil-fuel-based energy resources has been increased to 60 percent of cumulative

installed electric power capacity by 2035 (UNFCCC, 2026; Reuters, 2026; Mongabay India, 2026). Based on the current rate of renewable electricity deployments, Climate Action Tracker (2026) found India is on track to reach the 60 percent target for non-fossil electricity capacity before 2030, but to reach the 47 percent emissions-intensity target will demand faster decarbonisation of the industrial and transport sectors and peak coal use in the next 10 years.

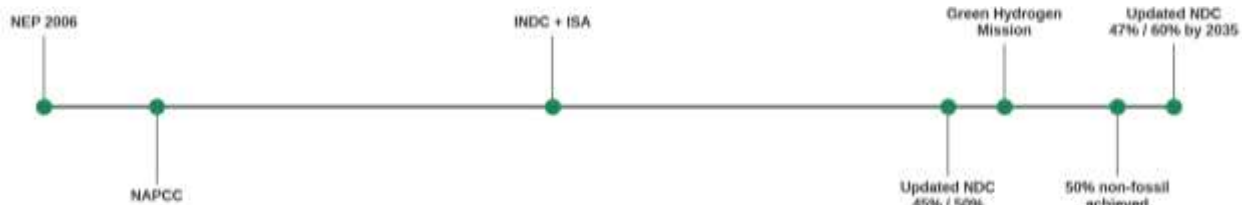


Figure 5.1: Key Environmental Policy and Climate Milestones in India, 2006–2026. (Source: Compiled from NEP 2006, NAPCC 2008, India's NDC submissions to UNFCCC, the National Green Hydrogen Mission, and related government releases cited).

Table 5.1: Evolution of India's NDC Targets, 2015–2026. (Source: Compiled from UNFCCC (2015, 2022, 2026), Government of India (2022), and PIB (2024)).

Indicator	INDC 2015	Updated NDC 2022	Updated NDC 2026
Emissions intensity of GDP reduction (vs 2005)	33–35% by 2030	45% by 2030	47% by 2035
Non-fossil installed power capacity share	40% by 2030	50% by 2030	60% by 2035
Additional carbon sink (forests, GtCO _{2e})	2.5–3.0 by 2030	2.5–3.0 by 2030	Reaffirmed (2.29 GtCO _{2e} achieved)
Net-zero target year	Not specified	2070 (LT-LEDS)	2070 (LT-LEDS)

5.5 Sectoral and Cross-cutting Schemes

In addition to the instruments that are specific to climate, there are also a number of sectoral schemes that have positive sustainability impacts. With subsequent rollouts, the Pradhan Mantri Ujjwala Yojana (PMUY) had already reached up to around 10.35 crore beneficiaries by December 2025, and an additional 25 lakh connections were approved in September 2025 (PIB, 2025). PMUY has significantly lowered the consumption of solid biomass for cooking and improved indoor air quality and women's time-poverty (Gaikwad, Pandey, & Patil, 2024). The schemes like Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME-II) and PM Electric Drive Revolution in Innovative Vehicle Enhancement (PM E-DRIVE), the former approved in 2017 with an outlay of ₹ 10,000 crore and the latter in 2024 with an outlay of ₹ 10,900 crore, have promoted EV adoption; cumulative sales of EVs in India have crossed 4.4 million units by mid-2025 (Ministry of Heavy Industries, 2025). The Production-Linked Incentive (PLI) schemes for advanced chemistry cell batteries, solar photovoltaic modules, and specialty steel are examples of India's industrial-policy approach to sustainability.

In terms of resource-efficiency, the recently formed National Resource Efficiency Policy (2019) and the Vehicle Scrappage Policy (2021), the EPR regime for plastics and e-waste, and the Green Credit Programme (notified 2023)

are emerging building blocks of a circular-economy policy. However, a NITI Aayog review of 2024 showed that India's circularity rate (percentage of secondary materials put back into the economy) is still low, at less than 10 percent, compared with the world average of around 7.2 percent and the 11.7 percent average for the European Union (NITI Aayog, 2024).

5.5.1 The Carbon Credit Trading Scheme and Domestic Market Mechanisms

The Carbon Credit Trading Scheme (CCTS) launched in June 2023 under the Energy Conservation (Amendment) Act 2022 is an important development from the old Perform-Achieve-Trade (PAT) framework. The CCTS is setup in two parts: a compliance market for the so called 'obligated entities' in energy intensive sectors, and a voluntary 'offset mechanism' for non-obligated entities (Ministry of Power, 2023). The Grid Controller of India has appointed the Bureau of Energy Efficiency as the administrator. The first compliance cycle will begin in 2025-26 and will apply to the iron and steel, aluminium, cement, fertiliser, chlor-alkali, paper and pulp, petroleum refineries and selected textile sub-sectors. The CCTS is conceptually compatible with cooperative methods in Article 6.2 under the Paris Agreement, but careful design will be needed to prevent double counting, ensure environmental integrity, and ensure that emissions intensity targets are not so weak as to let down the level of ambition (Jindal, Puri, & Shrimali, 2025)

5.5.2 The Green Credit Programme

The Green Credit Programme (GCP) is a voluntary environmental program notified by MoEFCC under the Environment (Protection) Act, 1986, announced in October 2023 with the aim of promoting environmental activities with eight thematic areas such as tree plantation, water conservation, sustainable agriculture, waste management, air pollution reduction, mangrove conservation, eco-mark labelling, sustainable building and infrastructure (MoEFCC, 2023b). The Programme's focus on measurable and third-party verified results is a methodological step forward, though there has been concern about whether there is any overlap with statutory requirements for compensatory afforestation. (Rajamani & Ghosh, 2024) It will rely on solid measurement reporting and verification (MRV) standards, fungibility with carbon credits prevention, and de-coupling from compensatory-afforestation obligations under the Forest (Conservation) Amendment Act 2023 for its future ecological credibility.

5.5.3 Disaster Risk Reduction and the National Adaptation Communication

In the last decade, the way India adapts has become more streamlined. The National Disaster Management Plan (NDMP) 2019 is the updated version of the previous plan, which incorporates the Sendai Framework for Disaster Risk Reduction 2015-2030 and combines disaster risk reduction with climate adaptation with 10 thematic priorities (National Disaster Management Authority, 2019). In 2023, India submitted its Third National Communication, with the accompanying Initial Adaptation Communication, which outlines eight priority areas for adaptation, including: agriculture, water, forestry and ecosystems, coastal zones, urban habitat and infrastructure, health, disaster management, and finance for adaptation (MoEFCC, 2023). As for implementation, however, it is highly dependent on subnational SAPCCs (which as mentioned were unevenly resourced). The Coalition for Disaster Resilient Infrastructure (CDRI, 2024), co-led by India and the United Kingdom, is an imminent complementary international platform for financing infrastructure for adaptation and technical assistance.

5.6 Ambition versus Implementation: A Critical Reading

Taken together, these instruments form a policy framework, on paper one of the most courageous in any large emerging economy. Four concerns about implementation are found repeatedly in the literature, however. The first problem is the inconsistencies in the regulatory enforcement process, where in most of the countries pollution control boards are understaffed and under-resourced, and in India, the CPCB and most of the State Pollution Control Boards (SPCBs) are over 35 percent vacant in technical cadre (Thakur & Patel, 2023). Second, fiscal imbalances between the Union, states, and urban local bodies limit delivery, with 'environment' and 'forests' being overlapping topics, and local bodies that are responsible for delivering services but lack revenues often rely on grants (Rao, 2023).

Third, financial gaps are still significant: The Third National Communication to the UNFCCC estimates that the costs of meeting India's NDC and adaptation needs will be around USD 2.5 trillion (at 2014 prices) by 2030, while flows observed have been a minor fraction of this (UNFCCC, 2023; Climate Policy Initiative [CPI], 2024). Fourth, path-

dependencies reduce the speed of transitions, even when targets are credible, such as for technological lock-in in the coal value-chain, freight rail cross-subsidies, and taxes on transport fuels (Dubash, 2019; IISD, 2025). In Chapter 6, it is time to look at the facts: Given the limitations, where has India performed in its development journey and where has it underperformed?

CHAPTER 6:

PROGRESS AND FINDINGS

6.1 Introduction

The chapter provides an assessment of India's current situation on environmental sustainability indicators for the period from 2015 to 2025 with some historical comparisons to the initial point, 2005, which is the reference point of the Indian NDCs. The findings are presented along four lines: (i) renewable energy and non-fossil power transition; (ii) emissions intensity and carbon sinks; (iii) the SDG India Index trajectory with special focus on SDG 13; and (iv) selected social-energy indicators (clean cooking, electric mobility). Weighing these achievements – that are in fact real successes in global leadership – against the continuing shortcomings in pollution control, waste management, and adaptive capacity, the chapter does so deliberately.

6.2 Renewable Energy: Record Capacity Additions and the 50 Percent Milestone

India's renewable energy timeline is the most significant this calendar year 2025. The total solar and wind capacity installed was at about 44.2 GW in calendar 2025 (or up to 50 GW as observed by some industry analysts in the count, which also included small hydro, biomass, and waste-to-energy) – the highest for the year in the country's history (MNRE, 2026; PIB, 2026). In this, the addition of solar photovoltaic (PV) power reached around 37.9 GW (up 54.7 percent year-on-year) and onshore wind power addition around 6.3 GW (up 85.3 percent year-on-year) due to the development of hybrid auction, decline in tariff, operationalisation of solar parks and the solar module incentive (PLI) scheme for high-efficiency PV modules (PV-Tech, 2026; Solar Quarter, 2026).

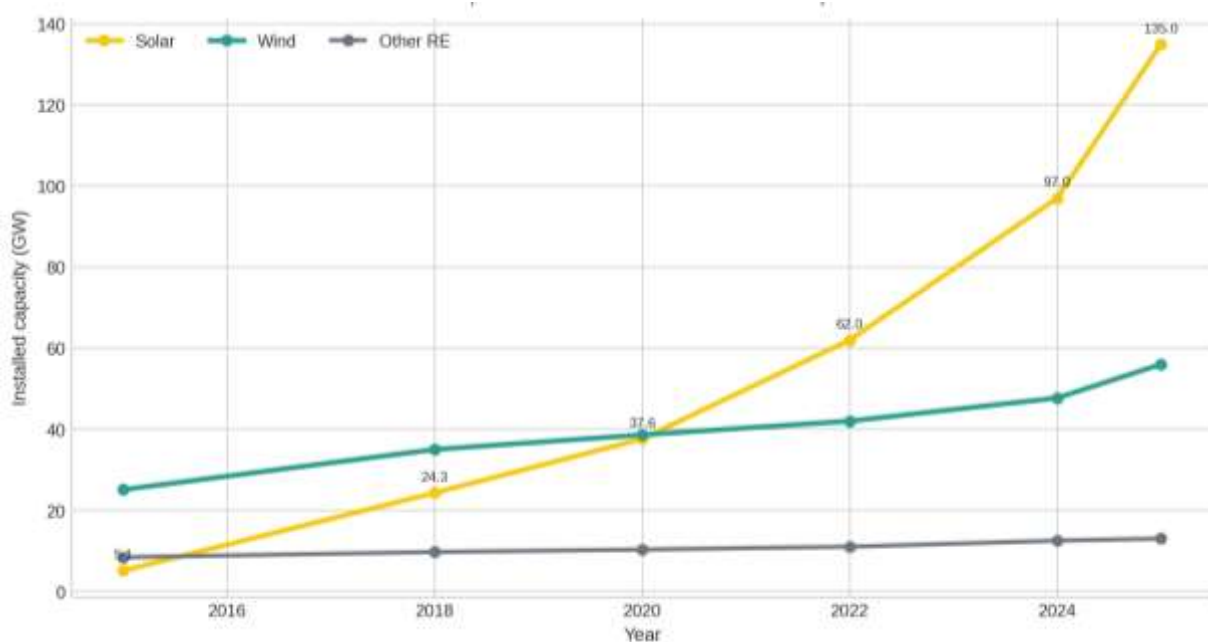


Figure 6.1: Growth of India's Renewable Energy Capacity, 2015–2025. (Source: Compiled from MNRE Renewable Energy Statistics, CEA monthly reports, and PIB updates cited).

As of November 2025, India's installed renewable energy capacity was around 254 GW, which includes solar (135 GW) and wind (56 GW), and if large hydro and nuclear are included, the total non-fossil energy installed capacity would be around 262 GW, or 51.9–52.5 percent of total installed power capacity of around 502 GW (MNRE, 2026; Yahoo Finance, 2025). This milestone of the 50 percent non-fossil percentage – first announced in mid-2025, further confirmed by the central government in December 2025 – was an early realization of the 2030 NDC by about five years (Reuters, 2025; Business Standard, 2025; S&P Global, 2026).

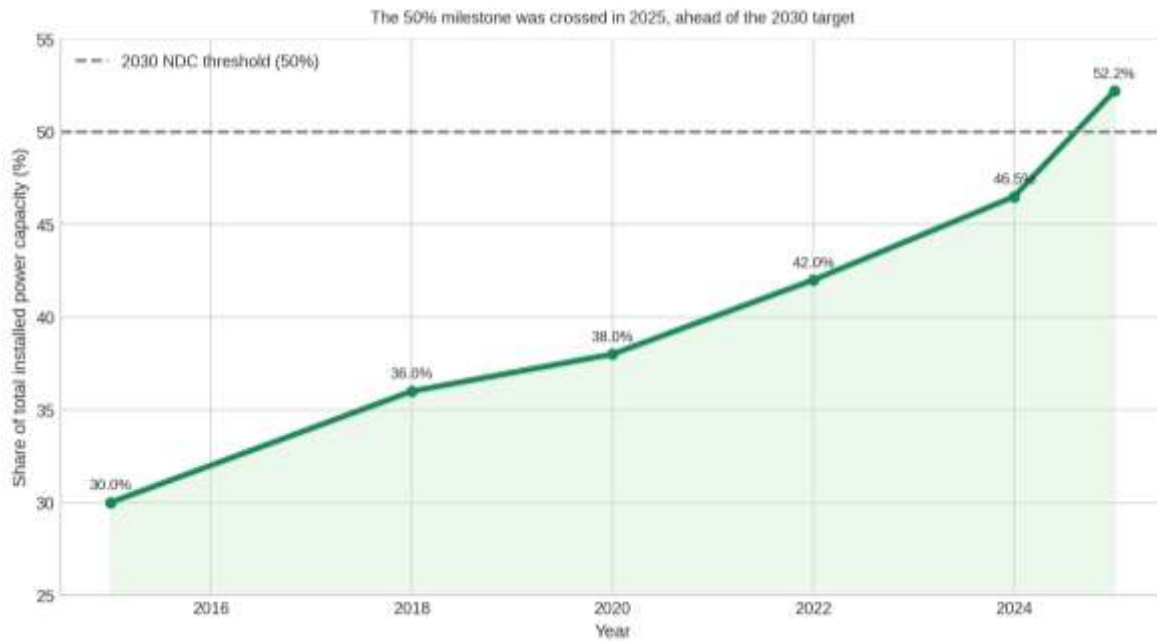


Figure 6.2: India's Non-Fossil Installed Power Capacity Share, 2015–2025. (Source: Compiled from MNRE, CEA, Reuters (2025), Business Standard (2025), and PIB material cited in the report).

Table 6.1: India's Renewable and Non-Fossil Power Capacity, 2015–2025. (Source: Compiled from MNRE Renewable Energy Statistics (MNRE, 2026), CEA Monthly Reports (CEA, 2025), and PIB (2026)).

Year-end	Solar (GW)	Wind (GW)	Other RE (GW)	Large Hydro + Nuclear (GW)	Non-fossil share (%)
2015	5.1	25.1	8.4	51.4	~30%
2018	24.3	35.0	9.7	53.6	~36%
2020	37.6	38.6	10.3	53.0	~38%
2022	62.0	42.0	11.0	53.5	~42%
2024	97.0	47.7	12.5	55.0	~46–47%
Nov 2025	~135	~56	~13	~58	~51.9–52.5%

There are a number of reasons behind this upswing. However, on the supply side, the LCOSE for solar power in India has dropped by almost 80 percent, from INR 10-12 per kWh during 2010 to INR 2.4-2.6 per kWh in recent UPA auctions (IEA, 2024; CEEW, 2024). Transaction costs have been reduced on the institutional side through the transparent Solar Energy Corporation of India (SECI) auction architecture, viability gap funding of hybrid projects and the green energy open access rules of 2022. On the international front, under the umbrella of the International Solar Alliance (ISA) launched in 2015 by India and France, and headquartered in Gurugram, several South-South

cooperation initiatives have come up, including the One Sun One World One Grid (OSOWOG) initiative by the International Solar Alliance (ISA) (2024).

However, there are two qualifications to keep in mind. First, the renewable increase has not yet resulted in a corresponding absolute decrease in coal-based generation: the total generation from thermal power has increased in absolute terms during the last five years (2020-2024), with the share of renewables growing mostly because of the growth in renewable generation rather than the decline in thermal power generation (Centre for Research on Energy and Clean Air [CREA], 2025; Ember, 2025). However, the month-on-month decline in coal generation was limited to 3 percent in calendar 2025, the first such decrease in more than 10 years and the result of record renewables growth and a mild monsoon (CEA, 2025). Second, there has been a lag in capacity addition for transmission, storage, and balancing infrastructure – with the Central Electricity Authority's National Electricity Plan (Volume I) estimating that 74 GW of battery energy storage and 27 GW of pumped storage will be needed by 2032 – and tenders are just starting to be awarded for 2024 and 2025 (CEA, 2024; MNRE, 2026).

6.3 Emissions Intensity and the Carbon Sink

The Biennial Update Report (BUR-3) and the Initial Adaptation Communication for India show that the emissions intensity of GDP has reduced by about 33 percent from 2005 to 2019, and subsequent updates in the National Communication and PIB reports indicate that the emissions intensity of GDP has decreased by 36 percent by 2020, (MoEFCC, 2023; PIB, 2024). The trends that have contributed to the decline are largely as follows: (i) Structural change towards service sector (currently, about 54 percent of GVA); (ii) Improvement in thermal efficiency of coal-based generation (from around 31.5 percent in 2005 to 36.5 percent in 2022); and (iii) Energy efficiency initiatives like the Perform, Achieve and Trade (PAT) scheme by the Bureau of Energy Efficiency, which is estimated to have contributed to cumulative energy savings of about 17 million tonnes of oil equivalent across PAT-I and PAT-II cycles (Bureau of Energy Efficiency (BEE), 2023).

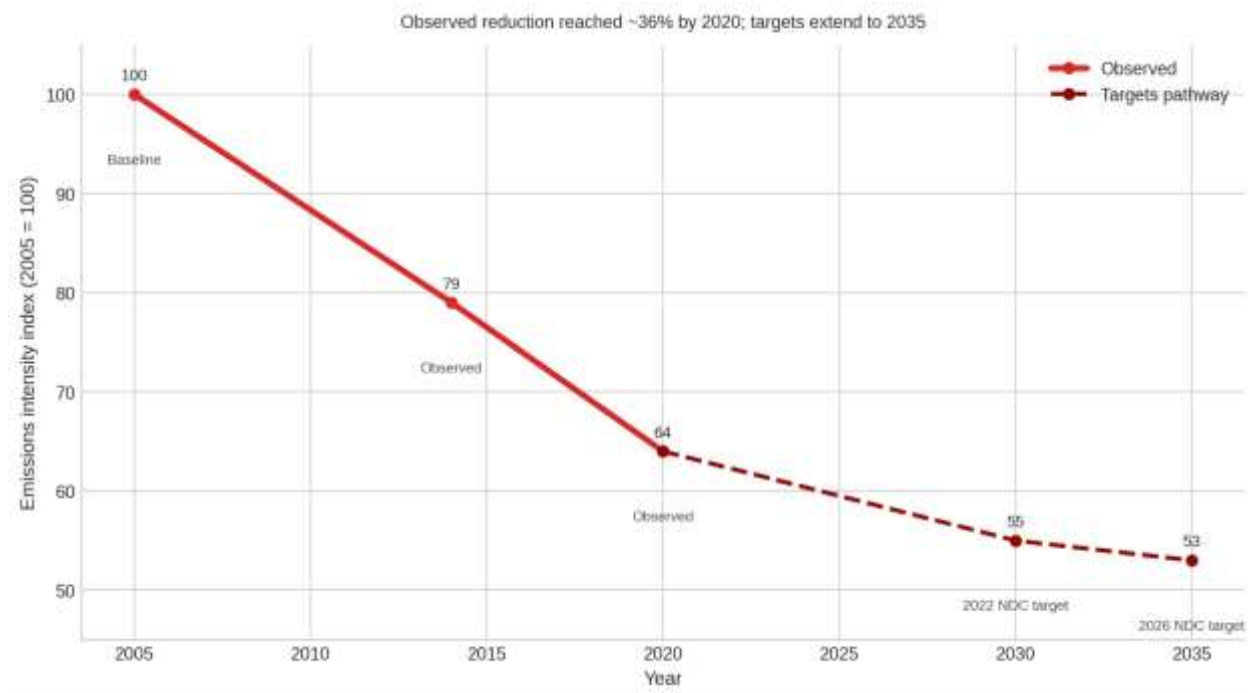


Figure 6.3: Emissions Intensity of GDP: Observed Decline and Future Targets. (Source: Compiled from MoEFCC national communications, PIB releases, and UNFCCC submissions cited).

Table 6.2: Emissions Intensity of GDP, 2005–2035 (Indexed, 2005 = 100). (Source: Compiled from UNFCCC (2015, 2022, 2026), MoEFCC (2023), PIB (2024)).

Year	Emissions Intensity (Index)	% Reduction vs 2005	Status / Target
2005	100	0%	Baseline
2014	~79	~21%	Observed
2020	~64	~36%	Observed
2030 target (2022 NDC)	55	45%	Pledge
2035 target (2026 NDC)	53	47%	Pledge

The extra carbon sink beyond the 2005 level is estimated to be around 2.29 billion tonnes of CO₂ equivalent, while the goal is to achieve a carbon sink of 2.5–3.0 billion tonnes by 2030 (FSI, 2024; PIB, 2024). The total carbon stock in Indian forests is estimated at 7,285.5 Mega tonnes carbon (or approximately 26,716 Mega tonnes CO₂ equivalent) which has increased by 4.86 percent from the 2017 assessment (FSI, 2024). The major initiatives for further improvement are the Green India Mission, the Compensatory Afforestation Fund Management and Planning Authority (CAMPA), and the Green Credit Programme. But gains in monoculture plantations could be ecologically inferior to losses in natural forests, at least in terms of biodiversity and water-regulation services, cautioned Reddy et al. (2015), even when carbon-equivalent metrics show a net positive.

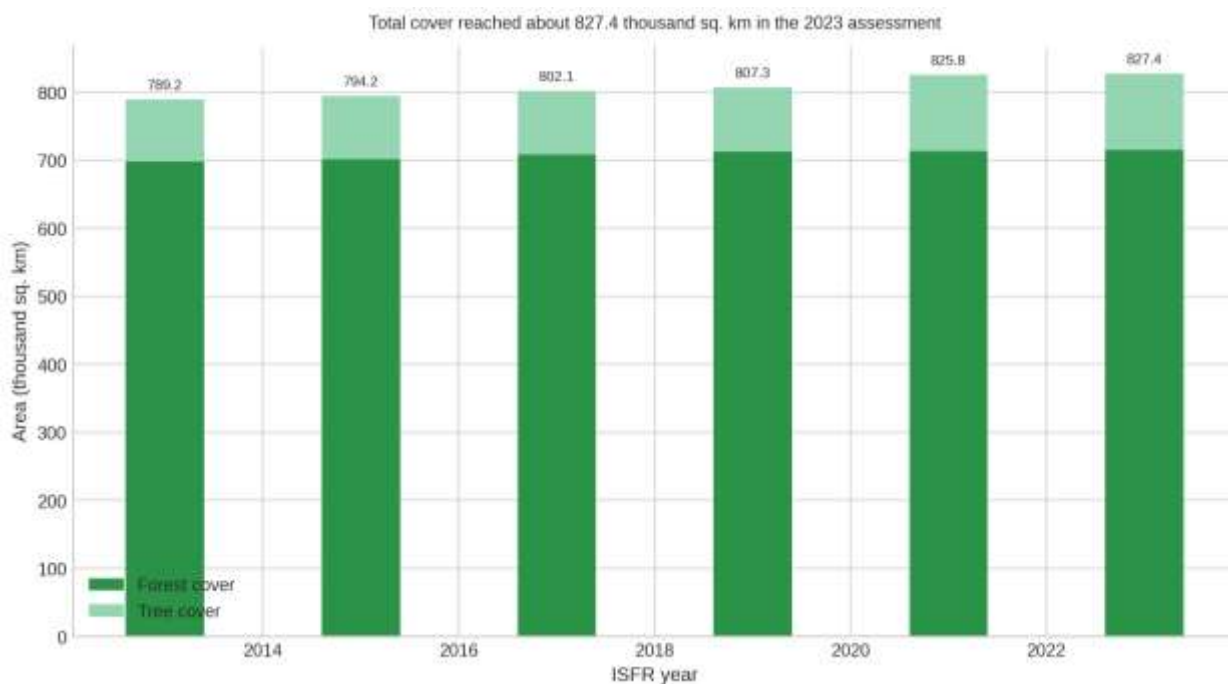


Figure 6.4: Forest and Tree Cover in India, 2013–2023. (Source: Compiled from the India State of Forest Report series, especially ISFR 2023 (FSI, 2024)).

6.4 SDG India Index: Improvements and Persistent Laggards

NITI Aayog SDG India Index is the most comprehensive and reliable composite indicator of SDG progress in India. The fourth edition (2023–24) recorded a national composite score of 71 out of 100, an improvement from 66 in 2020–21, 60 in 2019, and 57 in 2018 (NITI Aayog, 2024). The most notable improvement was on Goal 13 (Climate Action), which went from a score of 54 in 2020–21 to 67 in 2023–24, marking a 13-point increase – the highest of all goals in

the last two years – resulting from progress on renewable energy capacity, the spread of disaster management plans and increased coverage of early warning systems. Progress was also made on Goal 1 (No Poverty), Goal 8 (Decent Work and Economic Growth) and Goal 7 (Affordable and Clean Energy).

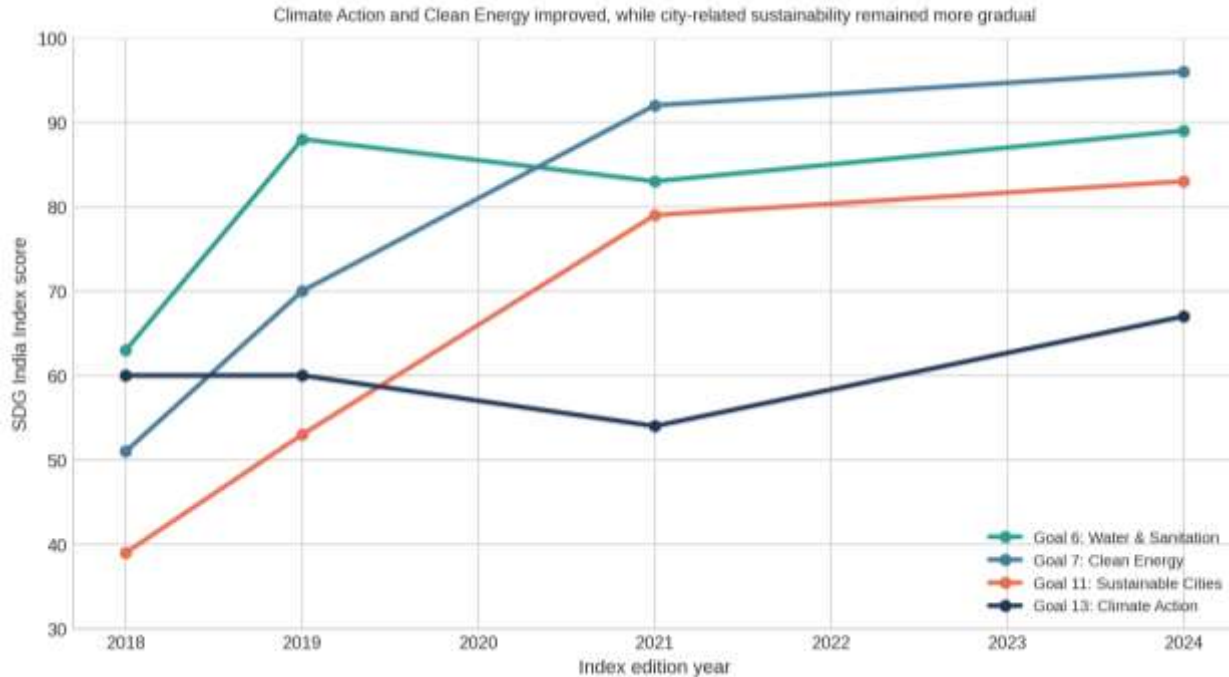


Figure 6.5: Selected SDG India Index Trends, 2018–2024. (Source: Compiled from NITI Aayog SDG India Index editions 2018, 2019, 2020–21, and 2023–24).

However, Goal 2 (Zero Hunger) and Goal 5 (Gender Equality) continued to be in the 'Performer' category and multiple environmental dimensions showed less progress. Goal 11 (Sustainable Cities and Communities) has seen a slight improvement but environmental PM_{2.5} in non-attainment cities, scientific solid waste processing and slum rehabilitation remain lagging in the Indo-Gangetic region and a few metros in the south (NITI Aayog, 2024). The indicators for Goal 6 (Clean Water and Sanitation) have improved considerably for the indicator concerning the connection of taps to water, but the indicators for river water quality and groundwater extraction have not done as well. These divergent trends highlight the central thesis of this report: the Government of India's progress on supply side, technology-deployment indicators has been faster as compared to its progress on regulatory-enforcement and behavioural-change indicators.

Table 6.3: SDG India Index Composite Scores, Selected Goals, 2018–2024. (Source: Compiled from NITI Aayog SDG India Index, Editions 1–4 (NITI Aayog, 2018, 2019, 2021, 2024)).

Goal	2018	2019	2020–21	2023–24	Direction
Composite Score	57	60	66	71	Improving
Goal 6: Water & Sanitation	63	88	83	89	Improving
Goal 7: Affordable & Clean Energy	51	70	92	96	Strong
Goal 11: Sustainable Cities	39	53	79	83	Slow gain
Goal 13: Climate Action	60	60	54	67	Strong gain
Goal 15: Life on Land	90	66	66	75	Mixed

6.5 Clean Cooking and Electric Mobility

The PMUY's growth has significantly contributed to clean cooking access. As of December 2025, there were about 10.35 crore households covered under the PMGSG and the cumulative LPG connections across the country have surpassed 33 crore (PIB, 2025). However, refill consumption per beneficiary has increased from around 3.0 to 3.95 cylinders per annum between 2019-20 and 2024-25, indicating more consistent fuel switching even though this is still short of the average household refill of 7–8 cylinders, suggesting continued use of biomass for ancillary cooking use (Ministry of Petroleum and Natural Gas, 2025; Gaikwad, Pandey, & Patil, 2024). For electric mobility, cumulative EV sales in India reached 4.4 million by mid-2025, with electric two and three-wheelers leading the volumes, while the electrification of passenger vehicles gained momentum during 2024-25 due to the investments of manufacturers and the PM E-DRIVE allocation of ₹ 10,900 crore for 2024-2026 (Ministry of Heavy Industries, 2025; JMK Research & Analytics, 2025).

6.6 The International Solar Alliance and Climate Diplomacy

In addition to domestic achievements, India's environmental efforts have also contributed to its foreign policy and its global leadership in the area of clean energy. The International Solar Alliance (ISA) has proved to be a critical platform: By 2024, the ISA had 124 signatory countries, and was running five flagship programmes, among them SolarX (Africa) for solar entrepreneurship and the Solar Technology Application Resource Centre (STAR-C) (ISA, 2024). India's participation in the Coalition for Disaster Resilient Infrastructure (CDRI), the Leadership Group for Industry Transition (LeadIT) and the Bali, New Delhi and Rio energy transition communiqués of the G20 further reflects an intentional soft power projection on climate issues under the principle of CBDR-RC and equity-anchored ambition (Ratha & Barik, 2025).

6.7 Where Progress Has Been Slower: A Reality Check

But balanced against these achievements are areas of less progress. Ambient PM_{2.5} levels are still over 10 times the WHO guideline in many cities monitored and in less than half of the non-attainment cities, the National Clean Air Programme 2024 target has been met (Greenpeace & IQAir, 2025; CPCB, 2024). The rate of scientific processing of solid waste remains at about 50-52 percent and the remediation of legacy dumpsites in SBM-U 2.0 is less than 20 percent (MoHUA, 2024). The overall water quality of the rivers is marginally better but extremely poor in the stretches which are designated as priority class-I and class-II stretches (CPCB, 2025a). Adaptation finance flows are far from the required finance: according to the Climate Policy Initiative (2024), tracked adaptation finance to India in 2022-23 was estimated at USD 9 billion, which is well short of the estimated USD 56-57 billion per year required in a Third National Communication.

Table 6.4: Summary Scorecard of India's Environmental Progress, 2025.

Domain	Direction	Indicative Quantitative Evidence
Renewable energy capacity	Strongly positive	~262 GW non-fossil; 50% NDC target hit 5 yrs early
Emissions intensity of GDP	Positive	36% ↓ by 2020; 47% target by 2035
Forest & tree carbon sink	Positive (mixed)	2.29 GtCO _{2e} additional sink achieved
Clean cooking access (PMUY)	Positive	~10.35 crore beneficiaries by Dec 2025
Rural tap-water (JJM)	Positive	~78% rural FHTC by Dec 2024
Air quality (PM _{2.5})	Slow / mixed	50.6 µg/m ³ in 2024; 10× WHO threshold
River water quality	Slow	296 polluted stretches across 271 rivers (CPCB 2025)
MSW & plastic waste	Slow	Only 50–52% scientifically processed; 19% legacy site

		clearance
Adaptation finance	Below need	~USD 9 bn tracked vs ~USD 56 bn/yr requirement

6.7.1 Disaggregated Performance: A State-Level Lens

There is significant variation between states on a number of national indicators. The SDG India Index 2023–24 shows that Kerala (79), Uttarakhand (79), Tamil Nadu (78) and Goa (77) are at the front of the pack and Bihar (57), Jharkhand (62) and Nagaland (63) are in the 'performer' category (NITI Aayog, 2024). The difference is due to the differences in the level of development, fiscal capacity, and administrative depth. Karnataka, Andhra Pradesh, Tamil Nadu, Gujarat and Rajasthan are among the leaders on Goal 13 (Climate Action) primarily due to their renewable energy installations, evacuation infrastructure and proactive state action plans on climate change. With regards to Goal 6 (Clean Water and Sanitation), Goa, Punjab, Telangana, Mizoram and Himachal Pradesh are in 'achiever' category, and several central-Indian states are still underperforming for river-water quality and groundwater management (NITI Aayog, 2024). Indore, Surat, Pune and Bengaluru have been consistently recording high scores in the Swachh Survekshan in the Sustainable Cities (Goal 11) category, while many smaller cities (tier-2) faced repeated low scores on source segregation in Swachh Survekshan 2024 (MoHUA, 2024b).

6.7.2 Critical Limitations of the Empirical Evidence

The evidence presented in this chapter is subject to a few methodological considerations. Ambient air-quality monitoring coverage in India is still not uniform; as of the end of 2024, India has around 552 continuous ambient air-quality (AQ) monitoring stations in 285 cities and is primarily located in tier-1 metropolitan cities, with sparse rural monitoring stations (CPCB, 2024). Nationwide averages of reported PM_{2.5} are thus skewed towards urban readings and may underestimate the exposure to biomass and brick kiln emissions in rural areas. Second, the data on water quality is limited to biochemical oxygen demand and a few physical-chemical parameters; emerging contaminants like pharmaceutical residues, micro plastics, endocrine disruptors are not systematically monitored on a large scale (Cullet, 2009; CPCB, 2025a). Third, the assessment of forest cover is based on 1 ha minimum mapping unit and is not entirely consistent and does not distinguish natural forests from plantation monocultures with similar canopy closure (Reddy et al., 2015). Fourth, reported emissions intensity data are sensitive to the adoption of a particular GDP price base, which must be used at constant prices for comparisons over time to avoid mis-attribution. Fifth, there are discrepancies between various climate finance sources as a result of different definitions of scope, additionality requirements, and how grants compare to concessional loans (CPI, 2024). These constraints do not detract from the general findings in the chapter, but they support further investments in measurement infrastructure as the basis for policy.

The environmental trajectory of India from 2015 to 2025 is best described as asymmetric, and with an increasingly global footprint: rapid and significant strides in clean energy deployment and in carbon sequestration, and slower and more uneven in pollution control, waste management and adaptive resilience. The subsequent chapter analyzes this imbalance in terms of structural political economy, federal coordination, finance and technology, placing the empirical results in the wider literature on transitions to a green economy in high-growth, middle-income economies.

CHAPTER 7:

DISCUSSION

7.1 Introduction

The empirical results combined in Chapter 6 naturally lend themselves to an interpretive question: why has India's environmental performance been significantly greater in renewable energy deployment than in air quality, water quality, and waste management results? Drawing on the existing literature on environmental governance in federal democracies, it develops a four-pronged explanation in this chapter. It asserts that the asymmetry is structural and the reasons can be attributed to (i) the political economy of supply-side versus demand-side interventions, (ii) federal coordination dynamics, (iii) finance and technology gaps and (iv) the embeddedness of coal in the developmental and fiscal architecture in India. The chapter also looks at international comparative literature to put India's performance in the context of the high growth emerging economies before extrapolating conclusions about sustainable development.

7.2 Why Renewable Energy Has Outpaced Pollution Control

7.2.1 *The Political Economy of Supply-Side Interventions*

In essence, deployment of renewable energy is a supply-side intervention, and involves mobilisation of capital, acquisition of land, transparent bidding and contracting, and grid integration of new generation. All of the above work is focussed in well-defined and resourced agencies at the national level, such as SECI, the Power Grid Corporation, the MNRE and the Central Electricity Regulatory Commission, all of which are subsidiaries of NTPC. The political sense of urgency and the incentives are aligned: capacity additions provide tangible 'milestone' moments like achieving 100 GW solar in January 2025 and 50 GW wind in March 2025, and there is measurable foreign and domestic investment, while also fostering an expanding manufacturing ecosystem under the Production-Linked Incentive scheme (Dubash, 2019; PIB, 2026). Pollution control on the other hand is a demand side, regulatory and behavioural intervention which will need continued enforcement action against a diverse set of actors – individual vehicles, brick kilns, small industries, agricultural residue burners, urban local bodies, and households (Thakur & Patel, 2023; Pandey et al., 2021).

The supply-side interventions have positive feedback loops: When more auctions are added, tariffs are reduced, manufacturing is increased, and politics are expanded, providing an even more significant justification for additional auctions. In contrast, demand-side interventions often have diffuse benefits (reduction in hospital admissions, fewer cardiovascular deaths) but concentrated costs (increased fuel costs, compliance etc, agricultural burning restrictions) which mean that there is more likely to be political opposition. The asymmetry is thus to some degree explainable by the usual public choice arguments of differential mobilisation of benefits and costs (Olson, 1971; Thakur & Patel, 2023).

7.2.2 *Federal Coordination and Subnational Capacity*

India's environmental governance is focused at the State and the urban-local level, while the Union and the States have both enacted laws on environmental issues in a concurrent fashion. The main frontline monitoring, prosecution and enforcement agencies are the State Pollution Control Boards, Municipal Corporations and District level Forest Departments. These agencies' capacity is quite uneven by state. The technical-cadre vacancy rate of CPCB and SPCBs combined is more than 35 percent, while several smaller states have a skeleton scientific staff (Thakur & Patel, 2023; Sahu, 2014).

Renewable energy, on the other hand, rests on federal coordination of central agencies, which have uniform procurement structures. SECI's reverse auction approach is replicable, standardized throughout the country and progressively standardized the contract design. The end result is that while there is one 'national market' for renewable electricity there are 28 distinct 'state markets' for pollution control. This contrast also accounts for the failure to achieve the essential governance of MSW even in the face of some comprehensive rules, issued by the central government (Khosla & Bhardwaj, 2019; Rao, 2023).

7.2.3 Finance Gaps and Adaptation Underinvestment

The third structural axis is finance. The estimated total climate-action costs in India in the Third National Communication (MoEFCC, 2023) and updated NDC (UNFCCC, 2022) are in the range of USD 2.5 – 3.5 trillion at 2014 prices, of which the estimated adaptation cost is in the range of USD 56 – 57 billion per year. This is the level of climate finance flows to India for adaptation as estimated by the Climate Policy Initiative (2024) was under USD 10 billion per year as of 2022–23, with total tracked climate finance to India at USD 49 billion per year. International public flows have been particularly disappointing when compared to the USD 100 billion per year (collective) developed country commitment made in 2009; the new collective quantified goal (NCQG) agreed at COP29 in 2024 (USD 300 billion per year by 2035) is described as 'considerably short' of identified needs in Indian and other developing-country submissions (UNFCCC, 2024; Government of India, 2024).

The gap is accentuated in the fiscal architecture within India. Pollution control and solid-waste management are local-government tasks, but the 73rd and 74th Constitutional Amendments failed to provide panchayats and urban local bodies with sufficient revenue-raising powers, with less than 1 percent of GDP being raised by them through own-source revenue, compared with 2–3 percent among comparable middle-income peers (Rao, 2023; World Bank, 2022). In contrast, renewable energy projects have been primarily funded through commercial bank loans, NBFC-IFC lending and green bonds, and more recently, international institutional capital, such as the predictable PPA regime, which has been helped by India's macroeconomic stability and creating an investable asset class (CEEW, 2024; CPI, 2024)

7.2.4 Technology and Storage Constraints

In spite of the rapid deployment of renewable-energy resources, technology challenges are still not trivial in two areas. First, increased penetration of variable renewable energy (VRE) in the total electricity mix is driving increased needs for grid flexibility, balancing reserves and storage. Despite the significant drop in battery energy storage (BESS) costs (INR 2.79–3.0 lakh per MW per month in competitive bidding through SECI in 2024–25), the actual installed BESS capacity in India was only 1 GW by the end of 2025 (CEA, 2025; MNRE, 2026). Second, the technologies of decarbonising industrial processes like steel production, cement production, fertiliser production, and refining – green hydrogen, carbon capture and storage, low carbon clinker substitutes – have leveled costs that are still too high without continued policy and finance interventions (Herrmann, 2024; IEA, 2024). The National Green Hydrogen Mission and the carbon credit trading scheme under the Energy Conservation (Amendment) Act 2022, along with the new regulatory requirements on the demand side are a credible direction of travel, but the 47 percent emissions-intensity target for 2035 will be met only if the timeframe for competitive deployments is on track.

7.2.5 Coal Dependency and the Just-Transition Challenge

The energy and fiscal architecture of India is the most important causal factor in the asymmetric development. In FY2024, about 74 percent of electricity generation was from coal and the sector has been a significant source of fiscal revenue for a number of States; it has directly provided employment to about 0.3 million people and several million indirectly (IISD, 2025; Bhushan, Banerjee, & Agarwal, 2020). The issue of decarbonisation in the coal-intensive districts of Jharkhand, Chhattisgarh, Odisha, Madhya Pradesh and Telangana is linked to the issues of poverty alleviation, public-finance autonomy, and political economy, both at the state and local levels. The just-transition

literature focuses on five policy areas: measures to replace coal-state income; targeted skilling and re-employment for coal workers; land restoration for retired thermal plants and coal mines; investment in new local industries; and social protection for informal-sector dependants (Bhushan & Srestha, 2023; Bhushan, Banerjee, & Agarwal, 2020). India's Just Transition architecture is still in its nascent stages when compared to the magnitude of the challenge and is supported by three core initiatives: the NITI Aayog's Just Transition framework, the World Bank's USD 1.5 billion of Just Transition operations and selected state-level pilots in Jharkhand and Odisha.

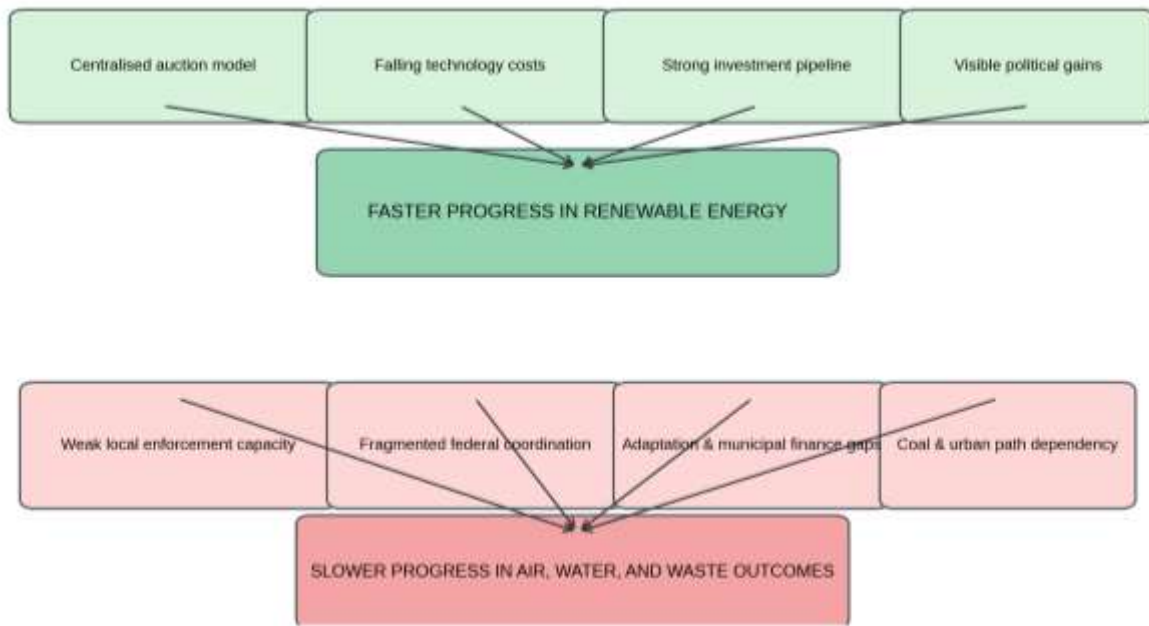


Figure 7.1: Why Environmental Progress Has Been Uneven in India. (Source: Author's analytical diagram based on the synthesis presented in Chapter 7 and the cited literature on federalism, finance, enforcement, and coal dependency).

7.3 Comparative Perspective: India among Emerging Economies

India's renewable energy trajectory has been found to be comparable with most emerging economies by cross-country analyses by IEA (2024), Climate Action Tracker (CAT, 2026) and World Bank (2022). India has been outpaced by Brazil, Indonesia and South Africa in annual renewable capacity additions as a percentage of total capacity between 2020 and 2025, and is rated 'highly insufficient' for 1.5°C – along with the EU and the US (CAT, 2026), though for the reasons cited in the report. Although India's emissions intensity of GDP has improved, it is still higher than that of Brazil and the EU, but lower than that of China; the emissions per capita (about 2 tonnes CO₂ per capita in 2023) are still lower than the global average, but higher than the OECD countries (IEA, 2024).

But on non-energy environmental indicators performance is more challenging in relative terms in India. Greenpeace & IQAir (2025), OECD (2023), the average PM_{2.5} levels are higher in urban areas than in any of the comparator G20 economies, while the efficiency of waste collection is not up to par when compared with OECD and comparable middle-income economies like Brazil and Mexico (OECD, 2023). The positive trend in India on forest cover is in contrast to the deforestation trend in the Brazilian Amazon, though both countries struggle with losing primary forests with high biodiversity compared to plantations (WWF, 2024; FSI, 2024).

7.4 Strengths and Weaknesses of India's Approach

From the above analysis, five strengths can be concluded. India has built a credible leadership role in the world in deploying renewable energy and championing clean-energy diplomacy through achieving India's first 50 percent non-fossil capacity target, launching the International Solar Alliance (ISA) and the G20 Energy Transitions Working Group (ETWG) leadership. Second, the country has developed an equity narrative that is based on CBDR-RC, which is consistent with the country's developmental policy space but has increased ambition over time (NDCs 2015, 2022, 2026). Third, mission mode delivery (Solar Mission, JJM, PMUY, Swachh Bharat) has shown its ability to achieve fast scale-up when there is a convergence of political leadership and financing. Fourth, there has been an investment in the measurement infrastructure in India, such as SDG India Index, ISFR, NCAP, and Energy Statistics, which offer comparable longitudinal data although there are still gaps between monitoring and actions (NITI Aayog, 2024). Fifth, India has also introduced new financial tools such as sovereign green bonds, viability gap funding for battery storage and green-credit market in the 2023 framework.

Just as obviously, there are four liabilities. First, environmental enforcement is routinely under-resourced at the subnational and local levels, compared to the scope of the regulatory mandate. Secondly, the federal system gives more weight to supply side, central government interventions than to demand side, local government interventions, which generates the unequal performance that was discussed in chapter 6. Third, international and domestic climate finance inflows are far from meeting the needs, particularly those for adaptation. Fourth, India's dependence on coal and the political economy of coal-bearing states represents a structural challenge that calls for the sequencing and equity of just transition planning, instead of sudden phase-out commitments (Dubash, 2019; Bhushan and Srestha, 2023; IISD, 2025).

7.4.1 Lessons from the Indian Just-Transition Pilots

While the programmes for just transitions are at a nascent stage in India, three sub-national experiences provide pedagogically valuable lessons. To put this into perspective, in 2022, the Government of Jharkhand has set up a Sustainable Just Transition Task Force specifically to prepare the State for the loss of coal revenues, and initial studies show that the most promising near-term interventions are mine restoration, agro-photovoltaic development on degraded coal land, and skilling for renewable-energy operations and maintenance (Bhushan, Banerjee, & Agarwal, 2020). Second, Odisha state government through its Climate Change Action Plan and the Department of Mines has started post-mining land rehabilitation as part of the revenue generation of the District Mineral Foundation, and its coverage and budgetary size are still not as large as required. Third, the World Bank supported Low-Carbon Transition operation, authorized in 2024 with a USD 1.5 billion development policy loan, specifically mentions the need for institutional infrastructure for just transition to coordinate implementation, including a national platform for coordination (World Bank, 2024). Based on these pilots, operational just-transition planning will need specific financing mechanisms, planning institutions at district level, and a staged process of transitioning away from fossil fuels and towards alternative livelihoods.

7.4.2 Behavioural Public Policy and Mission LiFE: A Critical Reading

At the heart of Mission LiFE is the concept of changing individual and household behaviour in the response to climate change. The scholars of behavioural public-policy are optimistic that demand side measures can provide significant mitigation potential, if they are coupled with complementary infrastructure, reliable information and price signals (Creutzig et al., 2023). The Sixth Assessment Report of the IPCC Working Group III estimates that GHG emissions in end-use sectors can be cut by 40 to 70 percent by 2050 compared to projected baseline emissions, through demand-side measures (IPCC, 2022). The opportunity areas for India are to use energy-efficient appliances through the star rating programmes of the Bureau of Energy Efficiency, to shift to public and non-motorised transport, to replace single-use plastics and to minimise food waste in retail and domestic settings. The downside, however, is the implicit

notion that behavioural change alone can be an effective replacement for regulation and pricing policy – international experience indicates otherwise, with behavioural campaigns having more modest and short-lived impacts (Anable et al., 2011).

7.4.3 The Role of Capital Markets and Sustainable Finance

The sustainable finance ecosystem has come a long way in India since 2022. The green bonds were first issued in January and February 2023 with two tranches of INR 16,000 crore, followed by subsequent tranches in 2023-24 and 2024-25 that have been dedicated to clean transport, renewable energy and energy efficiency (Ministry of Finance, 2024). The Securities and Exchange Board of India (SEBI) has increased the disclosure requirements for environmental, social, and governance (ESG) aspects by introducing the Business Responsibility and Sustainability Reporting (BRSR) framework for the top 1,000 listed companies, and the BRSR Core framework with assured key indicators applicable from 2023-24 (SEBI, 2023). Despite this progress, literature reflects that there are still some recurring challenges which include low issuance of green bonds by states, non-existence of a uniform taxonomy consistent with the international classification, lack of integration of climate-related financial risk in the supervisory frameworks (CPI 2024, CEEW 2024). The first steps taken by the Reserve Bank of India (RBI) in the form of their Discussion Paper on Climate Risk and Sustainable Finance (2022) and their guidance on green deposit (2023) are welcome but need to be operationalised further.

7.5 Implications for Sustainable Development in a High-Growth Economy

The Indian experience is significant for the general sustainable-development literature on high-growth, middle-income economies. First, the experience points to the fact that decarbonising electricity is the most readily achievable element of the green transition so far as technology costs and political setups go and can yield fast and visible change that can pave the way for subsequent transformations. Second, the experience also shows that this ‘easy win’ is not sufficient to lead to better quality of the local environment – air, water, and waste – without other investments in the capacity of subnational governments, fiscal devolution, and behavioural-policy levers. Thirdly, the Indian experience highlights the importance of just-transition planning in coal dependent communities to prevent stranded assets and social displacement (Dubash, 2019; Bhushan and Srestha, 2023).

Fourth, the gap between success of renewable energy and underinvestment in adaptation puts a big equity question on the table. Rural smallholders, informal urban workers, women and communities of the Scheduled Caste and Tribe are more vulnerable to the effects of climate change, while large renewable projects' immediate beneficiaries are more privileged actors like developers, financiers, and manufacturers. The green transition, if not explicitly designed to reduce inequalities, risks perpetuating them (Roy et al., 2018; Mehta et al., 2019). Chapter 8 presents policy recommendations and future research directions based on these implications.

CHAPTER 8: CONCLUSIONS AND RECOMMENDATIONS

8.1 Key Insights

In this study, the integrated, evidence-based approach has tried to assess the environmental sustainability in India, using government documents, peer-reviewed scholarship and international datasets. The analysis of the chapters 4-7 leads to five conclusions.

First, environmental issues in India are sectoral symptom of structural drivers – demographic momentum, urbanisation, coal dependency, economic growth etc. – not sectoral issues. Although each of these air pollution, water stress, land degradation, mismanagement of waste and climate vulnerability present different challenges, they also have common and interlinking drivers, and often exacerbate each other (Chapter 4). Secondly, the NEP, the NAPCC and its missions, as well as sectoral legislations, the National Green Hydrogen Mission, the Energy Conservation

(Amendment) Act 2022, Mission LiFE, the SAPCC framework, the Paris Agreement NDCs (2015, 2022, 2026), and the LT-LEDS for net zero by 2070 (Chapter 5) are some of the most ambitious environmental policy architectures in any major emerging economy in India.

Thirdly, India has achieved a number of significant results in the areas of renewable energy deployment, the intensity of emissions of GDP, and the development of carbon sink, all of which are significant at the global level, from 2015 to 2025, with India's total share of non-fossil energy installed power reaching 50-52 percent by the end of the 2025 target period, well ahead of schedule (Chapter 6); while the emissions intensity of GDP has come down five years before the 2020 target, and a carbon sink of approximately 2.29 billion tonnes of CO₂ equivalent (bn of CO₂e) has been created by the end of 2025 (Chapter 6). Fourth, although there are detailed rules and missions in each of the air-quality, water-quality, waste-management and adaptation dimensions, progress is clearly lagging. Fifth, this asymmetry can be attributed to the political economy of supply-side and demand-side interventions, federal coordination structure, finance and technology shortages, and structural coal dependency (Chapter 7).

8.2 Policy Recommendations

8.2.1 Strengthen Environmental Enforcement Mechanisms

A structural upgrading of pollution-control institutions is needed for closing the gaps in air, water and waste management. The recommendations are: (i) Filling up the technical vacancies in CPCB/SPCB to reduce the vacancy rates to less than 10 percent within five years with linkage of budget to performance; (ii) Implementing legally binding ambient air-quality standards based on the WHO guidelines with airshed-level governance instead of city-level governance in the Indo-Gangetic Plain; (iii) Strengthening the adjudicatory bandwidth of the National Green Tribunal including setting up specialised regional benches; and (iv) Systematisation of data disclosure, expansion of the continuous emission monitoring system for industries and continuous monitoring of ambient air-quality for tier-2 and tier-3 cities (Thakur & Patel, 2023; Greenpeace & IQAir, 2025).

8.2.2 Scale a Genuine Circular Economy

The circularity rate in India is estimated to be less than 10 percent. The key sectors for scaling a circular economy are: (i) mandatory source separation of MSW at the household level, with the introduction of deposit-refund schemes; (ii) strengthening the EPR system for plastics and e-waste products with the introduction of digital monitoring of the process and graduated penalties for non-compliance; (iii) introducing procurement preferences for products that contain recycled content in central and state government procurement; and (iv) implementing a national framework on industrial symbiosis and remanufacturing through the support of the Green Credit Programme and the Carbon Credit Trading Scheme (NITI Aayog, 2024; Gupta, & Dash, 2023).

8.2.3 Mobilize Blended Finance and Domestic Climate Capital

The gap in climate finance will have to be filled through reform of international climate finance and significant domestically sourced funding. India should: (i) utilize sovereign green bonds, viability gap funding and concessional financing by multilateral development banks to crowd in private sector financing for storage, transmission and green hydrogen; (ii) operationalize blended finance vehicles, adapted for agriculture, water and coastal areas, consistent with India's principles of additionality, equity and concessional terms; (iii) pursue bilateral and multilateral Just Energy Transition Partnerships (JETPs) based on demonstrated needs (CPI, 2024; UNFCCC, 2024); and (iv) advocate for a more ambitious New Collective Quantified Goal, post-2025, based on demonstrated needs (CPI, 2024; UNFCCC, 2024).

8.2.4 Implement a Just Transition for Coal Regions

Just transition planning should transition from concept to operational programmes. Some specific measures are: (i) establishment of dedicated district level transition cells in major coal bearing districts; (ii) establishment of revenue replacement mechanisms for revenue generation dependant state and district government in coal bearing districts; (iii) targeted skilling and entrepreneurship programme for coal workers and informal sector dependents; (iv) progressive restoration of coal mines land for agro-photovoltaic, ecological restoration and renewable energy use; (v) anticipatory

social protection (health and pension) scheme for coal district workers (Bhushan and Srestha, 2023; Bhushan, Banerjee, & Agarwal, 2020).

8.2.5 Integrate Traditional Ecological Knowledge

The traditional ecological knowledge of India, which can be applied to agriculture, water management, forest management and biodiversity management is underutilized. Recommendations encompass integration with the implementation of the Forest Rights Act 2006, formal recognition of community-led biodiversity-management committees under the Biological Diversity Act 2002 (as amended in 2023), and explicit inclusion of indigenous and local-community perspectives in National Adaptation Plans, SAPCCs and Mission LiFE (Berkes, 2018; Mehta et al., 2019).

8.2.6 Invest in R&D for Hard-to-Abate Sectors

Investment in R&D in the hard-to-abate sectors – steel, cement, fertiliser, refining, heavy transport, aviation, and shipping – will be required, especially under the National Green Hydrogen Mission, National Mission on Advanced and High-Impact Research (Mission Innovation), and the strategic partnership with IEA's Clean Energy Transitions Programme. Energy storage (long duration), low carbon clinker substitutes, manufacturing of electrolyser technologies, and second generation biofuels are identified as key areas of priority (MNRE, 2023; IEA, 2024). Public R&D investments for energy and environmental research should be increased to 0.05 percent of GDP and be targeted to 0.2 percent of GDP in the near future.

8.2.7 Improve Access to International Climate Finance and Technology

India needs to actively influence the design of climate financing for 2026 and beyond. The following are specific positions of advocacy: (i) Separation of adaptation and mitigation flows in the New Collective Quantified Goal (NCQG); (ii) a credible tracking mechanism, independently audited, which is aligned with IPCC, framing of additionality; (iii) operationalisation of Loss and Damage Fund with predictable contributions; and (iv) IP-based framework for enabling transfer of technology for hard-to-abate sectors (UNFCCC, 2024; Government of India, 2024).

8.2.8 Strengthen Subnational Capacity and Urban Local Bodies

Operational capacity of cities – specifically in the domains of air quality and water and waste – is the main driver of environmental outcomes, making a renewed push for subnational capacity critical. Specific measures include: (i) re-evaluating the inter-governmental fiscal architecture to make sure that municipal and panchayat bodies have predictable and formula based access to environment linked transfers in successive Finance Commissions; (ii) operationalisation of recommendations of the 15th Finance Commission on grants for air-quality improvement in million-plus cities, and supplementing with airshed level grants on the Indo-Gangetic Plain; (iii) systematic capacity-building of municipal and SPCB staff through the Indian Institutes of Technology, the National Institute of Urban Affairs and dedicated training academies; and (iv) institutionalised data infrastructure, including continuous monitoring at source level for industries, with mandatory public disclosure (Rao 2023; Thakur & Patel, 2023).

8.2.9 Mainstream Adaptation in Sectoral Planning

In India, the discussion on adaptation has been less prominent as compared to mitigation in the policy discourse. To achieve mainstreaming adaptation, the following will be required: (i) Climate-budget tagging in central and state expenditure to identify, monitor and gradually scale adaptation-relevant outlays; (ii) Integration of climate vulnerability and climate risk assessment in planning cycles of the agriculture, water, urban housing, transport and health departments; (iii) Scale-up of the agricultural insurance architecture, in particular weather-index insurance products tailored for rainfed and resource poor farmers; and (iv) Operationalisation of the National Adaptation Fund for Climate Change with predictable replenishment and access to the international Adaptation Fund and the Green Climate fund's adaptation window (MoEFCC, 2023; CPI, 2024).

8.2.10 Reform Subsidies and Strengthen Fiscal Instruments

Fiscal reform is a strong enabler of environmental transitions, though not explicitly on the policy agenda for climate change. Despite a downward trend, India's fossil-fuel subsidies have still been around INR 1.5 lakh crore in FY 2023–24, with the bulk of this coming from compressed natural gas (CNG) and LPG subsidies, and from implicit subsidies on coal (IISD, 2025). Progressively rationalise fossil fuel subsidies (with targeted support for people on low incomes and vulnerable workers), and reinvest carbon pricing revenues into adaptation and transition to just energy costs (IISD, 2025; Jindal, Puri, & Shrimali, 2025) would effectively change the relative cost of fossil fuel versus clean energy.

8.3 Future Directions

While this study has brought together evidence on the interconnections between the spheres of air, water, forest, waste and climate, there are some indications for further research. First, the sector-specific deep dives in agriculture and transport – the two biggest contributors of non-energy emissions and adaptation issues – would complement the energy-focused scholarship that takes center stage. Second, by comparing the other emerging economies (Brazil, Indonesia, South Africa, Mexico, Vietnam) with the same set of indicators, the experiences of these economies would provide insights on how policy and political-economy configurations can create different transition trajectories (CAT, 2026; OECD, 2023). Third, community-level adaptation studies in specific agro-ecological region(s) that captures the cumulative impact of adaptation and adaptation efforts among SCs, STs and women-headed households, and informal class of city dwellers such as small farmers would enhance empirical evidence for equity-based adaptation policy (Roy et al., 2018; Mehta et al., 2019). Fourth, ex-ante and ex-post evaluation of pilots of circular-economy, implementation of EPR and decentralized waste-to-energy projects would help to identify scalable models. Fifth, interdisciplinary studies connecting environmental economics, public-finance federalism, and constitutional law are required to implement the connections between fiscal reform and environmental results.

8.4 Concluding Reflection

The environmental narrative of the mid-2020s is not one that is uniformly triumphant, nor is it one of paralysation, but one of a series of challenges that India must meet. The country has proven that ambitious environmental goals are achievable along pathways of renewable energy and carbon sinks, while maintaining high economic growth and equity-based climate diplomacy. Likewise, it also has one of the world's worst levels of air, water and waste pollution and its climate vulnerability is highly socialized. The policy architecture has been established, the empirical record is growing and the research base is expanding. The task that lies at the heart of the challenge is one of implementation not aspiration: bridging the subnational capacity gap; scaling demand-side and circular-economy reforms; funding adaptation at the magnitude needed by science; and ensuring that the green transition is also a just transition. India's policy practice needs to match its policy ambition for the decade 2025–2035, if it does, then it will not only deliver its NDC commitments, but also provide a good template for sustainable development for the Global South as a whole.

REFERENCES

- Anable, J., Brand, C., Eyre, N., Layberry, R., Bergman, N., Strachan, N., ... & Tran, M. (2011). Lifestyle and energy consumption. *UKERC Report*. https://www.researchgate.net/profile/Christian-Brand-3/publication/378230994_Energy_2050_-_WG1_Energy_Demand_Lifestyle_and_Energy_Consumption/links/65cf3c47476dd15fb33c6646/Energy-2050-WG1-Energy-Demand-Lifestyle-and-Energy-Consumption.pdf
- Atteridge, A., Shrivastava, M. K., Pahuja, N., & Upadhyay, H. (2012). Climate policy in India: what shapes international, national and state policy? *Ambio*, 41(Suppl 1), 68-77.
- Berkes, F. (2018). *Sacred ecology* (4th ed.). Routledge.
- Berkes, F. (2026). *Sacred Ecology: Learning from Indigenous Knowledge and Stewardship*. Taylor & Francis.

- Bhushan C., and Srestha B. (2023). Just Transition Framework for India: Policies, Plans and Institutional Mechanisms. International Forum for Environment, Sustainability and Technology (iFOREST), New Delhi, India.
- Bhushan, C., Banerjee, S., & Agarwal, S. (2020). Just Transition in India: An inquiry into the challenges and opportunities for a post-coal future.
- Boora, S. (2023). Contradictions in conservation: India's forest (Conservation) Amendment Bill, 2023. *International Journal of Environmental Studies*, 80(5), 1212–1215. <https://doi.org/10.1080/00207233.2023.2247929>
- Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative research journal*, 9(2), 27-40.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, 3(2), 77-101.
- Bureau of Energy Efficiency. (2023). Annual report 2022–23. Ministry of Power, Government of India. <https://beeindia.gov.in>
- Business Standard. (2025, December 7). India achieved 50% of electricity capacity from non-fossil fuels: MNRE. <https://www.business-standard.com>
- CDRI (Coalition for Disaster Resilient Infrastructure). (2024). Global infrastructure resilience report 2024. CDRI. <https://www.cdri.world>
- CEED (Centre for Environment and Energy Development). (2024). From pollution to prevention: Rethinking plastic waste through circular design and segregation. CEED. <https://ceedindia.org>
- Central Electricity Authority. (2024). National Electricity Plan 2022–2032: Volume II – Transmission. Ministry of Power, Government of India. <https://cea.nic.in>
- Central Electricity Authority. (2025). Executive summary on power sector, October 2025. Government of India. <https://cea.nic.in>
- Central Electricity Authority. (2025). Monthly executive summary on power sector, December 2025. Ministry of Power, Government of India. <https://cea.nic.in>
- Central Ground Water Board. (2024). Dynamic ground water resources of India 2024. Ministry of Jal Shakti, Government of India. <https://cgwb.gov.in>
- Central Pollution Control Board. (2022). Polluted river stretches for restoration of water quality. Ministry of Environment, Forest and Climate Change, Government of India. <https://cpcb.nic.in>
- Central Pollution Control Board. (2023). Annual report on solid waste management 2022–23. Ministry of Environment, Forest and Climate Change. <https://cpcb.nic.in>
- Central Pollution Control Board. (2024). National Air Quality Monitoring Programme: Annual report 2023–24. Ministry of Environment, Forest and Climate Change, Government of India. <https://cpcb.nic.in>
- Central Pollution Control Board. (2024). National air quality monitoring programme: Annual data summary 2024. Ministry of Environment, Forest and Climate Change. <https://cpcb.nic.in>
- Central Pollution Control Board. (2025a). Polluted river stretches for restoration of water quality, 2022–2023 assessment. Ministry of Environment, Forest and Climate Change. <https://cpcb.nic.in>

- Central Pollution Control Board. (2025b). State of sewage treatment plants in India: Updated assessment. Ministry of Environment, Forest and Climate Change. <https://cpcb.nic.in>
- Centre for Energy, Environment and Water (CEEW). (2024). India renewable energy investment outlook 2024. CEEW. <https://www.ceew.in>
- Centre for Research on Energy and Clean Air (CREA). (2024). NCAP tracker 2024: Review of India's National Clean Air Programme. CREA. <https://energyandcleanair.org>
- Centre for Research on Energy and Clean Air (CREA). (2025). India power sector review 2025. CREA. <https://energyandcleanair.org>
- Centre for Research on Energy and Clean Air. (2026). India power sector review 2025. CREA. <https://energyandcleanair.org>
- Centre for Science and Environment. (2024). Climate India 2024: An assessment of extreme weather events. CSE. <https://www.cseindia.org>
- Centre for Science and Environment. (2025). Annual PM2.5 levels rose in 2024 for the second consecutive year despite a drop in stubble burning. CSE. <https://www.cseindia.org>
- Chauhan, A., & Mohanasundari, T. (2025). The impact of the Perform, Achieve, and Trade (PAT) scheme on energy intensity: Evidence from the pulp and paper industry. *Energy Sources, Part B: Economics, Planning, and Policy*, 20(1), 2588253.
- Climate Action Tracker. (2024). India: Country assessment, September 2024. Climate Analytics & New Climate Institute. <https://climateactiontracker.org/countries/india/>
- Climate Action Tracker. (2026). India: Country assessment, 2026 update. <https://climateactiontracker.org>
- Climate Policy Initiative. (2024). Landscape of green finance in India 2024. CPI. <https://www.climatepolicyinitiative.org>
- Convention on Biological Diversity. (2018). India's sixth national report to the Convention on Biological Diversity. Secretariat of the Convention on Biological Diversity. <https://www.cbd.int>
- Council on Energy, Environment and Water (CEEW). (2024). India's clean-energy financing landscape. CEEW. <https://www.ceew.in>
- Council on Energy, Environment and Water. (2024). Green Credit Programme: A short note. CEEW Green Finance Centre. <https://www.ceew.in>
- Creutzig, F., Roy, J., Devine-Wright, P., Díaz-José, J., Geels, F. W., Grubler, A., ... & Weber, E. U. (2023). Demand, services and social aspects of mitigation (Chapter 5). *IPCC 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, 503-612.
- Cullet, P. (2009). *Water law, poverty, and development: Water sector reforms in India*. OUP Oxford.
- Cullet, P. (2017). *Water law in India: An introduction to legal instruments* (2nd ed.). Oxford University Press.
- Dahiya, S., Myllyvirta, L., & Anand, A. (2024). Tracing the hazy air 2024: Progress report on the National Clean Air Programme. Centre for Research on Energy and Clean Air. <https://energyandcleanair.org>
- Dalberg & Confederation of Indian Industry. (2021). *Air pollution and its impact on business: The silent pandemic*. Dalberg-CII.

Department of Drinking Water and Sanitation. (2024). Jal Jeevan Mission: Operational guidelines and dashboard updates. Ministry of Jal Shakti, Government of India. <https://jaljeevanmission.gov.in>

Department of Science and Technology. (2021). Climate vulnerability assessment for adaptation planning in India using a common framework. Government of India, Department of Science and Technology and Swiss Agency for Development and Cooperation.

Dubash, N. K. (2012). *Handbook of climate change and India*. Oxford: Oxford University Press.

Dubash, N. K. (Ed.). (2019). *India in a warming world: Integrating climate change and development*. Oxford University Press.

Dubash, N. K., & Joseph, N. B. (2016). Evolution of institutions for climate policy in India. *Economic and Political Weekly*, 51(3), 44-54.

Dubash, N. K., Khosla, R., Rao, N. D., & Bhardwaj, A. (2018). India's energy and emissions future: an interpretive analysis of model scenarios. *Environmental Research Letters*, 13(7), 074018.

Dubash, N. K., Khosla, R., Rao, N. D., & Bhardwaj, A. (2018). India's energy and emissions future: an interpretive analysis of model scenarios. *Environmental Research Letters*, 13(7), 074018.

Ember. (2025). Global electricity review 2025: India country profile. <https://ember-energy.org>

Enerdata. (2025). India hits 500 GW in installed power, over 50% from non-fossil sources. Enerdata Daily Energy News. <https://www.enerdata.net>

Forest Survey of India. (2024). India State of Forest Report 2023 (Vol. 1). Ministry of Environment, Forest and Climate Change, Government of India. <https://fsi.nic.in/forest-report-2023>

Forest Survey of India. (2024). India state of forest report 2023 (Vol. 1). Ministry of Environment, Forest and Climate Change. https://fsi.nic.in/uploads/isfr2023/isfr_book_eng-vol-1_2023.pdf

Gaikwad, H., Pandey, S., & Patil, K. (2024). Empowering rural Indian women by clean fuel initiatives: an impact assessment of Pradhan Mantri Ujjwala Yojana. *Cogent Social Sciences*, 10(1), 2428823.

Germanwatch. (2025). Global climate risk index 2025. Germanwatch e.V. <https://www.germanwatch.org>

Government of India. (2008). National action plan on climate change. Prime Minister's Council on Climate Change.

Government of India. (2022). India's long-term low-carbon development strategy submitted to UNFCCC. <https://unfccc.int>

Government of India. (2024). India's submission on the new collective quantified goal on climate finance. UNFCCC. <https://unfccc.int>

Greenpeace, & IQAir. (2025). 2024 world air quality report. IQAir. <https://www.iqair.com>

Greenstone, M., & Hasenkopf, C. (2023). *Air quality life index: 2023 update*. Energy Policy Institute at the University of Chicago. <https://aqli.epic.uchicago.edu>

Greenstone, M., Hasenkopf, C., & Lee, K. (2022). *The air quality life index: Annual update*. Energy Policy Institute at the University of Chicago.

Guo, H., Kota, S. H., Sahu, S. K., Hu, J., Ying, Q., Gao, A., & Zhang, H. (2017). Source apportionment of PM_{2.5} in North India using source-oriented air quality models. *Environmental pollution*, 231, 426-436.

- Gupta, D., & Dash, S. (2023). Challenges of implementing extended producer responsibility for plastic-waste management: lessons from India. *Social Responsibility Journal*, 19(9), 1595-1612.
- Herrmann, P. R. (2024). *Decarbonising India's Hard-to-Abate Sectors*.
- India Meteorological Department. (2024). Climate of India 2024: Annual statement. Ministry of Earth Sciences, Government of India. <https://imd.gov.in>
- Indian Council of Agricultural Research. (2023). Climate change impacts on Indian agriculture: ICAR-NICRA assessment. ICAR. <https://icar.org.in>
- Indian Development Review. (2024). The case for counting rural plastic waste. IDR Online. <https://idronline.org>
- Indian Space Research Organisation. (2021). Desertification and land degradation atlas of India. Space Applications Centre, ISRO. <https://www.isro.gov.in>
- Intergovernmental Panel on Climate Change (IPCC) (Ed.). (2023). *Climate Change 2022 - Mitigation of Climate Change: Working Group III Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press. <https://dx.doi.org/10.1017/9781009157926>
- Intergovernmental Panel on Climate Change. (2023). AR6 synthesis report: Climate change 2023. IPCC. <https://www.ipcc.ch>
- International Energy Agency. (2024). World energy outlook 2024. IEA. <https://www.iea.org/reports/world-energy-outlook-2024>
- International Energy Agency. (2024). World energy outlook 2024. IEA. <https://www.iea.org>
- International Energy Agency. (2025). India: Country profile. IEA. <https://www.iea.org/countries/india>
- International Institute for Sustainable Development. (2025). Mapping India's energy policy 2025. IISD. <https://www.iisd.org>
- International Labour Organization. (2024). Working on a warmer planet: The impact of heat stress on labour productivity and decent work. ILO. <https://www.ilo.org>
- International Solar Alliance. (2024). Annual report 2023–24. ISA Secretariat. <https://isolaralliance.org>
- IPCC. (2022b). Climate change 2022: Mitigation of climate change. Contribution of Working Group III to the Sixth Assessment Report. Cambridge University Press.
- Iyer, R. R. (2003). *Water: Perspectives, issues, concerns*. Sage.
- Jindal, A., Puri, S., & Shrimali, G. (2025). Designing a prospective carbon trading market in India: Key properties, enabling features and linkages. *Applied Energy*, 386, 125595.
- JMK Research & Analytics. (2025, April). *India electric vehicle market overview FY2025 report*. <https://jmkresearch.com/electric-vehicles-published-reports/india-electric-vehicle-annual-ev-report-fy2025/>
- Jogesh, A., & Dubash, N. K. (2015). State-led experimentation or centrally-motivated replication? A study of state action plans on climate change in India. *Journal of Integrative Environmental Sciences*, 12(4), 247-266.
- Khosla, R., & Bhardwaj, A. (2019). Urban India and climate change. *India in a Warming World*, 459-476.
- Kumar, A., Tiwari, A. K., & Milani, D. (2024). Decarbonizing hard-to-abate heavy industries: Current status and pathways towards net-zero future. *Process Safety and Environmental Protection*, 187, 408-430.

- Kumar, S., Smith, S. R., Fowler, G., Velis, C., Kumar, S. J., Arya, S., ... & Cheeseman, C. (2017). Challenges and opportunities associated with waste management in India. *Royal Society open science*, 4(3).
- Lal, R. M., & Nagpure, A. S. (2026). Evaluation of India's National Clean Air Program Performance and Potential Health Benefits. *Environmental Science & Technology Letters*.
- Mazdiyasni, O., AghaKouchak, A., Davis, S. J., Madadgar, S., Mehran, A., Ragno, E., ... & Niknejad, M. (2017). Increasing probability of mortality during Indian heat waves. *Science advances*, 3(6), e1700066.
- Mehta, L., Srivastava, S., Adam, H. N., Alankar, Bose, S., Ghosh, U., & Kumar, V. V. (2019). Climate change and uncertainty from 'above' and 'below': perspectives from India. *Regional Environmental Change*, 19(6), 1533-1547.
- Ministry of Environment and Forests. (2006). National environment policy 2006. Government of India.
- Ministry of Environment, Forest and Climate Change. (2008). National Action Plan on Climate Change. Government of India. https://moef.gov.in/uploads/2018/04/NAP_E.pdf
- Ministry of Environment, Forest and Climate Change. (2019). National Clean Air Programme. Government of India. <https://moef.gov.in>
- Ministry of Environment, Forest and Climate Change. (2022a). India's long-term low-carbon development strategy. Submitted to UNFCCC at COP27. Government of India. <https://unfccc.int>
- Ministry of Environment, Forest and Climate Change. (2022b). Plastic Waste Management (Amendment) Rules, 2022. Government of India. <https://moef.gov.in>
- Ministry of Environment, Forest and Climate Change. (2022c). Mission LiFE: Lifestyle for Environment. Government of India. <https://missionlife-moefcc.nic.in>
- Ministry of Environment, Forest and Climate Change. (2023). Green Credit Rules, 2023. Notification, October 2023. Government of India. <https://moef.gov.in>
- Ministry of Environment, Forest and Climate Change. (2023). India. National Communication (NC). NC 3. Government of India. <https://unfccc.int/documents/636235>
- Ministry of Environment, Forest and Climate Change. (2023b). Notification on the Green Credit Programme, October 13, 2023. Government of India. <https://moef.gov.in>
- Ministry of Environment, Forest and Climate Change. (2024). State action plans on climate change. Government of India. <https://moef.gov.in/state-action-plan-on-climate-change>
- Ministry of Environment, Forest and Climate Change. (2024a). Annual report 2023–24. Government of India. <https://moef.gov.in>
- Ministry of Environment, Forest and Climate Change. (2024b). India's fourth biennial update report to the United Nations Framework Convention on Climate Change. Government of India. <https://unfccc.int/sites/default/files/resource/India%20BUR-4.pdf>
- Ministry of Finance. (2024). Economic survey 2023–24, Chapter 13: Climate change and India: Why we must look at the bigger picture. Government of India. <https://www.indiabudget.gov.in/budget2024-25/economicsurvey/doc/eschapter/echap13.pdf>
- Ministry of Finance. (2024). Status of sovereign green bonds: Allocation and impact reporting. Government of India. <https://dea.gov.in>

Ministry of Finance. (2025). Economic survey 2024–25, Chapter 10: Climate and environment: Adaptation matters. Government of India. <https://www.indiabudget.gov.in/budget2025-26/economicsurvey/doc/eschapter/echap10.pdf>

Ministry of Finance. (2025). Economic survey 2024–25, Chapter 10: Climate and environment – Adaptation matters. Government of India. <https://www.indiabudget.gov.in>

Ministry of Heavy Industries. (2024). FAME India Phase II: Status report. Government of India. <https://heavyindustries.gov.in/en/fame-ii>

Ministry of Heavy Industries. (2025). PM E-DRIVE scheme: Implementation status report. Government of India. <https://heavyindustries.gov.in>

Ministry of Housing and Urban Affairs. (2023). India urban outlook 2023. Government of India. <https://mohua.gov.in>

Ministry of Housing and Urban Affairs. (2024). Swachh Bharat Mission – Urban 2.0: Status update on legacy waste remediation. Government of India. <https://sbmurban.org>

Ministry of Housing and Urban Affairs. (2024b). Swachh Survekshan 2024: National rankings of Indian cities. Government of India. <https://swachhsurvekshan.org>

Ministry of Housing and Urban Affairs. (2025). Swachh Survekshan 2024–25 report. Government of India. <https://swachhsurvekshan.gov.in>

Ministry of Jal Shakti. (2023). National water mission: Annual report 2022–23. Government of India. <https://jalshakti-dowr.gov.in>

Ministry of Jal Shakti. (2024). Jal Jeevan Mission: Implementation dashboard, December 2024. Government of India. <https://jaljeevanmission.gov.in>

Ministry of New and Renewable Energy. (2023). National green hydrogen mission. Government of India. <https://mnre.gov.in/en/national-green-hydrogen-mission/>

Ministry of New and Renewable Energy. (2025). Physical progress: Renewable energy capacity additions, FY 2024–25 and 2025. Government of India. <https://mnre.gov.in>

Ministry of New and Renewable Energy. (2026). 2025 marks highest-ever renewable energy expansion in India's history. Government of India. <https://mnre.gov.in>

Ministry of Petroleum and Natural Gas. (2025). Year-end review 2025: Petroleum and natural gas. Government of India. <https://mopng.gov.in>

Ministry of Power. (2022). Energy conservation (amendment) act, 2022. Government of India. <https://powermin.gov.in>

Ministry of Power. (2023). Notification of the Carbon Credit Trading Scheme, 2023. Government of India. <https://powermin.gov.in>

Ministry of Statistics and Programme Implementation. (2024). Sustainable Development Goals – National Indicator Framework progress report 2024. Government of India. <https://www.mospi.gov.in>

Ministry of Statistics and Programme Implementation. (2025). Energy statistics India 2025. Government of India. https://mospi.gov.in/sites/default/files/publication_reports/Energy_Statistics_2025/Energy%20Statistics%20India%202025_27032025.pdf

- Mohanty, A., & Wadhawan, S. (2021). *Mapping India's climate vulnerability: a district level assessment*. Council on Energy, Environment and Water. <https://www.ceew.in>
- Mongabay India. (2026, March). India's updated climate plan targets 47% emissions cut and 60% clean power capacity by 2035. <https://india.mongabay.com/2026/03/indias-updated-climate-plan-targets-47-emissions-cut-and-60-clean-power-capacity-by-2035/>
- Mordor Intelligence. (2024). *INDIA MUNICIPAL SOLID WASTE MANAGEMENT MARKET SIZE & SHARE ANALYSIS - GROWTH, TRENDS, AND FORECASTS (2025 - 2030)*. <https://www.mordorintelligence.com/industry-reports/india-municipal-solid-waste-management-market>
- National Disaster Management Authority. (2019). National disaster management plan. Government of India. <https://ndma.gov.in/sites/default/files/PDF/ndmp-2019.pdf>
- National Mission for Clean Ganga. (2024). Annual progress report on the Namami Gange Programme. Ministry of Jal Shakti, Government of India. <https://nmcg.nic.in>
- NITI Aayog. (2018). SDG India index: Baseline report 2018. Government of India.
- NITI Aayog. (2019). SDG India index 2.0. Government of India.
- NITI Aayog. (2021). SDG India index 3.0, 2020–21. Government of India.
- NITI Aayog. (2023). Mission LiFE: Lifestyle for environment. Government of India. <https://niti.gov.in>
- NITI Aayog. (2024). SDG India index 2023–24. Government of India. https://www.niti.gov.in/sites/default/files/2024-07/SDG_India_Index_2023-24.pdf
- NITI Aayog. (2024). SDG India index 2023–24. Government of India. https://www.niti.gov.in/sites/default/files/2024-07/SDG_India_Index_2023-24.pdf
- Observer Research Foundation. (2023). Fiscal federalism for climate action in India: Expectations from the 16th Finance Commission. ORF Issue Brief. <https://www.orfonline.org>
- OECD. (2023). Environmental performance reviews. OECD Publishing. <https://www.oecd.org>
- Olson Jr, M. (1971). *The Logic of Collective Action: Public Goods and the Theory of Groups, with a new preface and appendix* (Vol. 124). Harvard university press.
- Pandey, A., Brauer, M., Cropper, M. L., Balakrishnan, K., Mathur, P., Dey, S., ... & Dandona, L. (2021). Health and economic impact of air pollution in the states of India: the Global Burden of Disease Study 2019. *The Lancet Planetary Health*, 5(1), e25-e38.
- Pasha, S. V., & Dadhwal, V. K. (2024). National analysis on variations in estimates of forest cover dynamics over India (2001–2020) using multiple techniques and data sources. *Spatial Information Research*, 32(4), 451–461.
- Pillai, A. V., Dubash, N. K., & Bhatia, P. (2021). Unlocking Climate Action in Indian Federalism. *Centre for Policy Research*. <https://cprindia.org>
- Pillai, A. V., Pasricha, T., Mohanty, A., & Wadhawan, S. (2023). How extreme heat is impacting India: Mapping climate risks and impacts of extreme heatwaves at the district level. Council on Energy, Environment and Water. <https://www.ceew.in>
- Press Information Bureau. (2024, December 21). Union Minister Bhupender Yadav releases India state of forest report 2023. Government of India. <https://www.pib.gov.in>

- Press Information Bureau. (2025). 2025 marks highest-ever renewable energy expansion in India. Ministry of New and Renewable Energy, Government of India. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2223720>
- Press Information Bureau. (2025, December). Year-end review 2025: Ministry of Petroleum & Natural Gas. Government of India. <https://www.pib.gov.in>
- Press Information Bureau. (2026, January). 2025 marks highest-ever renewable energy expansion in India's history. Government of India. <https://www.pib.gov.in>
- Prime Minister's Council on Climate Change. (2008). National Action Plan on Climate Change. Government of India. <https://static.pib.gov.in/WriteReadData/specificdocs/documents/2021/dec/doc202112101.pdf>
- Puyravaud, J. P., Davidar, P., & Laurance, W. F. (2010). Cryptic destruction of India's native forests. *Conservation Letters*, 3(6), 390-394.
- PV-Tech. (2026, January). India solar PV additions up 54.7% in 'record' 2025. <https://www.pv-tech.org>
- Rajamani, L., & Ghosh, A. (2024). India and the international climate change regime. In N. K. Dubash (Ed.), *Handbook of climate change and India: Development, politics and governance* (2nd ed.). Routledge.
- Rao, M. G. (2022). *Studies in Indian Public Finance*. Oxford University Press.
- Ratha, K. C., & Barik, A. (2025). India's climate diplomacy: A review (2014-2024). *Observer Research Foundation*, 1-15.
- Reddy, C. S., Jha, C. S., Diwakar, P. G., & Dadhwal, V. K. (2015). Nationwide classification of forest types of India using remote sensing and GIS. *Environmental monitoring and assessment*, 187(12), 777.
- Reserve Bank of India. (2022). Discussion paper on climate risk and sustainable finance. RBI. <https://www.rbi.org.in/Scripts/PublicationsView.aspx?id=21071>
- Reuters. (2025, July 14). India hits 50% non-fossil power milestone ahead of 2030 clean energy target. <https://www.reuters.com/business/energy/india-hits-50-non-fossil-power-milestone-ahead-2030-clean-energy-target-2025-07-14/>
- Reuters. (2026, March 25). India aims to cut emissions intensity by 47% from 2005 levels by 2035. <https://www.reuters.com/sustainability/cop/india-aims-cut-emissions-intensity-by-47-by-2035-2005-levels-2026-03-25/>
- Romanello, M., Di Napoli, C., Green, C., Kennard, H., Lampard, P., Scamman, D., ... & Costello, A. (2023). The 2023 report of the Lancet Countdown on health and climate change: the imperative for a health-centred response in a world facing irreversible harms. *The Lancet*, 402(10419), 2346-2394.
- Roy, J., Tscharket, P., Waisman, H., Abdul Halim, S., Antwi-Agyei, P., Dasgupta, P., ... & Suarez Rodriguez, A. G. (2018). Sustainable development, poverty eradication and reducing inequalities. *Global warming of 1.5° C: An IPCC special report*.
- S&P Global. (2026, January). India hits 50% non-fossil power capacity, seeks \$300 billion for energy transition. S&P Global Commodity Insights. <https://www.spglobal.com/energy/en/news-research/latest-news/lng/011226-india-hits-50-non-fossil-power-capacity-seeks-300-bil-for-energy-transition-by-2030>
- Sahu, G. (2014). *Environmental jurisprudence and the supreme court: litigation, interpretation, implementation*. Orient Blackswan.

- Saleth, R. M., & Dinar, A. (2004). The institutional economics of water: a cross-country analysis of institutions and performance. In *The Institutional Economics of Water*. Edward Elgar Publishing.
- Securities and Exchange Board of India. (2023). BRSR Core –Framework for assurance and ESG disclosures for value chain. SEBI. https://www.sebi.gov.in/legal/circulars/jul-2023/brsr-core-framework-for-assurance-and-esg-disclosures-for-value-chain_73854.html
- Singh, A., and Kolluri, S. (2025). Climate Change Governance in India: Building the Institutional Framework (CSEP Discussion Paper 21). New Delhi: Centre for Social and Economic Progress.
- Singh, R., & Dewan, A. (2022). Progress on indoor air quality regulation in India. *Int J Tuberc Lung Dis Off J Int Union Tuberc Lung Dis*, 26(8), 801b-8802.
- SolarQuarter. (2026, April). MNRE: India Achieves Record 6.05 GW Wind Capacity Addition in FY 2025–26, Cumulative Capacity Crosses 56 GW. <https://solarquarter.com/2026/04/07/mnre-india-achieves-record-6-05-gw-wind-capacity-addition-in-fy-2025-26-cumulative-capacity-crosses-56-gw/>
- Swiss Re Institute. (2021). The economics of climate change: No action not an option. Swiss Re. https://www.swissre.com/dam/jcr:5d558fa2-9c15-419d-8dce-73c080fca3ba/SRI_%20Expertise_Publication_EN_LITE_The%20economics_of_climate_change.pdf
- Thakur, A. K., & Patel, S. (2023). Indoor air quality in Urban India: current status, research gap, and the way forward. *Environmental Science & Technology Letters*, 10(12), 1146-1158.
- UNFCCC. (2015). India's intended nationally determined contribution. United Nations Framework Convention on Climate Change. <https://unfccc.int>
- UNFCCC. (2022). India's updated first nationally determined contribution under the Paris Agreement. <https://unfccc.int>
- UNFCCC. (2024). New collective quantified goal on climate finance: COP29 outcome. <https://unfccc.int>
- UNFCCC. (2026). India's updated nationally determined contribution 2031–2035. <https://unfccc.int/sites/default/files/2026-04/INDIA%20NDC%202031-35.pdf>
- United Nations Department of Economic and Social Affairs. (2022). World urbanization prospects: The 2022 revision. United Nations.
- United Nations Environment Programme. (2024). Adaptation gap report 2024: Come hell and high water. UNEP. <https://www.unep.org/resources/adaptation-gap-report-2024>
- United Nations Environment Programme. (2025). Adaptation gap report 2025. UNEP. <https://www.unep.org/resources/adaptation-gap-report-2025>
- United Nations Framework Convention on Climate Change. (2022). India's updated first nationally determined contribution under the Paris Agreement (2021–2030). Submitted on 26 August 2022. <https://unfccc.int/sites/default/files/NDC/2022-08/India%20Updated%20First%20Nationally%20Determined%20Contrib.pdf>
- United Nations Framework Convention on Climate Change. (2026). India's nationally determined contribution 2031–2035. <https://unfccc.int/sites/default/files/2026-04/INDIA%20NDC%202031-35.pdf>
- United Nations Population Division. (2024). World population prospects 2024. United Nations. <https://population.un.org>

- United Nations. (2015). Transforming our world: The 2030 agenda for sustainable development (Resolution A/RES/70/1). United Nations General Assembly. <https://sdgs.un.org/2030agenda>
- Vicedo-Cabrera, A. M., Scovronick, N., Sera, F., Royé, D., Schneider, R., Tobias, A., ... & Gasparrini, A. (2021). The burden of heat-related mortality attributable to recent human-induced climate change. *Nature climate change*, 11(6), 492-500.
- Wester, P., Mishra, A., Mukherji, A., & Shrestha, A. B. (2019). *The Hindu Kush Himalaya assessment: mountains, climate change, sustainability and people* (p. 627). Springer Nature.
- World Bank. (2022). Striving for clean air: Air pollution and public health in South Asia. World Bank. <https://www.worldbank.org>
- World Bank. (2024). India: First low-carbon energy transition development policy financing (P181402): Program document. World Bank. <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099060623092565311>
- World Commission on Environment and Development. (1987). Our common future. Oxford University Press.
- World Wildlife Fund. (2024). Living planet report 2024: A system in peril. WWF International. <https://www.wwf.org.uk/sites/default/files/2024-10/living-planet-report-2024.pdf>
- Yahoo Finance. (2025). India adds 50 GW renewables in 2025 with \$22.32 bn investment. <https://finance.yahoo.com/news/india-adds-50gw-renewables-2025-110629650.html>
- Zscheischler, J., Westra, S., Van Den Hurk, B. J., Seneviratne, S. I., Ward, P. J., Pitman, A., ... & Zhang, X. (2018). Future climate risk from compound events. *Nature climate change*, 8(6), 469-477.