Transitioning to a Green Economy in Emerging Markets: A Comparative Policy Analysis of India's Renewable Energy, Green Finance, and Emissions Trajectory: A Conceptual and Data-Driven Policy Analysis

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Abstract: *The transition toward a green economy has emerged as a central policy priority for emerging markets seeking to reconcile economic growth with environmental sustainability and climate commitments. This paper undertakes a conceptual and data-driven analysis of green economy transition in India, situating it within the comparative context of other major emerging economies including China, Brazil, and South Africa. Drawing on secondary data from the International Renewable Energy Agency (IRENA), the Ministry of New and Renewable Energy (Government of India), the Climate Bonds Initiative, the United Nations Environment Programme (UNEP), and the Council on Energy, Environment and Water (CEEW), the study traces the trajectory of India's renewable energy capacity expansion, green finance mobilisation, emission-intensity reduction, and green employment generation between 2014 and mid-2025. The analysis is organised around three theoretical pillars of the green economy paradigm — decoupling of growth from resource use, inclusive and equitable transition, and institutional-financial innovation — and evaluates India's progress against its Nationally Determined Contributions (NDC) under the Paris Agreement. Findings indicate that India has achieved rapid absolute capacity growth (installed renewable capacity rising from 76.38 GW in 2014 to 226.9 GW in June 2025) and reached its 2030 non-fossil capacity target five years ahead of schedule, while green finance instruments remain comparatively underdeveloped relative to global peers. The paper identifies structural barriers — financing gaps, state-level disparities, and grid integration constraints — that continue to limit the depth of India's green transition, and concludes with policy recommendations for scaling green finance, strengthening carbon pricing mechanisms, and embedding distributive equity into future NDC commitments.*

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Introduction

The concept of a "green economy" has evolved from a peripheral environmental concern into a mainstream macroeconomic and policy framework. The United Nations Environment Programme defines an inclusive green economy as one that improves human well-being and builds social equity while substantially reducing environmental risks and ecological scarcities (UNEP, 2025). Unlike conventional growth models, the green economy paradigm treats natural capital, low-carbon infrastructure, and social inclusion not as constraints on growth but as its foundation.

For emerging economies, the stakes of this transition are particularly high. These economies must simultaneously pursue industrialisation, poverty alleviation, and employment generation while confronting mounting climate risk, resource scarcity, and international pressure to decarbonise. India exemplifies this dual imperative. As the world's most populous nation and third-largest energy consumer, India's choices around energy mix, industrial policy, and green finance carry consequences that extend well beyond its borders.

This paper examines India's green economy transition through three analytical lenses drawn from the sustainability transitions literature: (i) the decoupling of economic growth from resource consumption and emissions intensity; (ii) the inclusiveness and distributive equity of the transition, particularly with respect to green employment; and (iii) the institutional and financial innovations — including green bonds, carbon markets, and regulatory frameworks — that underpin the shift. The analysis draws on verifiable secondary data from national and international agencies to construct an empirically grounded account of where India stands relative to its own climate commitments and relative to comparable emerging economies.

The paper is structured as follows. Section 2 reviews the theoretical foundations of the green economy concept and situates India's policy architecture within it. Section 3 presents the empirical trajectory of India's renewable energy expansion. Section 4 analyses green finance mobilisation. Section 5 offers a comparative assessment against China, Brazil, and South Africa. Section 6 discusses green employment. Section 7 identifies structural barriers, and Section 8 concludes with policy implications.

Theoretical Framework: Conceptualising the Green Economy

2.1 Origins and Definitions

The green economy concept gained international policy traction following the 2012 United Nations Conference on Sustainable Development (Rio+20), building on UNEP's foundational report Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication, which argued that greening economies is not generally a drag on growth but rather

a net generator of decent jobs and a vital strategy for poverty elimination (UNEP, 2011). Parallel to this policy framing, the OECD (2011) advanced a closely related "green growth" agenda, defined as fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which well-being relies. Jacobs (2012) situates both framings within a broader political-economic literature, arguing that green growth theory rests on the claim that environmental constraints can be reconciled with continued output growth through directed technological change, resource efficiency, and the correction of environmental market failures, rather than requiring a fundamental limit on growth of the kind proposed in earlier ecological-economics literature (Meadows et al., 1972). This reframing was significant: it positioned environmental sustainability as complementary to, rather than in tension with, economic development — a framing especially salient for emerging economies wary of growth-limiting environmental regulation.

2.2 The Porter Hypothesis and Regulation-Driven Innovation

A second theoretical strand relevant to the green economy literature concerns whether environmental regulation imposes a net cost on firms and economies, or whether it can induce offsetting innovation. The Porter Hypothesis, originally advanced by Porter (1991) and formalised in subsequent work, proposes that well-designed environmental regulation can stimulate innovation that partially or fully offsets compliance costs, thereby enhancing rather than eroding competitiveness (Ambec, Cohen, Elgie, & Lanoie, 2013). Empirical support for this hypothesis is mixed but generally favourable for flexible, market-based instruments: cross-country OECD firm-level evidence indicates that market-based and predictable environmental policy stringency is positively associated with multi-factor productivity growth (Albrizio, Kozluk, & Zipperer, 2017), while related work links environmental policy stringency to higher rates of green patenting and R&D investment (Dechezleprêtre & Sato, 2017). This literature underpins the paper's treatment of green finance and carbon pricing (Sections 4 and 7) as potential drivers of innovation rather than purely as compliance costs.

2.3 The Environmental Kuznets Curve and the Decoupling Debate

A third and directly relevant theoretical strand is the Environmental Kuznets Curve (EKC) hypothesis, which posits an inverted-U relationship between per-capita income and environmental degradation: pollution rises with income at early stages of industrialisation and falls once a threshold income level is reached, as cleaner technologies, stronger institutions, and shifting consumer preferences take hold (Grossman & Krueger, 1991, 1995). Dinda's (2004) widely cited survey traces the theoretical mechanisms — scale, composition, and technique effects — that are thought to generate this pattern. Evidence for the EKC hypothesis in the specific case of India is mixed: Mohapatra and Giri (2020) find only partial support for a conventional inverted-U relationship once energy consumption and urbanisation are controlled for, while other India-focused studies report a U-shaped rather than inverted-U pattern in aggregate models. This ambiguity motivates the paper's preference for direct empirical tracking of emissions intensity and renewable capacity share (Sections 3 and 7) over reliance on the EKC's income-threshold prediction alone.

2.4 Three Pillars of Green Economic Transition

Building on this literature — green growth theory (Jacobs, 2012; OECD, 2011), the Porter Hypothesis (Ambec et al., 2013), and the EKC/decoupling debate (Grossman & Krueger, 1995; Dinda, 2004) — the present analysis organises India's transition around three interlocking pillars.

- Decoupling: the extent to which GDP growth is being achieved with a declining emissions and resource intensity, measured through metrics such as emissions per unit of GDP and the share of non-fossil capacity in the energy mix, and assessed against the competing predictions of green growth theory and the EKC hypothesis.
- Inclusion and equity: the extent to which the transition generates broad-based employment and distributes costs and benefits equitably across regions and social groups, consistent with the International Labour Organization's "green jobs and decent work" framework (UNEP/ILO/IOE/ITUC, 2008).
- Institutional and financial innovation: the depth and maturity of green finance instruments — sovereign and corporate green bonds, sustainability-linked loans, carbon markets, and regulatory disclosure regimes — that mobilise capital toward the transition, informed by Porter-Hypothesis-style reasoning about regulation-induced innovation (Ambec et al., 2013; Albrizio et al., 2017).

This tripartite framework provides the organising structure for the empirical sections that follow, allowing the paper to move beyond a narrative of renewable energy capacity alone toward a more rounded, theoretically grounded assessment of transition quality.

India's Renewable Energy Transition: Empirical Trends

India's renewable energy capacity has expanded 2.97-fold over the past decade, rising from 76.38 GW in March 2014 to 226.9 GW as of June 2025 (Press Information Bureau, Government of India, 2025). This expansion accelerated markedly in the first half of 2025: India added a record 22 GW of new renewable capacity between January and June 2025 — a 57% increase over the same period in 2024 and the highest addition ever recorded in a six-month window (JMK Research, 2025). Figure 1 traces this trajectory.

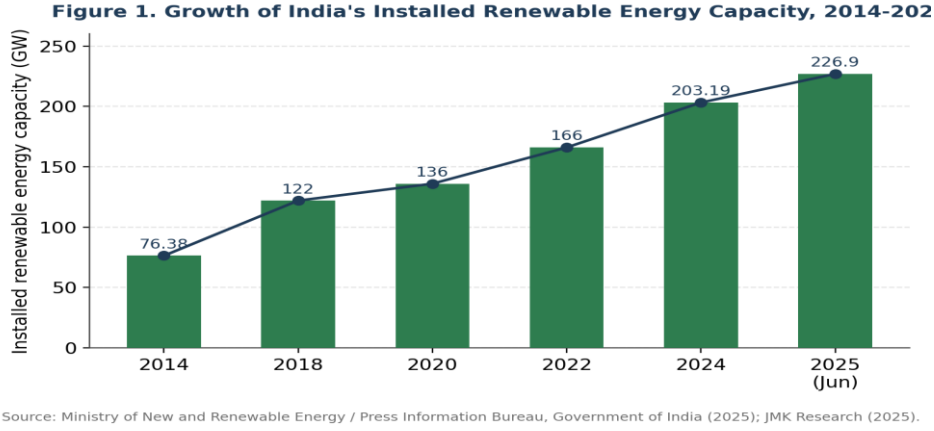
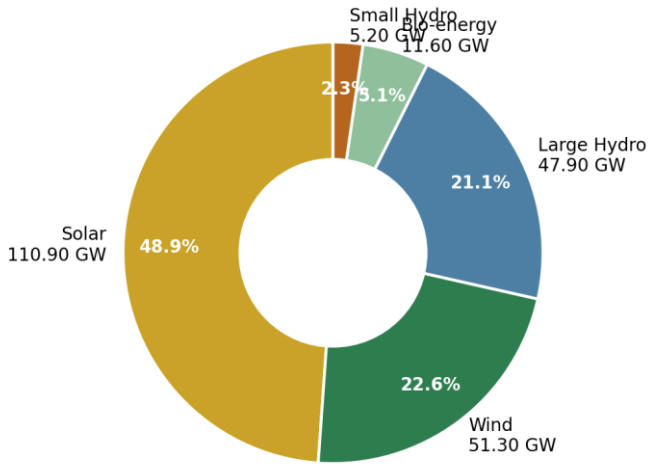


Figure 1. Growth of India's installed renewable energy capacity, 2014–June 2025 (GW). Source: PIB, Government of India (2025); JMK Research (2025).

A critical milestone was reached in June 2025, when non-fossil sources (renewables plus nuclear) accounted for 50% of India's cumulative installed electric power capacity — achieving the country's 2030 Nationally Determined Contribution target five years ahead of schedule (Press Information Bureau, Government of India, 2025). On 29 July 2025, India additionally reached its highest-ever renewable share of instantaneous electricity generation, with renewables meeting 51.5% of the country's total electricity demand of 203 GW on that day (Ministry of Power, Government of India, 2025). These generation-share peaks are important but should be interpreted cautiously: they reflect a single high-output day rather than an average annual generation share, and the broader decoupling literature cautions that installed-capacity metrics alone can overstate the pace of an energy transition relative to sustained emissions outcomes (Dinda, 2004; Jacobs, 2012).

The composition of this capacity remains solar-weighted but increasingly diversified. As shown in Figure 2, solar power constitutes 48.9% of total renewable capacity (110.90 GW), followed by wind (51.30 GW, 22.6%), large hydro (47.90 GW, 21.1%), bio-energy (11.60 GW, 5.1%), and small hydro (5.20 GW, 2.3%) (Press Information Bureau, Government of India, 2025; JMK Research, 2025). This concentration reflects India's comparative advantage in solar irradiance and falling module costs, but also raises grid-management and storage challenges associated with a solar-heavy portfolio.

ıre 2. Source-Wise Composition of India's Renewable Energy Capacity (as of June 2(



Source: Press Information Bureau, Government of India (2025); JMK Research (2025).

Figure 2. Source-wise composition of India's renewable energy capacity, June 2025. Source: PIB (2025); JMK Research (2025).

Geographically, this capacity remains concentrated in a small number of states: Rajasthan, Gujarat, and Maharashtra together accounted for more than half of India's total solar and wind capacity additions during the first half of 2025 (JMK Research, 2025), a concentration that has implications for regional equity in the distribution of green investment and employment, discussed further in Section 6.

Green Finance Mobilisation

Financing the green transition requires capital markets capable of channelling savings into environmentally aligned projects. India's green, social, and sustainability-linked (GSS+) debt market has grown substantially, with cumulative aligned issuance reaching USD 55.9 billion by December 2024 — a 186% increase since 2021 (Climate Bonds Initiative & MUFG, 2025). Green-labelled instruments dominate this market, accounting for 83% of total aligned volume, with green loans alone contributing USD 5.5 billion in 2024 across nineteen corporate issuances.

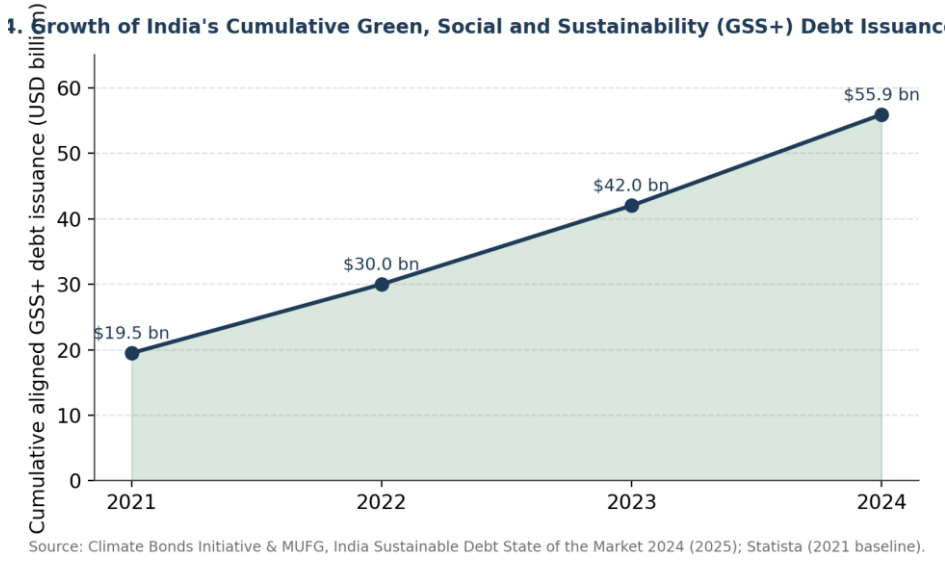


Figure 3. Growth of India's cumulative Green, Social and Sustainability-linked (GSS+) debt issuance, 2021–2024 (USD billion). Source: Climate Bonds Initiative & MUFG (2025); Statista (2021 baseline).

India has also developed a sovereign green bond programme since 2022, with the Reserve Bank of India issuing bonds to fund public-sector clean energy and climate-resilience projects at yields between 6.98% and 8.40%. However, sovereign green bonds have commanded only a modest "greenium" of 2–3 basis points, considerably smaller than the 7–17 basis point greeniums observed in mature markets such as Japan (Grip Invest, 2025), suggesting that Indian investors have not yet priced in a strong preference for green-labelled sovereign debt relative to conventional government securities.

Despite this growth, India's cumulative green finance mobilisation remains modest relative to the scale of the transition required. The Climate Bonds Initiative estimates India's overall climate investment need at USD 1.3 trillion by 2030, of which USD 756 billion is expected to come from private sources — implying that current annual green debt issuance covers only a small fraction of the financing gap (Climate Bonds Initiative & MUFG, 2025). Regulatory developments, including SEBI's enhanced Business Responsibility and Sustainability Reporting (BRSR) Core requirements, the RBI's Green Deposit Framework, and a forthcoming national climate taxonomy, are intended to standardise disclosure and improve investor

confidence, but their effectiveness in closing the financing gap remains to be empirically demonstrated in subsequent reporting cycles.

Comparative Assessment: India in the Context of Emerging Economies

Placing India's transition in comparative perspective clarifies both its achievements and its remaining gaps. Table 1 and Figure 3 present installed renewable energy capacity for the world's five largest holders as of the end of 2024, the most recent year for which complete comparative IRENA data are available.

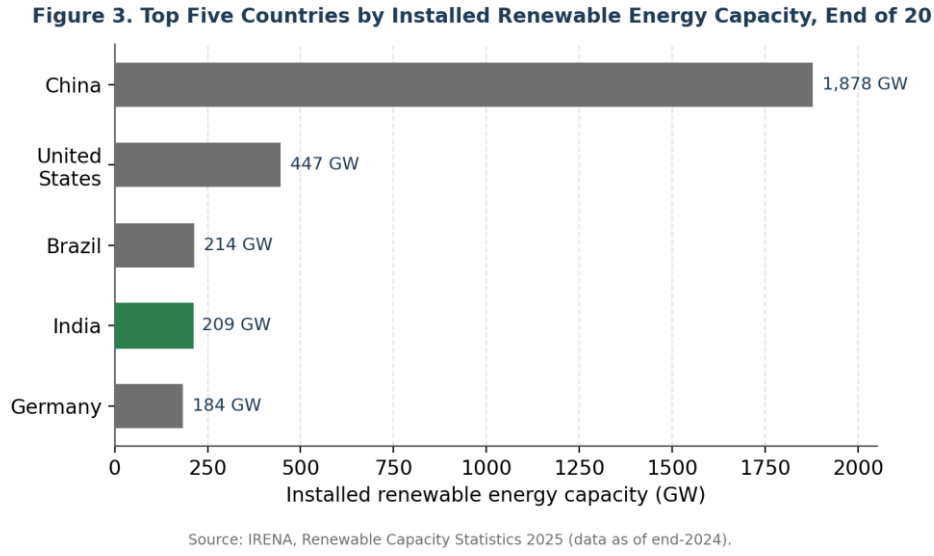


Figure 4. Top five countries by installed renewable energy capacity, end of 2024 (GW). Source: IRENA, Renewable Capacity Statistics 2025.

India ranks fourth globally in absolute installed renewable capacity, narrowly behind Brazil (209 GW versus 214 GW at end-2024), and trails China and the United States by a wide margin (IRENA, 2025). India's share of global renewable capacity stands at approximately 4.7% of the 4,448 GW installed worldwide despite the country accounting for roughly 17% of the world's population — a ratio that illustrates both the scale of progress already made and the substantial per-capita gap that remains relative to capacity leaders. Notably, India's mid-2025 capacity of 226.9 GW (Section 3) already exceeds its end-2024 IRENA-reported figure, reflecting the rapid pace of additions during the first half of 2025 and underscoring how quickly India's relative ranking may continue to shift.

Table 1 summarises selected comparative indicators across the four emerging economies most frequently discussed alongside India in the sustainable-development literature (China, Brazil, South Africa) using the most recent publicly available data for each, as of mid-2025.

Country	Installed RE Capacity (GW, end-2024)	Global RE Rank	Notable Green Economy Feature
China	1,878.0	1st	Dominant global manufacturer of solar modules and EV batteries; largest absolute green investment volume
United States	447.0	2nd	Large-scale green finance market; policy volatility across federal administrations
Brazil	214.0	3rd	High renewable share driven by hydropower and biofuels; mature ethanol-based green fuel sector
India	209.0 (end-2024); 226.9 (Jun 2025)	4th	Fastest-growing major renewable market in H1 2025; achieved 2030 non-fossil capacity target 5 years early
South Africa	n/a (sub-30 GW range)	Not in top 5	Just Energy Transition Partnership (JETP) financing; coal-dependent grid transition underway

Table 1. Comparative green economy indicators across major emerging economies. India's end-2024 IRENA figure (209 GW) and its more recent mid-2025 domestic figure (226.9 GW) differ owing to reporting cut-off dates and the rapid pace of capacity addition during H1 2025. Sources: IRENA (2025); Press Information Bureau (2025); Climate Bonds Initiative (2025).

This comparison suggests that India's distinguishing feature among emerging economies is not the scale of its renewable base — which remains far behind China's, and only narrowly ahead of Brazil's — but the speed of its recent capacity addition and its early achievement of a binding international climate commitment. By contrast, Brazil's green economy profile rests on a structurally different base (hydropower and biofuels rather than solar/wind), while South Africa's transition is more explicitly financed through the internationally-backed Just Energy Transition Partnership model, reflecting its greater dependence on coal-fired generation.

Inclusion and Equity: Green Employment Generation

The inclusiveness pillar of the green economy framework centres on employment. Global renewable energy employment has grown steadily and, in 2023, recorded its highest-ever annual increase: from 11.5 million jobs in 2019 to 16.2 million in 2023, an 18% year-on-year jump in the most recent year alone (IRENA & ILO, 2024). Figure 5 traces this growth.

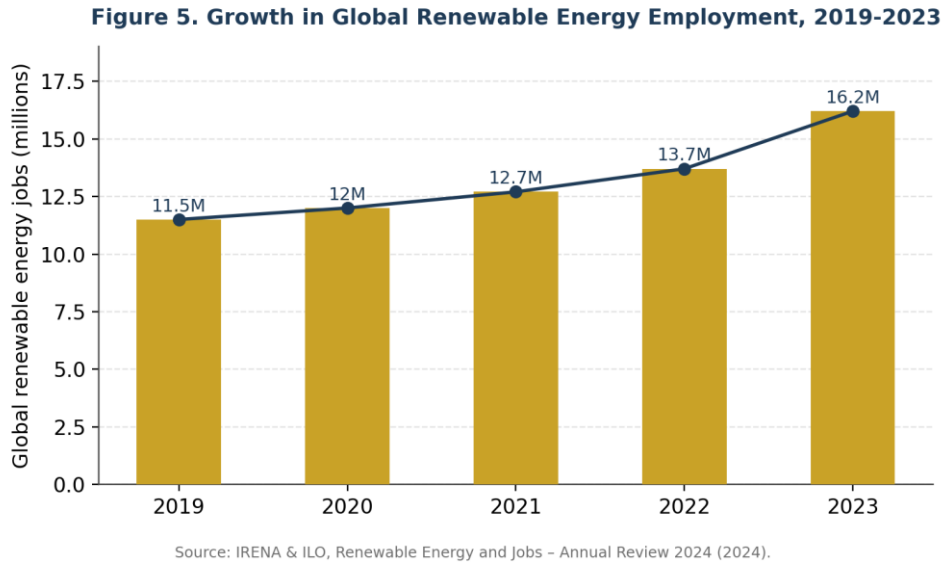


Figure 5. Growth in global renewable energy employment, 2019–2023 (millions). Source: IRENA & ILO, Renewable Energy and Jobs – Annual Review 2024 (2024).

This growth remains heavily concentrated: China alone accounted for an estimated 7.4 million renewable energy jobs in 2023, or 45% of the global total, while the European Union held 1.8 million, Brazil 1.6 million, and the United States and India each slightly more than 1 million (IRENA & ILO, 2024). India's renewable energy workforce, while growing, thus remains modest in absolute terms relative to its installed-capacity ranking, and considerably smaller than China's on a per-GW basis — a gap that reflects China's dominant position in solar and wind equipment manufacturing rather than deployment alone.

Earlier UNEP/ILO estimates specific to India projected that biomass gasification alone could generate approximately 900,000 jobs, split between manufacturing (roughly 300,000) and downstream processing, fuel supply, and briquette/pellet production (roughly 600,000) (UNEP/ILO/IOE/ITUC, 2008). While more recent India-specific green employment census data disaggregated by technology and state remain limited in public reporting, the concentration of installed solar and wind capacity in a small number of states (Section 3) suggests that green employment gains to date are likely to be similarly geographically concentrated, raising equity questions that are not fully resolved by aggregate national figures. This represents an important gap in the current evidence base and a priority for future empirical research using state-level employment data.

Structural Barriers to a Deeper Transition

Despite strong headline progress, several structural constraints limit the depth and resilience of India's green economy transition.

- Financing gap: annual green debt issuance, while growing rapidly, covers only a fraction of the estimated USD 1.3 trillion climate investment need through 2030 (Climate Bonds Initiative & MUFG, 2025).

- Capacity-versus-generation gap: even where installed non-fossil capacity has reached 50% of the total, actual electricity generation from renewables is necessarily lower on average than this peak instantaneous share, given the variability of solar and wind output — pointing to ongoing grid integration, storage, and curtailment challenges (Press Information Bureau, Government of India, 2025; Ministry of Power, Government of India, 2025).
- Regional concentration: the dominance of three states (Rajasthan, Gujarat, and Maharashtra) in over half of H1 2025 solar and wind capacity additions risks entrenching regional disparities in green investment, employment, and associated economic spillovers (JMK Research, 2025).
- Underdeveloped carbon pricing: analyses by the Council on Energy, Environment and Water indicate that achieving India's long-term net-zero-by-2070 goal will require carbon pricing mechanisms, electricity tariff reform, and stronger fiscal support for clean technologies beyond current policy settings (CEEW, 2025).
- Modest green-bond price signal: the small greenium commanded by India's sovereign green bonds (reportedly in the low single-digit basis points) remains considerably smaller than the greeniums observed in some mature green bond markets, suggesting investor demand for green-labelled instruments is still less differentiated than in more developed green finance markets (Grip Invest, 2025).

Discussion and Policy Implications

The evidence assembled in this paper supports a qualified assessment of India's green economy transition. On the decoupling pillar, India has demonstrated genuine and rapid progress: the country met its 2030 non-fossil capacity target five years ahead of schedule and is, according to CEEW/AEEE modelling, on track to exceed its emissions-intensity reduction target of 45% below 2005 levels, with projected reductions of 48–57% by 2030 (CEEW, 2025). On the institutional-financial innovation pillar, progress is real but comparatively shallow: green finance instruments have grown substantially in relative terms (a 186% increase in cumulative GSS+ issuance since 2021) but remain small relative to the financing need and relative to more mature green bond markets. On the inclusion and equity pillar, the evidence base is the weakest of the three, with employment gains likely concentrated in a small number of states and limited recent India-specific green jobs data available in the public domain.

These findings carry several policy implications. First, India's forthcoming 2035 NDC — not yet submitted as of mid-2025 — offers an opportunity to embed more ambitious, and more geographically distributed, targets, building on CEEW's modelled range of a 55–66% emissions-intensity reduction and 60–68% non-fossil capacity share (CEEW, 2025; India's World, 2025). Second, closing the green financing gap will likely require both deepening domestic green bond markets — potentially through stronger fiscal incentives to widen the sovereign greenium — and mobilising the private capital contemplated in Climate Bonds Initiative estimates. Third, addressing the regional concentration of renewable investment will require deliberate policy attention to distributing green industrial policy, grid infrastructure, and associated employment beyond the current leading states. Finally, strengthening carbon

pricing and electricity tariff reform, as recommended by CEEW's scenario modelling, would help align market incentives more closely with the country's stated decarbonisation trajectory. This paper is subject to certain limitations inherent to a secondary-data, conceptual analysis. Reported figures for renewable capacity vary modestly across sources (IRENA, MNRE) owing to differing reporting cut-off dates, and India-specific green employment data disaggregated by state or sector remain sparse in the public domain. Future research employing primary survey data or state-level administrative datasets would usefully extend the inclusion and equity analysis presented here, and a formal econometric decoupling analysis using panel data across emerging economies — building on the ESG panel data traditions applied elsewhere in the sustainability literature — would strengthen the comparative claims made in Section 5.

Conclusion

India's green economy transition illustrates both the promise and the incompleteness of the green economy paradigm as applied in a large, diverse emerging economy. Rapid, policy-driven expansion of renewable energy capacity has allowed India to meet a major international climate commitment ahead of schedule, positioning it as the fastest-growing major renewable energy market globally. Yet the transition's financial and social foundations — green capital markets and inclusive employment generation — remain considerably less developed than its physical infrastructure. A durable and equitable green economy transition in India, and in emerging economies more broadly, will depend on the extent to which policymakers can extend the same ambition demonstrated in renewable energy deployment to green finance deepening and distributive employment policy.

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