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Mapping the Green Economy in India: A Multi-Sectoral Conceptual Framework Integrating Technology, Sustainability, and Inclusive Growth

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ABSTRACT

The green economy has emerged as a transformative paradigm that reconciles environmental sustainability with economic growth and social equity. Despite India's ambitious commitments to net-zero emissions by 2070 and its rapidly expanding renewable energy sector, existing literature remains fragmented across individual industries, offering little integrative conceptual guidance. This article addresses that gap by developing a multi-sectoral conceptual framework that maps the architecture of India's green economy across twelve interrelated industry clusters. Drawing on conceptual synthesis and a systematic review of secondary literature, the study integrates Green Economy Theory, the Sustainable Development Framework, Circular Economy principles, Innovation Systems Theory, and Environmental, Social, and Governance (ESG) criteria into a unified analytical model. The framework identifies four functional layers—core productive sectors, enabling technology and finance sectors, circular and resource management systems, and social and inclusive drivers—and theorises the relational logic connecting them. The paper further discusses India-specific drivers, structural challenges, and policy implications. The findings contribute a replicable conceptual architecture applicable to large emerging economies navigating the sustainability transition, while providing a foundation for empirical validation and sector-specific research.

Keywords: green economy; sustainable development; circular economy; ESG; climate innovation; renewable energy; India; green finance; environmental sustainability; innovation systems

INTRODUCTION

The convergence of accelerating climate change, resource depletion, and persistent socioeconomic inequality has elevated the green economy to the centre of global development discourse. Defined by the United Nations Environment Programme (UNEP, 2011) as an economy that results in improved human well-being and social equity while significantly reducing environmental risks and ecological scarcities, the green economy represents a structural departure from carbon-intensive growth models. The Intergovernmental Panel on Climate Change (IPCC, 2022) has underscored that limiting global warming to 1.5°C requires rapid, far-reaching transitions in energy, land use, transport, and industry—a mandate that demands systemic, cross-sectoral action.

India occupies a singularly important position in this global transition. As the world's most populous nation and the third-largest emitter of greenhouse gases, India's sustainability trajectory carries profound global consequences. The country's formal declaration at COP26 of a net-zero emissions target by 2070, combined with the National Action Plan on Climate Change (NAPCC), Production-Linked Incentive (PLI) schemes for solar manufacturing, and the FAME-II policy for electric mobility, signals a structural commitment to green economic transformation (Government of India, 2022; Shukla et al., 2022). India's renewable energy installed capacity

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surpassed 175 GW by 2023, and the country has articulated an ambition of 500 GW of non-fossil electricity capacity by 2030 (Ministry of New and Renewable Energy, 2023).

Yet, despite this policy momentum, the academic literature on India's green economy remains largely sectoral and fragmented. Studies have examined renewable energy transitions (Niti Aayog, 2021; Tongia & Gross, 2019), electric vehicle adoption (Luthra et al., 2020), sustainable agriculture (Pingali, 2012), and green finance (Soundarrajan & Vivek, 2016) in relative isolation. No unified conceptual architecture integrates these diverse streams into a coherent analytical framework that captures the structural interdependencies of India's emerging green economy. This gap is not merely academic; without an integrative model, policymakers lack the systemic lens necessary to align incentives across sectors and avoid the sub-optimal outcomes that fragmented policy generates.

This article addresses this lacuna with three objectives. First, it conceptualises the green economy in the specific institutional and developmental context of India. Second, it classifies and systematises the industries constituting India's green economy into twelve clusters. Third, it proposes a multi-layered integrated conceptual framework that maps the structural relationships among these clusters. The framework is grounded in five established theoretical traditions: Green Economy Theory (Jacobs, 1991; UNEP, 2011), the Sustainable Development Framework (Brundtland Commission, 1987; Sachs, 2015), Circular Economy principles (Ellen MacArthur Foundation, 2013), Innovation Systems Theory (Lundvall, 1992; Geels, 2002), and ESG criteria (Friede et al., 2015). The paper proceeds as follows: Section 2 reviews the theoretical foundations; Section 3 contextualises the green economy in India; Section 4 presents the sectoral classification; Section 5 develops the integrated framework; Sections 6 and 7 offer discussion and policy implications; Section 8 concludes.

Theoretical Foundations

Green Economy Theory

The intellectual lineage of the green economy concept traces to Pearce, Markandya, and Barbier's (1989) Blueprint for a Green Economy, which argued that environmental assets must be valued within national accounting systems. UNEP's (2011) landmark report formalised the concept as a policy paradigm, distinguishing it from ecological economics through its accommodation of economic growth, provided that growth is decoupled from resource consumption and environmental degradation. Jacobs (1991) situated the green economy within a broader critique of neoclassical economics, advocating for ecological tax reform and public investment in environmental infrastructure. More recently, Bowen and Hepburn (2014) positioned the green economy as a framework for investment-led recovery that simultaneously addresses climate risk and stimulates long-run productivity—a perspective particularly relevant to post-pandemic development planning in India.

Sustainable Development Framework

The Brundtland Commission's (1987) definition of sustainable development—meeting the needs of the present without compromising the ability of future generations to meet their own needs—established the canonical tripartite architecture of environmental, economic, and social sustainability. Sachs (2015) extended this framework through the lens of the Sustainable Development Goals (SDGs), arguing that sustainability transitions require coordinated institutional action across governments, businesses, and civil society. The SDG framework is operationally significant for India, which has integrated the 17 goals into its national planning architecture through NITI Aayog's India Voluntary National Review process (NITI Aayog, 2020). The sustainable development framework supplies the normative architecture—the "why"—of the present conceptual model.

Circular Economy Theory

The circular economy (CE) challenges the linear "take-make-dispose" industrial model by designing waste and pollution out of production systems, keeping products and materials in use, and regenerating natural systems (Ellen MacArthur Foundation, 2013). Geissdoerfer et al. (2017) situate the CE within a broader sustainable development agenda, noting its potential to decouple economic activity from primary resource consumption. For India, which generates approximately 62 million tonnes of solid waste annually (CPCB, 2022), the CE represents

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both an environmental imperative and an economic opportunity. The CE framework supplies the structural logic connecting manufacturing, waste management, agriculture, and construction within the proposed model.

Innovation Systems Theory

Innovation Systems Theory (Lundvall, 1992; Freeman, 1995) posits that technological change is a systemic process embedded in institutional relationships between firms, universities, government agencies, and markets. Geels (2002) applied this framework to sustainability transitions through the Multi-Level Perspective (MLP), which conceptualises transitions as interactions between technological niches, socio-technical regimes, and exogenous landscape pressures. The MLP has been applied extensively to energy transitions (Markard, Raven & Truffer, 2012) and is directly applicable to India's green economy transition, where digital technologies—artificial intelligence, the Internet of Things, and blockchain—are reshaping multiple sectors simultaneously. Innovation Systems Theory supplies the dynamic dimension of the conceptual model, explaining how technological change propagates across sectors.

ESG Framework

The Environmental, Social, and Governance (ESG) framework emerged from socially responsible investment discourse (Friede et al., 2015) and has evolved into a systemic lens for corporate sustainability performance. Eccles and Klimenko (2019) argue that ESG integration is no longer a peripheral concern but a strategic imperative as institutional investors, regulators, and consumers increasingly reward sustainability performance. In India, the Securities and Exchange Board of India (SEBI) has mandated Business Responsibility and Sustainability Reports (BRSR) for the top 1,000 listed companies from 2022–23 (SEBI, 2021), signalling the institutionalisation of ESG metrics within the national regulatory architecture. The ESG framework supplies the evaluative dimension of the conceptual model, providing measurement criteria across all sectors.

Synthesis: A Unified Theoretical Proposition

Integrating these five traditions, this paper proposes that:

Green Economy = f (Sustainability + Innovation + Policy + Market Transformation)

This formulation treats the green economy as an emergent property of the interaction between environmental sustainability imperatives, technological innovation systems, institutional and regulatory frameworks, and market-level transformation processes. Each of the twelve sectoral clusters identified in Section 4 can be mapped onto this functional equation, providing analytical tractability while preserving systemic complexity.

Conceptualising the Green Economy in India

Key Dimensions

The green economy in India operates across four intersecting dimensions. Environmental sustainability involves the reduction of greenhouse gas emissions, the conservation of biodiversity and ecosystems, and the transition away from fossil fuel dependence—a dimension where India's coal-heavy energy mix (currently supplying approximately 50% of electricity generation) presents the sharpest structural challenge (IEA, 2023). Economic growth, the second dimension, reflects India's developmental imperative: with a GDP per capita below $2,500 and aspirations to become a $5 trillion economy, India cannot subordinate growth to environmental objectives but must embed sustainability within its growth architecture (World Bank, 2023). Social inclusion, the third dimension, is especially salient in the Indian context given the 300 million citizens still lacking energy access at the onset of the transition and the concentration of agricultural livelihoods among economically vulnerable rural populations (Niti Aayog, 2021). Technological innovation, the fourth dimension, represents India's most significant comparative advantage: a 1.4 billion-person domestic market, a world-class technology sector, and a startup ecosystem ranked third globally by venture capital deal volume (NASSCOM, 2023).

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India-Specific Drivers

Several structural features distinguish India's green economy transition from those of advanced industrialised nations. Policy-driven transformation is the most proximate driver, with the National Solar Mission, National Wind Energy Mission, Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME-II), and the Green Hydrogen Mission collectively constituting one of the most ambitious sustainability policy portfolios among G20 economies (MoEFCC, 2022). India's demographic dividend—the largest youth population in the world, with over 600 million persons below the age of 25—simultaneously creates demand-side pressure for green employment and a supply of technically trained labour for emerging green industries (ILO, 2022). Digital transformation, accelerated by the India Stack digital infrastructure architecture, enables the deployment of smart grids, precision agriculture platforms, and fintech solutions for green finance at scale. Finally, the Indian startup ecosystem, which has produced 107 unicorns as of 2023 (DPIIT, 2023), provides a dynamic source of clean technology innovation that complements state-led investment.

Structural Challenges

Against these drivers stand significant structural challenges. Policy fragmentation across ministries—Energy, Environment, Agriculture, Urban Development—produces conflicting incentive structures and regulatory uncertainties that deter private investment (Chaudhary, Krishna & Sagar, 2015). High upfront capital requirements, particularly for renewable energy, EV infrastructure, and green buildings, create financing gaps that India's underdeveloped green bond market has not yet resolved (Climate Policy Initiative, 2022). Infrastructure deficits—in transmission capacity, cold chains, and urban waste management—constrain the scalability of green solutions across sectors. Finally, awareness and behavioural barriers among producers and consumers, particularly in Tier-2 and Tier-3 cities, slow market adoption of green products and services (Verma & Chandra, 2018).

Sectoral Classification of Green Economy Industries in India

The following twelve clusters constitute the proposed classification of India's green economy industries. The classification is grounded in sectoral interdependence and functional role rather than conventional industrial codes, reflecting the systemic nature of the green economy.

EcoTech and Climate Innovation

EcoTech encompasses the application of digital and computational technologies—artificial intelligence, the Internet of Things (IoT), blockchain, and advanced analytics—to environmental sustainability challenges. This cluster functions as a horizontal enabler across all other sectors. AI-driven energy management systems can reduce commercial building energy consumption by 15–30% (IEA, 2022); IoT-enabled precision agriculture reduces fertiliser and water application; blockchain enables transparent carbon credit markets and supply chain traceability. India's EcoTech sector is nascent but fast-growing, with 200+ climate-tech startups attracting approximately $7.6 billion in cumulative investment by 2022 (Climatech India Report, 2022). The cluster aligns with UNEP's (2021) Digital Finance for Sustainable Development framework and Geels's (2002) conceptualisation of niche technologies generating systemic disruption.

Clean Energy and Energy Storage

Clean energy constitutes the backbone of India's green transition. Solar photovoltaic capacity reached 67 GW by early 2023, making India the fourth-largest solar market globally (IRENA, 2023). Wind energy, small hydropower, and biomass collectively contribute an additional 60+ GW. The Green Hydrogen Mission, launched in 2023 with a target of 5 million metric tonnes of annual production by 2030, represents the next frontier of energy decarbonisation (Ministry of New and Renewable Energy, 2023). Energy storage—particularly grid-scale lithium-ion and emerging vanadium flow batteries—is critical for managing intermittency; India's Battery Energy Storage System (BESS) capacity is projected to reach 51 GWh by 2030 (Niti Aayog, 2022). The transition in this sector directly addresses SDG 7 (Affordable and Clean Energy) and generates systemic co-benefits for energy access, air quality, and employment.

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Sustainable Mobility and the EV Ecosystem

India's transport sector accounts for approximately 14% of energy-related CO_2 emissions, making sustainable mobility a priority transition area (MoEFCC, 2022). Electric vehicle penetration has accelerated significantly: EV sales across all segments reached 1.5 million units in 2022–23, a 155% year-on-year increase (SIAM, 2023). The FAME-II scheme and state-level incentives have catalysed two-wheeler and three-wheeler electrification; four-wheeler EVs remain nascent but are supported by the PLI scheme for Advanced Chemistry Cell batteries. Urban mobility solutions—bus rapid transit, metro expansion, and last-mile electric connectivity—are equally important. Luthra et al. (2020) identify infrastructure readiness, consumer awareness, and total cost of ownership as the critical barriers to mass EV adoption in India, barriers that require coordinated policy, industry, and financial sector responses.

Circular Economy and Waste-to-Energy

India's waste management challenge is both an environmental liability and an economic opportunity. The country generates 62 million tonnes of municipal solid waste annually, of which only 43% is processed (CPCB, 2022). The transition to a circular economy model—encompassing extended producer responsibility (EPR), industrial symbiosis, and waste valorisation—offers significant resource savings. Waste-to-energy plants, of which India had approximately 13 operational facilities in 2023, convert non-recyclable waste fractions into electricity. The formal recycling sector—spanning e-waste, construction and demolition waste, and plastic waste—is estimated at $14 billion and growing at 8% annually (FICCI, 2022). The Ellen MacArthur Foundation's (2013) circular economy model, adapted to India's informal recycling sector (the kabadiwala network), provides the theoretical basis for a hybrid formal-informal circular economy that is institutionally feasible and socially inclusive.

Green Manufacturing and Sustainable Consumer Products

Green manufacturing encompasses the redesign of industrial production processes to minimise resource consumption, waste generation, and emissions. Bureau of Energy Efficiency (BEE) star-rating programmes and ISO 14001 environmental management certifications have driven efficiency improvements across Indian manufacturing; the PAT (Perform, Achieve, and Trade) scheme has generated cumulative energy savings of over 30 million tonnes of oil equivalent (BEE, 2023). The sustainable consumer products cluster—encompassing energy-efficient appliances, sustainable home goods, and green personal care products—is growing rapidly in response to rising environmental awareness among Indian middle-class consumers. Nielsen's (2021) research indicates that 73% of global consumers would change consumption habits to reduce environmental impact, a trend increasingly visible in premium Indian urban markets. Eco-design principles (Brezet & van Hemel, 1997) and life-cycle assessment tools are progressively being adopted by Indian manufacturers supplying global ESG-conscious retail chains.

Sustainable Agriculture and Food Systems

Agriculture employs approximately 46% of India's workforce and accounts for 16% of GDP, yet it is both a major source of greenhouse gas emissions—primarily methane from rice cultivation and enteric fermentation—and a sector highly vulnerable to climate impacts (World Bank, 2023). Sustainable agriculture encompasses organic farming (India ranks ninth in organic cultivation area globally, APEDA, 2022), agroecological practices, precision farming technologies, and food waste reduction. The National Mission for Sustainable Agriculture (NMSA) provides the policy architecture for climate-resilient agriculture. Pingali (2012) argues that the pathway from India's Green Revolution legacy to a truly sustainable food system requires institutional innovation, public investment in soil health, and market development for sustainably produced foods. The Agri-tech sector—encompassing digital advisory platforms, drone-based crop monitoring, and AI-driven market linkages—is a critical enabling layer, with over 1,000 active agri-tech startups in India (AgFunder, 2023).

Water and Natural Resource Management

India faces acute and worsening water stress: the country has 18% of the world's population but only 4% of its freshwater resources, and per capita water availability has declined by 73% since 1947 (Central Water

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Commission, 2022). Smart water management—encompassing IoT-enabled distribution monitoring, wastewater recycling, and demand-side management—is an emerging sector aligned with the Jal Shakti Abhiyan national water conservation mission. The watershed management industry, driven by the MGNREGS programme and corporate CSR mandates, has restored over 14 million hectares of degraded land (Ministry of Rural Development, 2022). Climate-resilient water storage—including managed aquifer recharge and decentralised rainwater harvesting—offers adaptation co-benefits that are especially relevant to India's rain-fed agricultural regions. Postel (2000) and Grey and Sadoff (2007) provide the foundational theoretical framework linking water security to economic productivity that underpins this sector's green economy significance.

Sustainable Infrastructure and Construction

India's urbanisation trajectory—an additional 400 million urban residents projected by 2050 (UN-Habitat, 2022)—makes the built environment one of the highest-stakes arenas of the green economy transition. Buildings account for approximately 33% of India's total electricity consumption (BEE, 2023). The Indian Green Building Council (IGBC) has certified over 10,000 projects covering 10.58 billion square feet as of 2023, making India the second-largest green building market globally. The Smart Cities Mission, covering 100 cities, integrates green building standards, renewable energy mandates, and intelligent mobility systems. Sustainable construction materials—including fly ash bricks, recycled aggregate concrete, and bamboo composites—reduce embodied carbon while supporting circular economy objectives. Kibert (2016) and Ding (2008) provide the theoretical architecture for sustainable construction assessment that informs this sector.

Sustainable Fashion and Textiles

India's textile industry—the second-largest employer after agriculture—is simultaneously one of the most resource-intensive and pollution-generating sectors in the economy (Ministry of Textiles, 2022). The sector consumes approximately 93 billion cubic metres of water annually and is responsible for 20% of global wastewater discharge. The sustainable textiles cluster encompasses circular fashion (rental, repair, and resale models), natural and recycled fibre adoption, chemical management, and ethical supply chain practices. India's handloom sector, which employs over 43 lakh weavers, represents an indigenous form of low-impact, craft-based production that aligns intrinsically with circular economy principles. Global sustainability standards—GOTS (Global Organic Textile Standard), bluesign, and the Higg Index—are progressively being adopted by Indian exporters supplying European and North American brands with ESG-compliant supply chain requirements (Choudhary & Bhardwaj, 2021).

Sustainable Services

The services dimension of the green economy encompasses sustainable tourism, ESG consulting, carbon market services, and environmental compliance advisory. Sustainable tourism—aligned with the UN's definition of ecotourism and the responsible travel principles of the Global Sustainable Tourism Council—has particular significance in India given the country's unparalleled biodiversity and heritage assets. India's ESG consulting market is expanding rapidly in response to SEBI's BRSR mandate and international investor demands for credible sustainability disclosure. Carbon market services—including project development, verification, and brokerage under India's emerging domestic carbon credit framework—represent an emergent financial services segment. Font (2002) and Higham (2007) provide the foundational literature for sustainable tourism theory applicable to the Indian context.

Green Finance and Impact Investing

Green finance is the enabler sector par excellence: without adequate capital flows, the transformational potential of all other green economy sectors remains constrained. India's green bond market has grown to approximately $20 billion in cumulative issuances as of 2023, though this represents a fraction of the estimated $2.5 trillion in green infrastructure investment required through 2030 (Climate Policy Initiative, 2022). SEBI's green bond framework, the RBI's priority sector lending guidelines for renewable energy, and NABARD's climate finance programmes constitute the institutional architecture of green finance in India. Fintech innovation—digital green lending platforms, climate risk analytics, and ESG data providers—is beginning to address the access and

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information gaps that have historically restricted green finance to large institutional borrowers. Friede et al.'s (2015) meta-analysis of over 2,000 studies demonstrating a positive relationship between ESG integration and financial performance provides the empirical foundation for impact investing in Indian green sectors.

Social and Inclusive Green Economy

The final cluster foregrounds the social dimension of India's green economy, encompassing women-led micro-enterprises in clean energy distribution, youth climate entrepreneurship, community-based natural resource management, and environmental education. UNEP's (2011) emphasis on social equity as a constitutive element—not merely a co-benefit—of the green economy is especially resonant in India, where environmental burdens and climate vulnerability are disproportionately concentrated among lower-income, lower-caste, and tribal communities. Self-Help Groups (SHGs), of which India has over 10 million, have become important vehicles for grassroots green economy participation: over 80,000 SHGs are engaged in clean cooking, solar entrepreneurship, and waste management activities (NRLM, 2022). Feminist political ecology (Rocheleau, Thomas-Slayter & Wangari, 1996) and the capabilities approach (Sen, 1999) provide the normative foundations for an inclusive green economy that centres distributional justice alongside ecological sustainability.

An Integrated Conceptual Framework for India's Green Economy

Framework Architecture

The preceding sectoral analysis reveals that India's green economy cannot be adequately understood as an aggregation of independent green sectors. Rather, it constitutes a complex socio-technical ecosystem characterised by multi-directional interdependencies, enabling hierarchies, and circular feedbacks. The Integrated Green Economy Framework (IGEF) proposed here organises this ecosystem into four functional layers, each performing a distinct systemic role:

Layer 1: Core Productive Sectors

The core productive sectors—Clean Energy, Sustainable Agriculture, Sustainable Mobility, and Sustainable Infrastructure—constitute the primary productive base of the green economy. These sectors directly displace carbon-intensive alternatives and generate the largest volumes of green employment and GDP contribution. They are characterised by capital intensity, regulatory dependence, and long asset lifetimes, making policy stability a critical determinant of investment flows.

Layer 2: Enabling Sectors

EcoTech and Climate Innovation, Green Finance, and Sustainable Services function as enabling sectors that enhance the productivity, scale, and quality of core sector outputs. EcoTech reduces transaction costs and information asymmetries across sectors; Green Finance mobilises capital and manages climate risk; Sustainable Services (ESG consulting, carbon management) build the institutional capacities required for credible sustainability performance. The enabling character of these sectors aligns with Lundvall's (1992) conceptualisation of knowledge-intensive services as productivity multipliers in innovation systems.

Layer 3: Circular and Resource Management Systems

Circular Economy and Waste-to-Energy, Water and Natural Resource Management, and Sustainable Fashion and Textiles form the circular layer of the framework. These sectors close material and resource loops across the productive economy, converting waste streams into inputs, regenerating natural capital, and reducing systemic resource vulnerability. The circular layer instantiates the Ellen MacArthur Foundation's (2013) regenerative design principles at the economy-wide level.

Layer 4: Social and Inclusive Drivers

The Social and Inclusive Green Economy, Sustainable Services (tourism and community dimensions), and Green Manufacturing (consumer behaviour dimension) together constitute the social layer. This layer drives demand-

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side transformation through consumer choice, community mobilisation, and inclusive entrepreneurship. It also ensures that the distributional outcomes of the green economy transition align with India's constitutional commitments to social justice. Without this layer, the risk of a "green economy without green equity" is substantial, as structural transformations in energy and mobility may displace informal livelihoods without adequate just transition mechanisms.

Inter-Layer Relational Logic

The IGEF posits four dominant relational logics connecting its layers. Technology enhancement flows from enabling to core sectors: AI-driven grid management improves the capacity utilisation of renewable energy assets; blockchain enables transparent carbon accounting in agriculture; IoT sensors optimise water distribution in infrastructure systems. Financial intermediation flows from enabling to all other layers: green bonds and climate finance unlock investment in core sectors; impact investing supports inclusive green enterprises in the social layer; ESG risk analytics discipline corporate behaviour across the circular layer. Policy regulation and incentivisation operates exogenously across all four layers, shaping investment decisions, consumption choices, and innovation trajectories. Social adoption, flowing from the social layer outward, determines the velocity of green economy market development: consumer preferences for sustainable products, community acceptance of renewable infrastructure, and political economy of environmental regulation are all fundamentally shaped by social dynamics. These relational logics are consistent with the systemic transition logic of Geels's (2002) Multi-Level Perspective, where niche innovations, regime change, and landscape pressures interact across temporal and spatial scales.

India-Specific Framework Adaptations

Three adaptations distinguish the IGEF from generic green economy frameworks. First, the framework explicitly incorporates the informal economy—India's 90% informally employed workforce participates in the green economy through the kabadiwala recycling network, informal clean energy entrepreneurship, and smallholder organic agriculture. Ignoring this layer produces systematically incomplete analysis. Second, the framework treats digital infrastructure (India Stack, UPI, ONDC) as a structural enabler across all layers rather than confining digital transformation to the EcoTech sector, reflecting the distinctive role of India's digital public infrastructure in enabling scale. Third, the framework positions social inclusion not as a residual distributional concern but as a core structural driver, reflecting the empirical reality that environmental transitions in India require social legitimacy to succeed politically and institutionally.

DISCUSSION

Theoretical Contributions

The IGEF makes three contributions to the theoretical literature. First, it demonstrates that the green economy in India is structurally ecosystem-based: the sectoral boundaries that structure policy and investment decisions are analytically insufficient for understanding the interdependencies that determine system-level outcomes. This finding aligns with and extends the "socio-technical system" ontology of transition management research (Rotmans, Kemp & van Asselt, 2001). Second, the framework demonstrates that technology functions as a cross-sectoral multiplier rather than a sector-specific driver: EcoTech's enabling logic permeates all twelve clusters, suggesting that public investment in digital green infrastructure generates returns disproportionate to its direct GDP contribution. Third, the inclusion of the social layer as a co-constitutive element of the green economy—rather than a policy add-on—advances UNEP's (2011) formulation by providing a structural basis for the social inclusion imperative that is often asserted but rarely operationalised in green economy frameworks.

Challenges and Opportunities

India's green economy transition confronts four structural challenges that the IGEF illuminates with particular clarity. Policy fragmentation—the distribution of green economy governance across at least eight central ministries and 28 state governments—generates conflicting regulatory signals that increase investment risk and delay project execution. High initial capital requirements, amplified by India's relatively high cost of capital

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compared to OECD economies, constrain the speed of private investment mobilisation despite attractive long-run economics. Infrastructure gaps—in transmission, EV charging, cold chains, and digital connectivity in rural areas—limit the spatial scope of the green economy transition, concentrating green activity in metropolitan and coastal regions. Awareness and capacity deficits among SMEs, financial intermediaries, and local governments slow the adoption of green practices and ESG standards.

Against these challenges, the IGEF highlights three structural opportunities. India's startup ecosystem is generating continuous innovation in green technologies and business models, with climate tech attracting increasing attention from global venture capital. The Government of India's Production-Linked Incentive schemes, covering ten sectors including solar, batteries, and textiles, provide a proven demand-stimulus instrument that can be extended to additional green sectors. India's international positioning as a Global South leader on climate—the International Solar Alliance, the Coalition for Disaster Resilient Infrastructure, and the COP28 presidency of UAE's framing of India as a "net-zero emerging economy model"—creates export, partnership, and technology transfer opportunities that can subsidise domestic transition costs (Dubash, 2021).

Policy Implications

The IGEF generates several specific policy implications. An integrated green economy policy framework, administered through a nodal inter-ministerial coordination mechanism, would address the fragmentation challenge by aligning incentives across sectors and eliminating regulatory conflicts. The existing institutional precedent—NITI Aayog's role in SDG coordination—provides a template for such a mechanism. Targeted incentives for green startups, including preferential public procurement, regulatory sandboxes, and R&D tax credits, would accelerate EcoTech innovation across the enabling layer.

Mandatory ESG compliance, extended progressively from large listed companies to mid-cap and unlisted enterprises, would create demand for green products, services, and finance across the entire economy. SEBI's BRSR mandate is an important step, but its scope and enforcement rigour require expansion (SEBI, 2021). Public-private partnerships in green infrastructure—particularly in EV charging, renewable energy transmission, and urban waste management—would crowd in private capital in sectors where first-mover risks currently deter investment. Finally, large-scale investment in skills development for the green economy—green construction, clean energy operations, EV service, sustainable fashion design—is essential for realising the employment potential of the transition and preventing the just transition deficit that has characterised energy transitions in other national contexts (ILO, 2022).

Research Implications

The IGEF establishes a conceptual architecture that requires empirical validation across multiple research agendas. Primary quantitative research is needed to measure the actual inter-sectoral linkages hypothesised by the framework—input-output analysis, social network analysis of green supply chains, and econometric modelling of technology spillovers across layers would test the relational logic proposed here. Sector-specific performance metrics, grounded in the ESG framework but adapted to Indian institutional conditions, are needed to enable comparative assessment of green economy progress across states and industries. Longitudinal sustainability studies tracking the evolution of India's green economy over a 10–20 year horizon would generate the time-series evidence needed to assess transition velocity and identify structural bottlenecks. Comparative studies situating India's green economy trajectory within the broader South and South-East Asian context would test the replicability of the IGEF in analogous developmental settings, contributing to the global green economy governance literature.

CONCLUSION

This paper has developed an Integrated Green Economy Framework (IGEF) for India that maps twelve green industry clusters across four functional layers and theorises the relational logics connecting them. Grounded in Green Economy Theory, the Sustainable Development Framework, Circular Economy principles, Innovation Systems Theory, and the ESG framework, the IGEF addresses a significant gap in the literature by providing the first unified conceptual architecture for India's multi-sectoral green economy.

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The framework's core argument is that India's green economy is structurally ecosystem-based: the outcomes of any single sector—energy, agriculture, mobility—are fundamentally conditioned by the enabling functions of technology and finance, the circularity functions of waste and water management, and the social adoption dynamics of inclusive communities and consumers. Policy frameworks that treat green sectors in isolation will therefore generate sub-optimal outcomes, missing the cross-sectoral synergies and feedbacks that constitute the distinctive productivity advantage of an integrated green economy.

India's unique combination of developmental aspiration, demographic scale, digital infrastructure, and policy commitment positions it as a potential global leader in demonstrating how large emerging economies can achieve the sustainability transition without sacrificing growth or equity. Realising this potential requires the kind of systemic, multi-stakeholder coordination that the IGEF is designed to support. The authors call for collaborative research, policy, and investment architectures that match the integrative complexity of the transition challenge ahead.

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