सत्यमेव जयते
NITI Aayog

SCENARIOS TOWARDS VIKSIT BHARAT AND NET ZERO

FINANCING NEEDS

(VOL. 9)

NITI Aayog
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(VOL. 9)

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Foreword

Under the visionary leadership of the Hon'ble Prime Minister, India stands at a defining moment in its development journey. As the nation pursues the vision of *Viksit Bharat @2047*, to become a developed society by the centenary of its independence, it is equally committed to achieving net-zero emissions by 2070. The choices made today across energy systems, industrial transformation, mobility, and finance will shape not only India's long-term growth trajectory, but also the credibility and success of the global climate transition. India's Net Zero trajectory represents a development opportunity of historic significance, with the potential to catalyse new industries, generate high-quality employment, strengthen energy security, and consolidate India's position as a global leader in sustainable development.

Over the past decade, India has demonstrated that development and climate action can advance together. The economy has become the world's fourth-largest, while the emissions intensity of GDP has declined by approximately 36% (in 2020 over 2005 levels). By 2025, India had achieved over 50% of its installed power capacity from non-fossil fuel sources, fulfilling a key Nationally Determined Contribution (NDC) target five years ahead of schedule. These outcomes reflect strong political resolve, policy consistency, and the growing competitiveness of clean technologies.

This transformation, however, will unfold within a complex and evolving global environment. Several critical decarbonization technologies remain commercially nascent, while rising protectionism and the spread of tariff and non-tariff barriers, including carbon-linked measures such as the EU's Carbon Border Adjustment Mechanism, pose new challenges. Against this backdrop, NITI Aayog has undertaken a comprehensive exercise to articulate a long-term energy vision grounded in India's development priorities and structural realities, supported by extensive inter-ministerial collaboration.

This report on climate finance constitutes a core output of that effort. The *Pathways to Net Zero: Financing Needs (Vol 9)* report assesses India's long-term investment requirements for achieving Net Zero, evaluates the capacity of domestic and international financial systems to meet these needs, identifies financing gaps and structural constraints, and proposes actionable policy and institutional measures to mobilise capital at scale and at competitive cost.

The analysis situates India's financing challenge in the broader global climate finance landscape, in which nearly advanced economies remain the beneficiaries of 80 percent of flows. Despite strong macroeconomic fundamentals, emerging markets such as India continue to face persistently high costs of capital, constraining the pace and scale of clean investment.

In Indian context, the established goal achieving Net Zero by 2070 is estimated to exceed to require cumulative investments of approximately USD 22.7 trillion, with a financing gap USD 6.5 trillion. While domestic capital will remain the backbone of finance for India's low-carbon path, international finance through concessional capital, blended finance, and risk-sharing mechanisms will play a critical role. Financing strategies must also be technology specific. Mature renewable energy and transmission infrastructure can increasingly access low-cost market finance, while emerging solutions such as grid-scale storage, green hydrogen, carbon capture utilization and storage will require targeted risk mitigation and innovative financial structures.

I commend the members of the Inter-Ministerial Working Group and all contributing institutions for their rigorous analysis and collaborative spirit. It is my hope that this report will serve as a valuable guide for policymakers, investors, and stakeholders as India charts a credible and ambitious pathway towards *Viksit Bharat @2047* and a Net Zero economy by 2070.

(Suman Bery)

Place- New Delhi
Dated- 05th February, 2026

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एक कदम स्वच्छता की ओर

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FOREWORD

India today stands at a defining moment in its development journey. Our twin national commitments—to become a developed economy by 2047 under the vision of Viksit Bharat and to achieve Net Zero emissions by 2070—reflect an ambition that is both transformative and responsible. As the world's fastest-growing major economy, India's pathway will significantly shape both domestic prosperity and international climate outcomes.

India has already demonstrated tangible actions as a responsible global citizen. We have reduced emissions intensity by 36% from 2005 levels and achieved 50% non-fossil fuel capacity in the power sector well ahead of our Nationally Determined Contributions (NDC) timeline. Yet the road ahead is far more demanding. Achieving Net Zero by 2070 will require a scale and pace of transformation without precedent, as India continues to urbanise, and industrialise. Finance will be the central enabler of this transition.

India's low-carbon transition spans technologies at very different stages of maturity. Mature renewable energy technologies require large volumes of capital for rapid scale-up. Solutions such as energy storage and electric mobility need concessional and structured finance to overcome risk and cost barriers. Frontier technologies—including green hydrogen and Carbon Capture, Utilisation and Storage (CCUS)—will depend on grants and blended finance. A stage-sensitive, technology-specific financing strategy is essential to ensure that capital flows efficiently across this spectrum.

This report provides a rigorous, India-specific assessment of the scale of finance required to meet our Net Zero ambition. Using integrated assessment modelling across the power, industry, and transport sectors, the analysis estimates that to achieve Net Zero, India will require cumulative investments of approximately USD 22.7 trillion by 2070.

On the supply side, the analysis finds that with targeted reforms and deeper integration with global capital markets, India could mobilise around USD 16.2 trillion by 2070. In addition, international finance will need to play an increasingly critical role. Under these assumptions, there is a projected financing gap of USD 6.53 trillion. This gap has to be met by developed countries as part of their obligations to the developing world.

I thank Vice Chairman, NITI Aayog Shri Suman Bery for his leadership, and the perspectives he brought to the work. I also thank the members of the working group for their insights and analysis. I thank NITI colleagues - Dr. Anshu Bharadwaj and his team, Shri Venugopal Mothkoor, Ms. Divya Midha and Dr. Anjali Jain, for their research and analytical contributions. I am confident that this report will help India raise the financing required to achieve our developmental and climate goals.

Dated: 5th February, 2026

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List of Abbreviations

ACVAs	Accredited Carbon Verification Agencies
AIFs	Alternative Investment Funds
AMFI	Association of Mutual Funds in India
ASSET	Accelerating Sustainable State Energy Transition
AT&C	Aggregate Technical and Commercial
AUC	Assets Under Custody
AUM	Assets Under Management
BaaS	Battery-as-a-Service
BEE	Bureau of Energy Efficiency
BIS	Bureau of Indian Standards
BF–BOF	Blast Furnace–Basic Oxygen Furnace
BRSR	Business Responsibility and Sustainability Reporting
CAPEX	Capital Expenditure
CCFU	Climate Change Finance Unit
CCS	Carbon Capture and Storage
CCUS	Carbon Capture, Utilisation, and Storage
CCTS	Carbon Credit Trading Scheme
CES	Constant Elasticity of Substitution
CGE	Computable General Equilibrium
CKM	Circuit Kilometer
CPI	Climate Policy Initiative
CPS	Current Policy Scenario
DAC	Direct Air Capture
DEA	Department of Economic Affairs
DFIs	Development Financial Institutions
DISCOM	Distribution Company
DRI	Direct Reduced Iron
EAF	Electric Arc Furnace
ECBC	Energy Conservation Building Code
EESL	Energy Efficiency Services Limited
EMDEs	Emerging Markets and Developing Economies

EPDs	Environmental Product Declarations
ESCO	Energy Service Company
ESG	Environmental, Social, and Governance
ETS	Emissions Trading System
EU	European Union
EVs	Electric Vehicles
FCFE	Free Cash Flow to Equity
FDI	Foreign Direct Investment
FPI	Foreign Portfolio Investment
FX	Foreign Exchange
GCFs	Global Climate Funds
GEI	Greenhouse Gas Emission Intensity
GGA	Global Goal on Adaptation
GHG	Greenhouse Gas
GIFT City	Gujarat International Finance Tec-City
IAM	Integrated Assessment Modelling
ICE	Internal Combustion Engine
IDFs	Infrastructure Debt Funds
IESS	India Energy Security Scenarios
IF	Induction Furnace
IFSCA	International Financial Services Centres Authority
IGBC	Indian Green Building Council
IHLEG	Independent High-Level Expert Group on Climate Finance
InvIT	Infrastructure Investment Trust
IPPU	Industrial Process and Product Use
IREDA	Indian Renewable Energy Development Agency
IRENA	International Renewable Energy Agency
IRDAI	Insurance Regulatory and Development Authority of India
LAF	Liquidity Adjustment Facility
LCA	Life Cycle Analysis
LIC	Life Insurance Corporation of India
LPS	Late Payment Surcharge
LTGM	Long-Term Growth Model
LTV	Loan-to-Value
MENA	Middle East and North Africa
MDBs	Multilateral Development Banks
MoEFCC	Ministry of Environment, Forest and Climate Change
MoSPI	Ministry of Statistics and Programme Implementation
MPO	Macro Poverty Outlook

MRV	Monitoring, Reporting, and Verification
MSMEs	Micro, Small and Medium Enterprises
MT	Million Tonnes
NABFID	National Bank for Financing Infrastructure and Development
NAP	National Adaptation Plan
NAS	National Accounts Statistics
NBFCs	Non-Banking Financial Companies
NDC	Nationally Determined Contribution
NDTL	Net Demand and Time Liabilities
NGFI	National Green Finance Institution
NIP	National Infrastructure Pipeline
NMP	National Monetisation Pipeline
NPS	National Pension System
NZS	Net Zero Scenario
OEMs	Original Equipment Manufacturers
PCMC	Pimpri-Chinchwad Municipal Corporation
PCI	Public Charging Infrastructure
PE/VC	Private Equity and Venture Capital
PFC	Power Finance Corporation
PFRDA	Pension Fund Regulatory and Development Authority
PLI	Production Linked Incentive
PPAs	Power Purchase Agreements
PSM	Payment Security Mechanism
R&D	Research and Development
RBI	Reserve Bank of India
REC	Rural Electrification Corporation
RE	Renewable Energy
REITs	Real Estate Investment Trusts
RESCO	Renewable Energy Service Company
RDSS	Revamped Distribution Sector Scheme
SAM	Social Accounting Matrix
SDGs	Sustainable Development Goals
SEBI	Securities and Exchange Board of India
SECI	Solar Energy Corporation of India
SLR	Statutory Liquidity Ratio
SMEs	Small and Medium-Sized Enterprises
SPV	Special-Purpose Vehicle
SPTs	Sustainability Performance Targets
SRO	Self-Regulatory Organisation

SUT	Supply and Use Tables
SWFs	Sovereign Wealth Funds
T&D	Transmission and Distribution
TFP	Total Factor Productivity
TOD	Transit-Oriented Development
TRL	Technology Readiness Level
TReDS	Trade Receivables Discounting System
ULBs	Urban Local Bodies
UNFCCC	United Nations Framework Convention on Climate Change
VGF	Viability Gap Funding

Executive Summary

India's pursuit of development and low-carbon transition will define both its own growth trajectory and the global climate transition. Standing at a pivotal juncture, the country aims to achieve developed economy status by 2047 (Viksit Bharat) while reaching Net Zero emissions by 2070. It has already made strong progress, reducing emissions intensity by 36% over 2005[1] levels and achieving 50% non-fossil power capacity[2] five years ahead of Nationally Determined Contribution (NDC) target. However, meeting long-term goals will require unprecedented capital mobilisation of trillions required by 2070, compared to current annual flows of just USD 135 billion (of which USD 80-90 billion supports clean energy)[3]. High capital costs, limited concessional finance, and structural constraints continue to deter investment in emerging and hard-to-abate sectors. India's transition spans technologies at different maturity levels ranging from mature renewables requiring scale-up capital, mid-stage options like storage and e-mobility requiring concessional or structured finance, while frontier areas such as green hydrogen and Carbon Capture, Utilisation, and Storage (CCUS) depends on grants and blended capital. A stage-sensitive, technology-specific financing strategy is therefore essential.

Global financing gaps and india's emerging green finance architecture: Globally, finance for climate action has risen to about USD 1.9 trillion[4,5] annually in 2023, but remains well below the USD 6–9 trillion required annually to stay on a 1.5°C trajectory[6,7,8]. Finance flows remain heavily concentrated with 80% in East Asia, Western Europe, and North America, leaving South Asia and Sub-Saharan Africa dependent on limited public sources[4]. Debt dominates global flows, while adaptation and early-stage technologies continue to be underfunded. For India, these global imbalances highlight both the urgency and opportunity to mobilise diversified finance through concessional, blended, and risk-sharing instruments. The country's emerging climate finance ecosystem anchored in a national taxonomy, carbon market, Production-Linked Incentive (PLI) schemes, green bonds, and strengthened disclosure frameworks provides a strong foundation.

A rigorous, India-specific modelling approach: The analysis adopts an Integrated Assessment Modelling (IAM) framework to estimate India's investment needs and financing capacity across power, industry, and transport sectors. Macroeconomic projections from the Long-Term Growth Model (LTGM) feed into energy models, TIMES and the India Energy Security Scenarios (IESS), to simulate energy demand, technology adoption, and emissions trajectories under Current Policy Scenario and Net Zero Scenario.

Technology-specific Capital Expenditure (CAPEX) assumptions are applied to quantify investment requirements for generation, storage, transmission, mobility, and industrial decarbonisation. The finance supply analysis adopts an asset-flow model to estimate the total capital that can be mobilised domestically and from foreign sources. The asset flow model estimates flows from banks, Non-Banking Financial Companies (NBFCs), institutional investors, and capital markets,

alongside foreign inflows via Foreign Direct Investment (FDI), Foreign Portfolio Investment (FPI), external borrowing, etc. Together, this framework captures both the scale of investment required and the composition of capital available, revealing sectoral financing gaps and dependencies between domestic mobilisation and global finance.

Key Modelling Insights

India's Net Zero transition requires an unprecedented USD 22.7 trillion in cumulative investment by 2070, underscoring the need for urgent, massive and long-term capital mobilisation. The power sector dominates, accounting for nearly half of total investment needs through large-scale deployment of renewables, storage, and transmission. The transport sector represents roughly one-fifth of total investments, focused on Electric Vehicles (EVs), charging networks, and hydrogen, while industry contributes about a quarter, reflecting capital-intensive decarbonisation in steel, cement, and chemicals post 2045.

Transitioning from Current Policy Scenario to Net Zero Scenario requires an additional USD 8.1 trillion in incremental investments by 2070. This incremental financing requirement is estimated as the difference in investment between USD 22.7 trillion required in Net Zero Scenario and USD 14.7 trillion in Current Policy Scenario. The incremental gap is led by the power sector (USD 4.5 trillion), followed by industry (USD 2.7 trillion) and transport (USD 0.9 trillion). In terms of temporal requirement, the additional requirement sharply increases from USD 2.25 trillion till 2050 to USD 8.1 trillion by 2070, emphasising the scale-up of technological solutions such as Carbon Capture, Utilisation, and Storage (CCUS), Long Duration Storage, Offshore wind, Hydrogen, Mobility, etc in the post-2050 period. Although finance needs peak in later decades, the near term poses the toughest challenge, requiring rapid capital deployment to accelerate clean infrastructure and energy independence.

Technology-wise, investment needs shift from mature renewables to emerging and hard-to-abate technologies. While renewables and transmission infrastructure dominate mid-century investments, by 2070 the focus shifts to EV Battery Storage, Grid Storage, and Charging Infrastructure (nearly 40% of total), alongside major roles for Green Hydrogen (10%), Carbon Capture, Utilisation and Storage (CCUS) and Direct Air Capture (DAC) (6%). This evolution underscores a growing reliance on complex, capital-intensive technologies with lower Technology Readiness Levels (TRLs) and higher financing risks.

India can mobilise approximately USD 16.2 trillion for its Net Zero transition by 2070 through targeted reforms in its financial system and stronger integration with global capital markets. On the domestic side this requires deeper capital markets, greater channeling of household savings into productive assets, and a shift by institutions toward high-quality corporate and green investments. Credible transition plans and a robust project pipeline can attract sustained foreign capital. Together, these measures can significantly scale the financing available for India's Net Zero pathway.

In terms of sources, banks and Non-Banking Financial Companies (NBFCs) continue to dominate, accounting for 42% of total flows, followed by institutional investors and corporations (36%). In terms of instruments, the financing mix continues to be driven by equity (49%) and loans (45%) with a complementary role played by bonds. Across sectors, capital allocation continues to be concentrated in the power sector (43%), followed by industry and transport.

India faces a cumulative financing gap of USD 6.5 trillion by 2070, led by the power sector. The analysis shows total investment needs of USD 22.7 trillion against USD 16.2 trillion in available finance, leaving a gap of USD 6.5 trillion. Power constitutes 82% to this gap followed by industry (13%) and transport (5%). The financing gap expands from USD 2.5 trillion by 2050 to USD 6.5 trillion by 2070 as the cost of full low-carbon transition rises in post-2050 period with investment in hard-to-abate solutions along-side investments in large-scale renewable integration, storage, and clean technology deployment.

International finance is expected to play a critical role in India's Net Zero transition, potentially meeting up to 42% of total investment needs by 2070. Limited domestic capital and the risk of crowding out private investment make external financing essential for sustaining growth. This marks a sharp rise from the 17% share of international flows in 2022–23. Concessional finance and grants will be especially important for supporting currently unviable but essential Net Zero technologies.

Sectoral financing patterns reflect both domestic dominance and emerging foreign participation. The power sector attracts the largest share of available capital (43%), financed primarily through domestic banks and Non-Banking Financial Companies (NBFCs), with rising contributions from Foreign Direct Investment (FDI) and institutional equity. Industry and transport follow, with increasing reliance on corporate bonds and institutional investors to fund capital-intensive low-carbon transition. These shifts signal deeper financial intermediation, growing market maturity, and stronger integration of domestic and global capital in India's Net Zero transition.

Priority Challenges and Policy Suggestions

Challenges	Suggestions
1. Data, Definitions, and Transparency — Build a Credible Climate Finance Data Backbone	
Fragmented and inconsistent climate finance data, limited disclosures, and weak assurance systems reduce investor confidence and obscure real financing gaps.	Establish a unified national climate-data platform integrating Capital Expenditure (CAPEX) and finance-flow tracking, mandate third-party assurance using harmonised standards, and create a sectoral life-cycle analysis (LCA) repository to set science-based baselines for project eligibility and investment due diligence.
2. Ensure Regulatory Coherence — Align to a Single Climate Finance Taxonomy	
Multiple taxonomies and inconsistent regulatory frameworks risk overlap and greenwashing weakening capital formation.	Adopt the DEA Climate Finance Taxonomy as the single reference framework across regulators (RBI, SEBI, IRDAI, PFRDA, IFSCA), harmonise disclosure requirements and apply proportionality so smaller institutions face calibrated yet credible obligations.

3. Financing Gap, Sources, and Intermediation — Bridge Scale and Execution Deficits	
Large financing gap of USD 6.5 trillion by 2070, combined with shallow long-tenor markets, asset–liability mismatches, and high risk premia prevent projects from reaching closure.	Deepen the corporate bond market from 16% in 2025 to 30% of GDP by 2070, expand the role of instituitional players, mobilise household savings, scale foreign direct investment and foreign portfolio investment through standardised co-investment platforms, technology partnerships and creation of bankable pipeline. Establish a National Green Finance Institution (NGFI)[i], complementing existing institutions to refinance, de-risk, and aggregate green assets.
4. Fragmented Project Pipeline — De-risk and Deepen the Pool of Bankable Projects	
Thin, fragmented project pipelines with sector-specific risks such as discom distress, weak Power Purchase Agreement (PPA) enforcement, and Micro, Small and Medium Enterprises (MSMEs) credit constraints.	Leverage the Accelerating Sustainable State Energy Transition (ASSET) platform launched by NITI Aayog to standardise project preparation and prioritisation. Priority early win projects include upgrading urban water pumping and industrial efficiency through Energy Service Company (ESCO) and Renewable Energy Service Company (RESCO) models, accelerating efficient cooling and Electric Vehicle (EV) adoption through demand aggregation and green finance, and electrifying municipal fleets through structured risk mitigation. Transit systems can be financed through value capture, while blended finance can support hard-to-abate areas such as waste heat recovery and low-carbon industrial electrification.
5. Transition Finance — Bridge Brown-to-Green Investments Credibly	
Financing for hard-to-abate sectors (steel, cement, heavy transport) remains constrained by weak frameworks and high perceived risks.	Strengthen transition finance through credible sectoral roadmaps, verified transition plans, and instruments such as transition and sustainability-linked bonds; expand guarantees and blended finance to de-risk investments; enhance disclosure through Securities and Exchange Board of India's (SEBI) Business Responsibility and Sustainability Reporting (BRSR) and National Climate Finance Taxonomy; and leverage Gujarat International Finance Tec-City (GIFT City) to anchor transition debt markets, bridging the brown-to-green financing gap.

Conclusion and Way Forward

India's Net Zero journey represents a defining opportunity to align growth, sustainability, and financial innovation. The analysis makes clear that while the investment challenge is immense, the foundations of a robust climate finance ecosystem are already in place. The way forward lies in translating this ecosystem into action, centred around reform pillars like data integrity, regulatory alignment, financing innovation, project bankability, risk sharing, and credible transition pathways. With coordinated policy action and global financial partnerships, India can bridge its financing gap, unlock green jobs, and establish itself as a global leader in financing sustainable development.

i A dedicated white paper is being developed through structured consultations with regulators, financial institutions, industry, and investors to define NGFI's operational design, mandate, governance, risk framework, and capitalisation.

1

INTRODUCTION

1 Introduction

India's pursuit of development and Net Zero will shape its long-term growth and transition pathway

India stands at a pivotal crossroads, aiming to become a developed economy by 2047 *(Viksit Bharat)* while committing to Net Zero emissions by 2070. The policy and investment decisions made in the next decade will shape the trajectories of prosperity and energy transition with implications across the entire economy.

Over the past decade, India has made substantial progress on climate action. By 2020, the country had reduced the emissions intensity of GDP by 36% from 2005[1] level, exceeding its first Nationally Determined Contribution (NDC) target. In 2025, India achieved a major milestone by reaching 50% of its installed electricity capacity from non-fossil fuel sources, five years ahead of the 2030 target[2], reflecting strong progress in renewable energy expansion. Meeting the 2070 Net Zero goal, however, will require a far-reaching transformation across the economy, including in energy, industry, transport, land-use, buildings, agriculture, forestry, waste, and water systems, alongside significant adaptation measures.

Emerging clean technologies need public support and blended finance to bridge viability gaps

While commercial finance is increasingly flowing into mature sectors such as solar and onshore wind, several critical technologies remain economically unviable without public support. Solutions like solar-plus-storage systems, green hydrogen, etc., require targeted financial tools, including subsidies, guarantees, and concessional capital. Frontier innovations, such as Carbon Capture, Utilisation, and Storage (CCUS), Small Modular Reactors (SMR), etc., remain in their early stages of development, necessitating public investment in research and development (R&D) and demonstration projects. Each technology lies at a different stage of readiness, demanding a customised mix of financing instruments to achieve scale effectively.

High capital costs remain a core barrier to clean investment in India's low-carbon transition

One of the most binding constraints in India's low-carbon transition is the persistently high cost of foreign capital due to distortionary credit ratings, which elevate perceived risk and deter affordable capital inflows. While domestic interest rates are anchored by monetary policy instruments such as repo and reverse repo rates, India's sovereign and corporate credit ratings often fail to reflect the country's strong repayment record and macroeconomic fundamentals, resulting in higher risk premiums for clean infrastructure projects. This disproportionately affects

capital-intensive and early-stage clean technologies that require long-tenor, patient capital. Addressing these constraints will require greater use of credit enhancement mechanisms to mitigate rating biases, along with concessional and blended finance solutions to reduce financing costs and improve project bankability.

India's climate goals demand trillions in finance, requiring systemic shifts in capital mobilisation

Several studies have estimated India's investment requirements to achieve Net Zero, with total needs ranging between USD 10 to 20 trillion by 2070, translating to USD 250–450 billion annually, against current flows of only about USD 135 billion, of which USD 87 billion is directed toward clean energy (FY2023-24)[3]. Despite being among the most climate-vulnerable countries, the majority of the current flows for climate action are focused on mitigation, leaving adaptation critically underfunded.

Moreover, the financing mix remains heavily domestic, 83% of average flows in FY2020-22 period were sourced internally, with just 17% from international sources[9]. Private capital continues to concentrate in commercially viable sectors like utility-scale renewables and energy-efficient appliances, while Micro, Small and Medium Enterprises (MSMEs), adaptation infrastructure, and early-stage clean technologies remain underserved. Bridging this gap will require not only a significant scaling up of finance but also greater use of concessional and blended finance, and risk sharing mechanisms to channel capital into priority sectors.

India's financial system faces structural barriers in mobilising capital at scale for the low-carbon transition. These include the high cost of capital, heightened perceptions of macroeconomic and sectoral risk, limited access to low-cost foreign capital, and institutional bottlenecks. Fiscal space is constrained, and public finance is already under pressure from competing developmental needs. While domestic reforms can alleviate some of these constraints, international public finance and multilateral development banks (MDBs) must play a more active role in risk sharing, deploying concessional capital, and market development.

India is building a stronger policy framework to channel flows for climate action at scale

India is actively strengthening its climate finance ecosystem through a series of coordinated policy and regulatory interventions. Recent initiatives include the development of a National Climate Finance Taxonomy draft which provides clarity on climate supportive and transition supportive activities, thereby reducing risks of greenwashing. In parallel, a domestic carbon market is being established to support low-carbon transition in industrial sectors.

The government has also expanded its Production-Linked Incentive (PLI) schemes and announced the National Manufacturing Mission to scale up domestic manufacturing of clean energy technologies. To attract greater private and international capital, blended finance platforms have been launched with support from sovereign and multilateral institutions[10].

Meanwhile, the green bond market is gaining momentum, with both sovereign and corporate issuances helping to channel long-term capital into clean infrastructure. India has also strengthened sustainability-related financial disclosures through initiatives such as the Business Responsibility and Sustainability Reporting (BRSR) framework, enhancing transparency and investor confidence.

Against this backdrop, NITI Aayog launched a comprehensive initiative to frame a Net Zero-aligned development vision. A set of inter-ministerial working groups were convened to assess the impact of long-term transition pathways across key domains like macroeconomic aspects of transition; sectoral low-carbon transition in transport, power, industry, buildings, waste and agriculture; financing for climate action; critical minerals; R&D and manufacturing; and the social implications of transition.

Within this effort, the Inter-Ministerial Working Group on Financing for Net Zero (IMWG3) chaired by Vice Chairman, NITI Aayog was tasked with the following mandate:

a. Estimating India's finance requirements to meet the Net Zero target in key mitigation sectors.

b. Estimating the potential of various domestic and foreign finance sources and instruments.

c. Estimating the financing shortfalls and barriers to capital mobilisation at lower than market rates.

d. Recommending policy, regulatory, and institutional interventions to crowd in capital at scale.

In this study, the assessment was deliberately scoped to estimate the finance required to achieve India's Net Zero goal, and did not include detailed costing of climate adaptation measures. At the national level, the Ministry of Environment, Forest and Climate Change (MoEFCC) is currently leading the preparation of India's first comprehensive National Adaptation Plan (NAP) which will provide a strategic framework for identifying adaptation priorities and estimating financing needs for adaptation, consistent with Government of India and UNFCCC guidance. Subsequent versions of NITI's study will incorporate adaptation cost assessments to present a more holistic view of financing requirements.

By integrating financing needs, potential sources of capital, and financing gaps into a unified framework, the analysis will support policymakers in aligning financial flows with India's Net Zero goal, while balancing development priorities, fiscal considerations, and long-term economic stability.

2

CURRENT CLIMATE FINANCE LANDSCAPE

Current Climate Finance Landscape

2

This chapter examines the status and trends of global climate-related finance, highlighting regional disparities, sectoral landscape, and progress in the broader financing architecture. It covers current flows, geographic distribution, sectoral allocation, financing instruments, and the roles of public and private actors. The chapter also reviews emerging frameworks such as taxonomies, carbon markets, and adaptation plans that are shaping the evolution of climate-related financial architecture.

2.1 EVOLUTION OF GLOBAL CLIMATE FINANCE FLOWS

2.1.1 Current Status and Trends

Climate change is no longer a distant threat but a macroeconomic and developmental disruptor

The escalating impacts of climate change, manifesting through extreme weather events, biodiversity loss, and economic losses have prompted urgent calls for a paradigm shift in climate action. If the world remains on its current trajectory, global temperatures are projected to rise beyond 3°C, potentially resulting in economic losses of up to 18% of global GDP by 2050[11] and nearly 20% by 2100[12]. This scenario highlights the scale and urgency of climate action and the need for unprecedented capital mobilisation.

To remain aligned with a 1.5°C pathway, the world must mobilise an estimated USD 5-9 trillion annually by 2030, with requirements rising further through mid-century[6,7,8].

The International Renewable Energy Agency (IRENA) projects average annual investment of over USD 5 trillion between 2023 and 2030 to meet global energy transition goals[7]. Climate Policy Initiative (CPI), in its Global Landscape of Climate Finance 2023 report, estimates an annual climate finance need of USD 9 trillion through 2030[6]. The Independent High-Level Expert Group on Climate Finance (IHLEG) estimates that between USD 6.3 and 6.7 trillion is required annually by 2030 to achieve global climate targets, of which USD 2.3–2.5 trillion must flow to Emerging Markets and Developing Economies (EMDEs), excluding China, to meet the Paris Agreement goals and the Sustainable Development Goals (SDGs)[8].

Global climate finance has grown, but it remains far below required levels.

In 2023, climate finance flows were estimated at about ~USD 1.9 trillion[4,5] compared to USD 0.6–1.2 trillion recorded in 2017 *(Figure 2.1).* While this represents significant progress, the gap between actual flows and required levels remains stark.

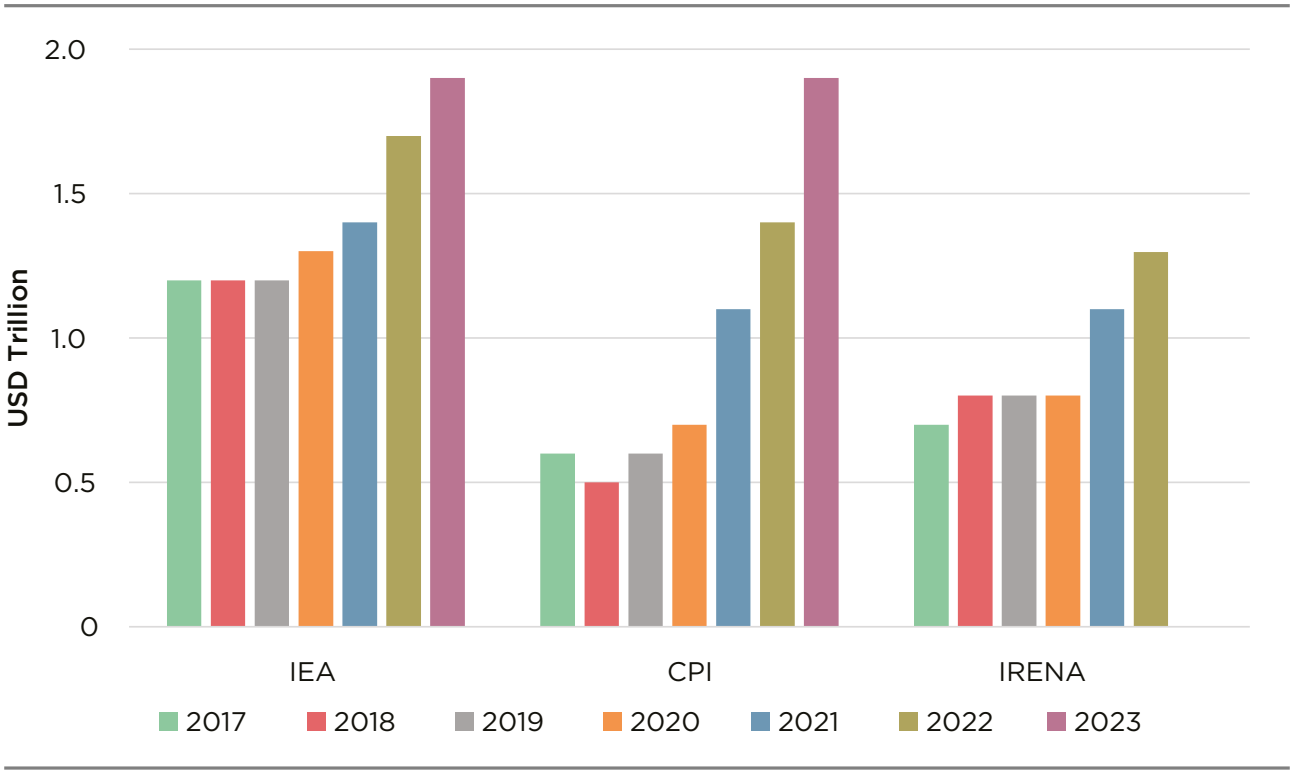


Figure 2.1: Tracked climate, energy transition, and clean energy finance (annual average)

Source: *Climate Policy Initiative (CPI), 2025, Global Landscape of Climate Finance[4]; International Energy Agency (IEA) (2024), World Energy Investment[5]; International Renewable Energy Agency (IRENA), 2023, Global Landscape of Renewable Energy Finance[13].*

Note: *The CPI estimates include both mitigation and adaptation finance across sectors such as energy systems; transport; industry; waste; water and wastewater; building and infrastructure; information and communication technology; Agriculture, Forestry, Other Land Uses (AFOLU); and fisheries.*

The IEA tracks investment in clean energy technologies and infrastructure, covering renewable power, grids and storage, energy efficiency and end-use, nuclear and other clean power sources, and low-emission fuels.

IRENA provides estimates of global investment in energy transition technologies, including renewable energy, energy efficiency, and electric transport and heating, energy storage, hydrogen, and Carbon Capture and Storage (Ccs). The most recent figures are for 2022.

Divergent methodologies and coverage obscure actual finance flows, complicating comparability and tracking.

Differences in sectoral scope, definitions, and estimation methods lead to significant variation in reported figures. For instance, some frameworks include transitional or low-carbon investments, while others adopt a broader lens that also captures adaptation-related finance. These diversions underline the complexity of tracking and forecasting finance for climate action. While precise figures differ, there is consensus that current flows are far below what is needed, and that greater coordination, harmonisation, and scale are essential to bridge the gap.

2.1.2 Regional Disparities and Uneven Flows

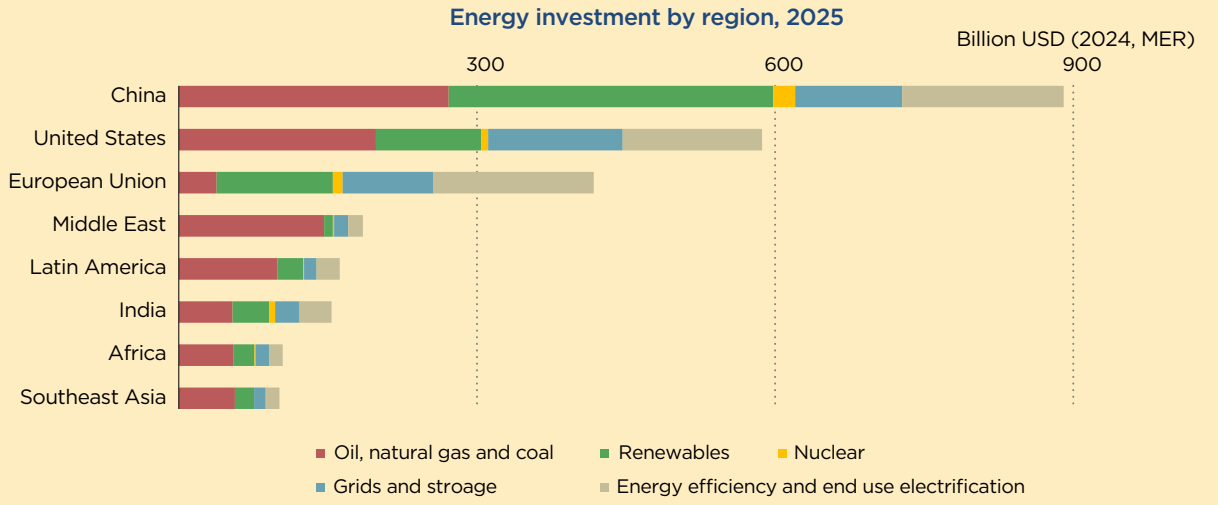
Despite steady growth in global climate finance, regional flows remain highly uneven and concentrated in a few markets.

Between 2018 to 2023, nearly 80% of global climate finance was mobilised in three regions- East Asia and the Pacific, Western Europe, and the United States and Canada[4] *(Figure 2.2).* By contrast, many Emerging Markets and Developing Economies (EMDEs), particularly in Sub-Saharan Africa and parts of South Asia, remain heavily dependent on public finance, with limited access to private capital due to high perceived risks and elevated cost of capital.

China's Dominance in Global Clean Energy Investment Reshapes Supply Chains

China remains the world's largest energy investor, with its share of global clean energy investment rising from one-quarter a decade ago to nearly one-third today[5]. The country leads in solar PV, batteries, and clean manufacturing, with clean energy-related technologies contributing over 10% to its GDP in 2024. Domestic climate finance in China, driven primarily by households and commercial actors, has contributed significantly to the global rise in climate-related flows. Internationally, China has also become a leading investor in clean energy manufacturing in countries such as Indonesia, Türkiye, Brazil, and Thailand.

However, this concentration of investment and manufacturing capacity has raised concerns about the resilience of global clean energy supply chains. According to the International Energy Association (IEA), Chinese exports of solar modules to developing countries have surged. While these exports accelerate clean energy deployment in capital-scarce regions, heavy concentration in upstream and midstream supply chains poses future risks related to pricing, policy dependence, and potential trade restrictions.



Source: *International Energy Agency. World Energy Investment 2025.*

MER: Market Exchange Rate

International climate finance to EMDEs was USD 196 billion in 2023[4] of which 78% came from public actors. Cross-border private investment in EMDEs rose from USD 19 billion in 2018 to USD 42 billion in 2023[4], but this remains far below needs. While Latin America, Middle East and North Africa (MENA), and parts of Central Asia have seen an recent uptick in private flows, many of the least developed countries still lag significantly.

According to the IEA, Africa's total energy investment in 2025 is projected to be 30% lower than in 2015, and the continent captures just 2% of global clean energy investment despite accounting for 20% of the world's population. Currency risks, debt servicing challenges, and shallow capital markets collectively hamper the ability of these regions to mobilise meaningful private finance[3].

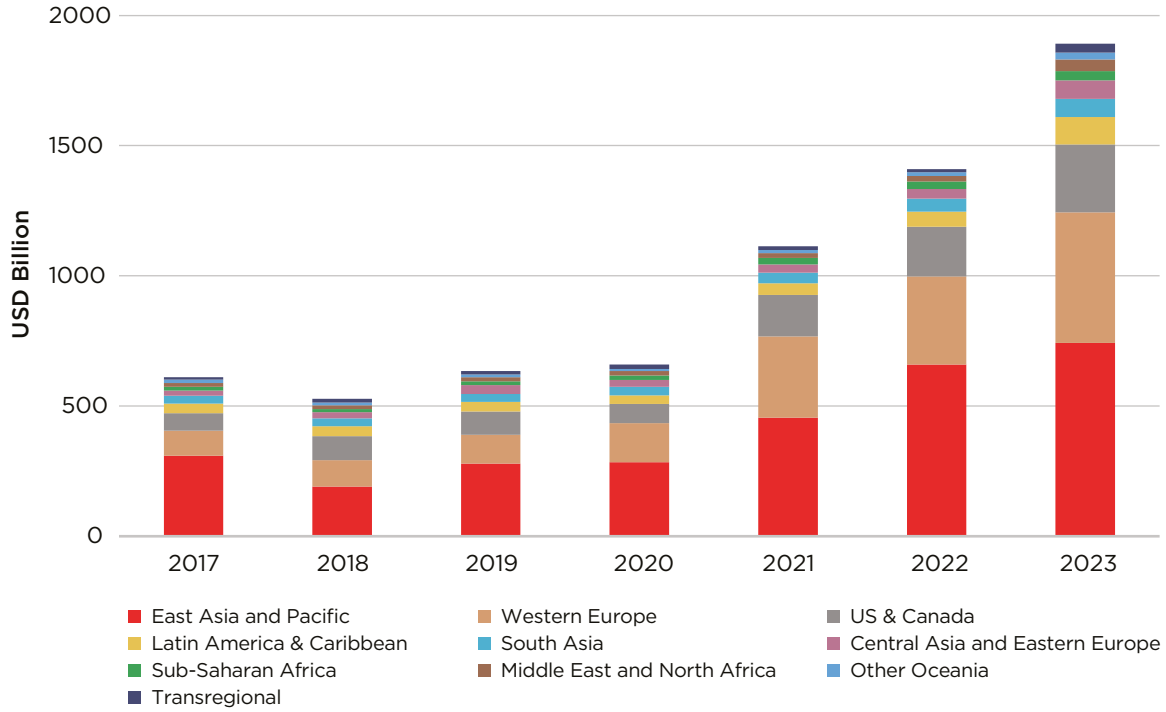


Figure 2.2: Annual climate finance by regions

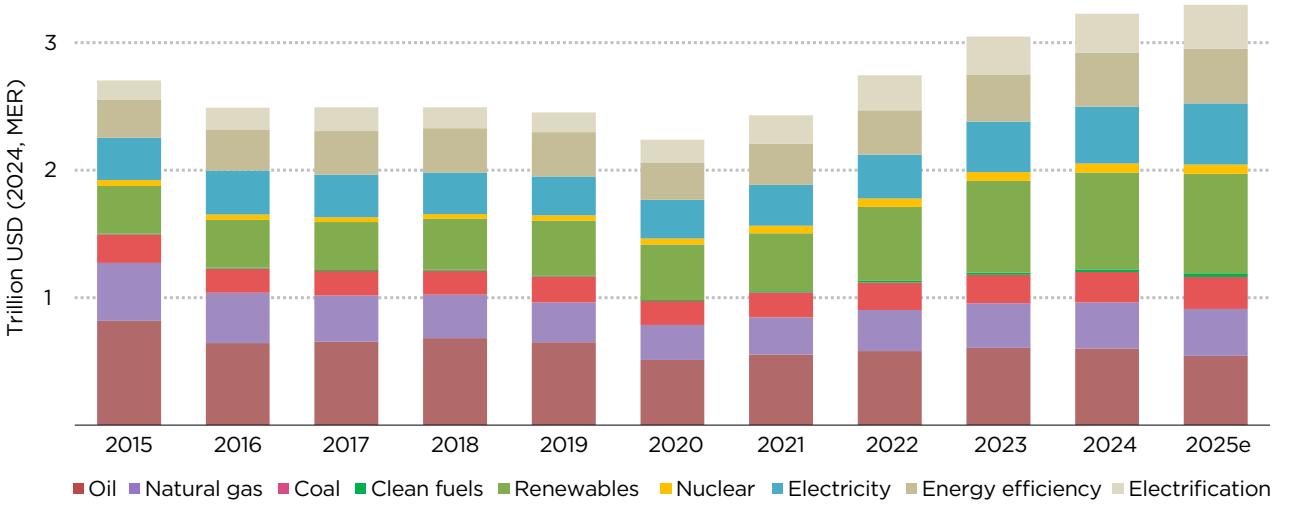
Source: *Climate Policy Initiative (CPI) (2025), Global Landscape of Climate Finance*

2.1.3 Sectoral Landscape: Energy Leads, But Gaps Persist

Clean energy dominates climate finance, but some sectors remain significantly underfunded

Climate finance remains overwhelmingly skewed toward mitigation, primarily directed towards the renewable energy and transport sectors. This reflects strong private sector interest, supportive regulatory frameworks, and falling technology costs. By contrast, sectors such as Agriculture, Forestry, and Other Land Use (AFOLU), along with waste and water systems, etc., continue to be severely underfunded, despite their high potential in enhancing resilience to climate change. Despite elevated geopolitical tensions and economic uncertainty, global capital flows to the energy sector are projected to rise to USD 3.3 trillion in 2025 *(Figure 2.3),* a 2% increase in real terms over 2024[3]. Of this, roughly USD 2.2 trillion will go collectively to

renewables, nuclear, grids, storage, low-emissions fuels, energy efficiency and electrification, twice the USD 1.1 trillion expected to be directed toward oil, natural gas, and coal[3].



MER: Market Exchange Rate

Figure 2.3: Annual global energy investment by sector (2015-2025)

Source: *International Energy Agency (2025), World Energy Investment 2025*

Debt dominates climate finance instruments, while equity and guarantees remain underutilised.

In terms of instruments, debt remains the primary channel for global climate finance, accounting for around 61% of total flows from 2018 to 2023. Equity follows at roughly 33%, while grants comprise just 4%[4.] Debt dominates in mature, commercially viable sectors such as energy, transport, and buildings, where private capital participation is strong.

Energy systems and transport each received nearly equal shares of market-rate debt and equity, while buildings relied heavily on debt (68%)[4]. In contrast, less commercially attractive sectors such as waste, water, Agriculture, Forestry and Other Land Use (AFOLU), and fisheries, depend primarily on public and concessional finance, reflecting long return periods and complex project dynamics.

The high cost of capital continues to hinder the deployment of clean energy in developing economies, despite falling technology costs.

Most technologies essential for achieving Net Zero such as solar, wind, green hydrogen, grid infrastructure, etc., are highly capital-intensive, requiring substantial upfront investment. As a result, the cost of capital plays a critical role in determining their commercial viability and affordability.

In Emerging Markets and Developing Economies (EMDEs), the cost of capital is far higher than in developed countries or China, driven by real and perceived risks[14]. This cost is further inflated by currency volatility, which increases the cost of servicing foreign debt. When combined with domestic borrowing costs and currency hedging, the total cost of capital becomes prohibitively high for companies seeking international debt financing.

While domestic reforms can improve investment conditions, international public financial institutions like Multilateral Development Banks (MDBs), Development Financial Institutions (DFIs) and climate focused funds must play a larger role by offering credit - enhancement tools and other risk-mitigation instruments to bring down the cost of capital in these markets.

Public vs. Private Flows: A balanced mix with divergent roles

The global climate finance landscape exhibits a relatively balanced contribution from private and public actors, with private sources accounting for about 45-50% of total flows in 2023[4]. Private funds are primarily concentrated in sectors such as energy, transportation, construction, and infrastructure. In contrast, public finance plays a critical role in supporting underfunded sectors, including industry, water and waste management, and Agriculture, Forestry, and Other Land-Use (AFOLU).

Among private actors, commercial financial institutions, mainly banks, are the leading contributors, providing around 45% of the private climate finance, followed by households. On the public side, Development Financial Institutions (DFIs) played a pivotal role, accounting for 46% of total public climate finance.[4]

2.1.4 Global Progress on Climate Finance Architecture: Taxonomies, Carbon Markets, and Adaptation Plans

Global Taxonomy Developments

As of 2025, more than 50 national or regional Taxonomies are in use or under development to align financial flows with climate and environmental goals[15]. The European Union (EU) Taxonomy for sustainable activities, one of the earliest frameworks, classifies economic activities according to their contribution to six environmental objectives, including climate change mitigation and adaptation[16]. China's green finance Taxonomy, updated in 2023, closely aligns with the EU's green list but includes clean coal and transition activities, reflecting domestic energy priorities. Singapore's Green Taxonomy, released in 2023 and updated in 2025, introduced a traffic-light system (green, amber, red) to guide financial institutions in managing transition risks across sectors[17]. South Africa's 2022 green finance taxonomy addresses both climate and broader sustainability outcomes.

India launched its draft National Climate Finance Taxonomy in 2025 to provide clarity on climate supportive activities, transition supportive activities, and reduce risks of greenwashing. Collectively, these efforts highlight a growing global consensus on the need for frameworks to channel capital toward sustainable development.

Carbon Markets Across Countries

As of 2025, more than 75 jurisdictions have adopted or are developing carbon pricing instruments, including Emissions Trading Systems (ETS) and carbon taxes[18]. China's national ETS, launched in 2021 for the power sector, expanded in 2025 to include steel, cement, and aluminum[19]. Colombia and Indonesia have launched ETS pilots, while the EU ETS has broadened its scope under the Green Deal to include, road transport, buildings and maritime transport.

Voluntary carbon markets are also growing, particularly in Africa and Latin America, though concerns persist regarding credit quality and price volatility[20]. In a major 2025 update, India

operationalised its Carbon Credit Trading Scheme (CCTS) by issuing sector-specific emission intensity targets for four sectors – Aluminium, Cement, Chlor-Alkali, and Pulp & Paper, in October 2025 to accelerate domestic decarbonisation[21].

Adaptation Plan Progress

Adaptation finance is being increasingly integrated into national policy frameworks, driven in part by the Global Goal on Adaptation (GGA) under the United Nations Framework Convention on Climate Change (UNFCCC), which calls for measurable progress in enhancing adaptive capacity and resilience. As of 2025, more than 140 countries have initiated National Adaptation Plan (NAP) processes aimed at integrating climate risks into national planning and budgeting[22].

Despite this momentum, adaptation continues to be underfunded. India is preparing its first NAP to be submitted to the UNFCCC, following multi-sectoral consultations and scientific assessments across nine priority sectors, including agriculture, water, health, and infrastructure. This effort builds on India's Initial Adaptation Communication, submitted in December 2023[23].

Even with rising climate finance flows and record investments in clean energy, current levels remain well below what is needed to meet global climate goals. Deep regional disparities, high capital costs in developing countries, and persistent underfunding of adaptation continue to constrain progress. With a few economies dominating key technology supply chains and finance flows, concentration risks are growing. Bridging these gaps will require coordinated global action, scaling both public and private finance, enhancing regulatory tools such as taxonomies and carbon markets, and ensuring equitable and affordable access to capital for developing economies. The focus must now shift from commitments to implementation and scaled impact.

2.2 INDIA'S CLIMATE FINANCE LANDSCAPE

India's Climate Ambitions and the Centrality of Finance. India has set ambitious climate goals, including achieving Net Zero greenhouse gas (GHG) emissions by 2070, reducing the emissions intensity of its GDP by 45% by 2030 (relative to 2005 levels), and having 50% of installed electricity capacity from non-fossil fuel sources by the end of this decade (achieved in 2025, five years ahead of the 2030 target)[24]. These commitments are reflected in India's updated first NDC and supported by flagship national missions on renewable energy, electric mobility, and green hydrogen.

As India strives to become a developed nation by 2047 under the ***Viksit Bharat*** vision, it faces the unprecedented challenge of decarbonising a rapidly growing economy. This dual ambition of development with decarbonisation demands large and sustained investment across sectors. In this context, mobilising adequate, predictable, and concessional finance for climate action is not only critical but foundational to delivering on both climate and development goals.

Policy and Regulatory Initiatives Driving Climate Finance. Indian policymakers and regulators increasingly recognise the scale of capital required to achieve Net Zero. Over the past decade, the government has introduced a range of public schemes, including grants, subsidies, and incentives, aimed at accelerating deployment of clean energy, sustainable transportation, and low-carbon transition across industries. Public finance has played a foundational role, with institutions such as the Indian Renewable Energy Development Agency (IREDA), the Solar Energy Corporation of India (SECI), and Energy Efficiency Services Limited (EESL) driving renewable

energy and energy efficiency financing. The Climate Change Finance Unit (CCFU) under the Ministry of Finance anchors India's climate finance strategy and international engagement.

Regulatory institutions have also intensified efforts to enable finance for climate action. The Reserve Bank of India (RBI) has introduced instruments such as green deposits, sovereign green bonds, and priority sector lending for green projects, alongside disclosure frameworks on climate-related financial risks. The Securities and Exchange Board of India (SEBI) has strengthened Environmental, Social, and Governance (ESG) transparency through the Business Responsibility and Sustainability Reporting (BRSR) framework, green bond guidelines, and the regulation of ESG rating providers. To align capital flows with climate goals and curb greenwashing, the government announced a National Climate Finance Taxonomy in the Union Budget 2024, with the draft framework released by the Department of Economic Affairs (DEA) in 2025[25]. *Figure 2.4* depicts major climate change and climate finance initiatives in India.

Despite this progress, the scale of private capital required demands deeper institutional and regulatory reforms. Unlocking finance at scale will require structural measures to make climate-aligned investments commercially viable and attractive to mainstream investors.

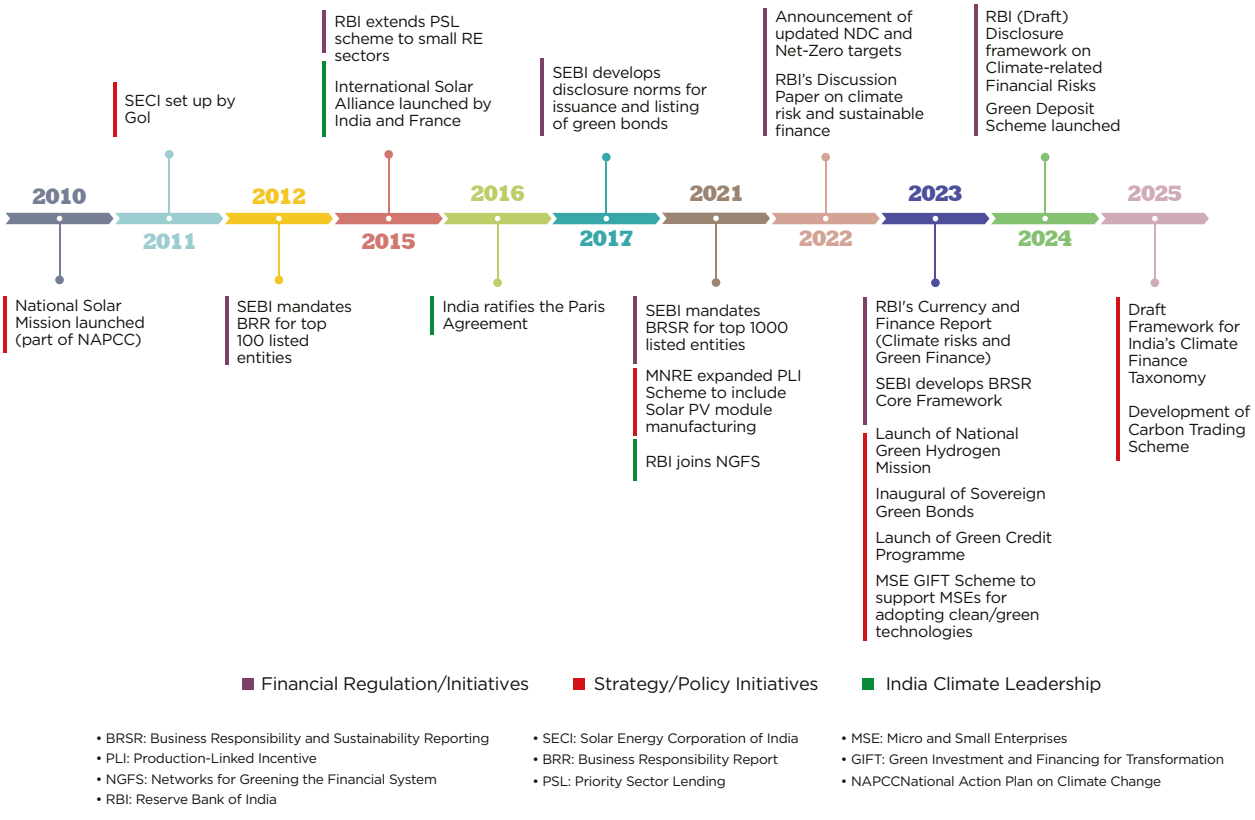


Figure 2.4: Timeline of major initiatives in India on climate change and climate finance

2.2.1 Climate Finance Flows in India—Trends and Composition

India's finance flows for climate action have shown steady growth over the past decade *(Figure 2.5)*. Climate Policy Initiative (CPI) estimates that tracked green investments rose from USD 17 billion in FY2016-17 to USD 57 billion in FY2021-22[9], reflecting a compound annual growth rate of 22.3%. IEA estimates that clean energy investment reached USD 87 billion in 2024, a 42% increase over the annual average of USD 61 billion between 2021-2023[5].

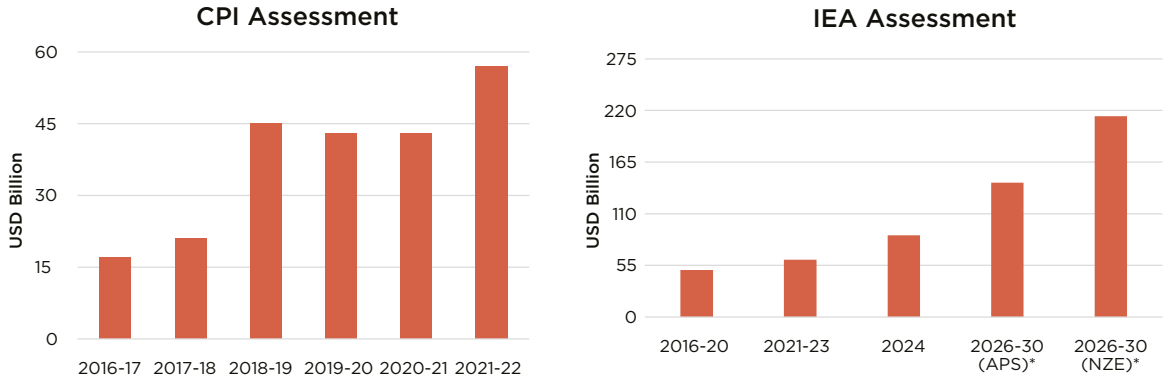


Figure 2.5: India's clean energy flows (USD billion) estimated by two separate studies

Source: *Left Hand Graph - Climate Policy Initiative (CPI), 2024, Landscape of Green Finance in India; Right Hand Graph - International Energy Agency (IEA), 2024, World Energy Investment (annual average).*

Note: *The difference between the CPI and the IEA estimates of capital flows towards climate and clean energy technologies arises from differing methodologies. CPI estimates include mitigation-related uses, such as clean energy, clean transport, and energy efficiency. The IEA tracks India's clean energy investments across low-emission electricity, grid and storage, clean supply, and end-use sectors.*

****APS** = Announced Pledges Scenario; **NZE** = Net Zero Emissions by 2050 Scenario (as defined by IEA)*

During FY 2020-22, tracked mitigation-related financial flows in India averaged INR 3,712 billion per year (approximately USD 50 billion) marking a 20% increase from FY 2018-20 *(Figure 2.6).* Domestic sources accounted for the vast majority, contributing nearly 83% of the total flows[9]. Within this, private sector actors, including commercial financial institutions and corporations, collectively provided about two-thirds. Public sources, comprising union and state budgets and public sector undertakings, accounted for roughly one-third. International sources represent only 17% of total flows emphasizing that India's climate finance flows are predominantly domestic.

In terms of sectoral allocation, clean energy attracted the largest share of 47% of total flows, followed by energy efficiency (35%) and clean transport (18%). On the instruments side, debt accounted for about 50% of total flows, followed by equity at nearly 29% and Government budgetary expenditure at 16%. Within debt, balance-sheet financing continued to dominate (64%) followed by low-cost project debt (24%) and project-level debt (12%). A similar pattern was observed in equity, where balance sheet financing had majority of contribution (88%), with the remainder coming from project-level equity[9].

These trends highlight the concentration of finance in mature technologies and established lending channels, with limited diversification across instruments or sectors. Flows towards early-stage, innovative, and hard-to-abate industries remain limited.

Despite recent growth, current finance flows for climate action fall far short of India's estimated annual finance needs to meet its Nationally Determined Contribution (NDC) and Net Zero

targets.

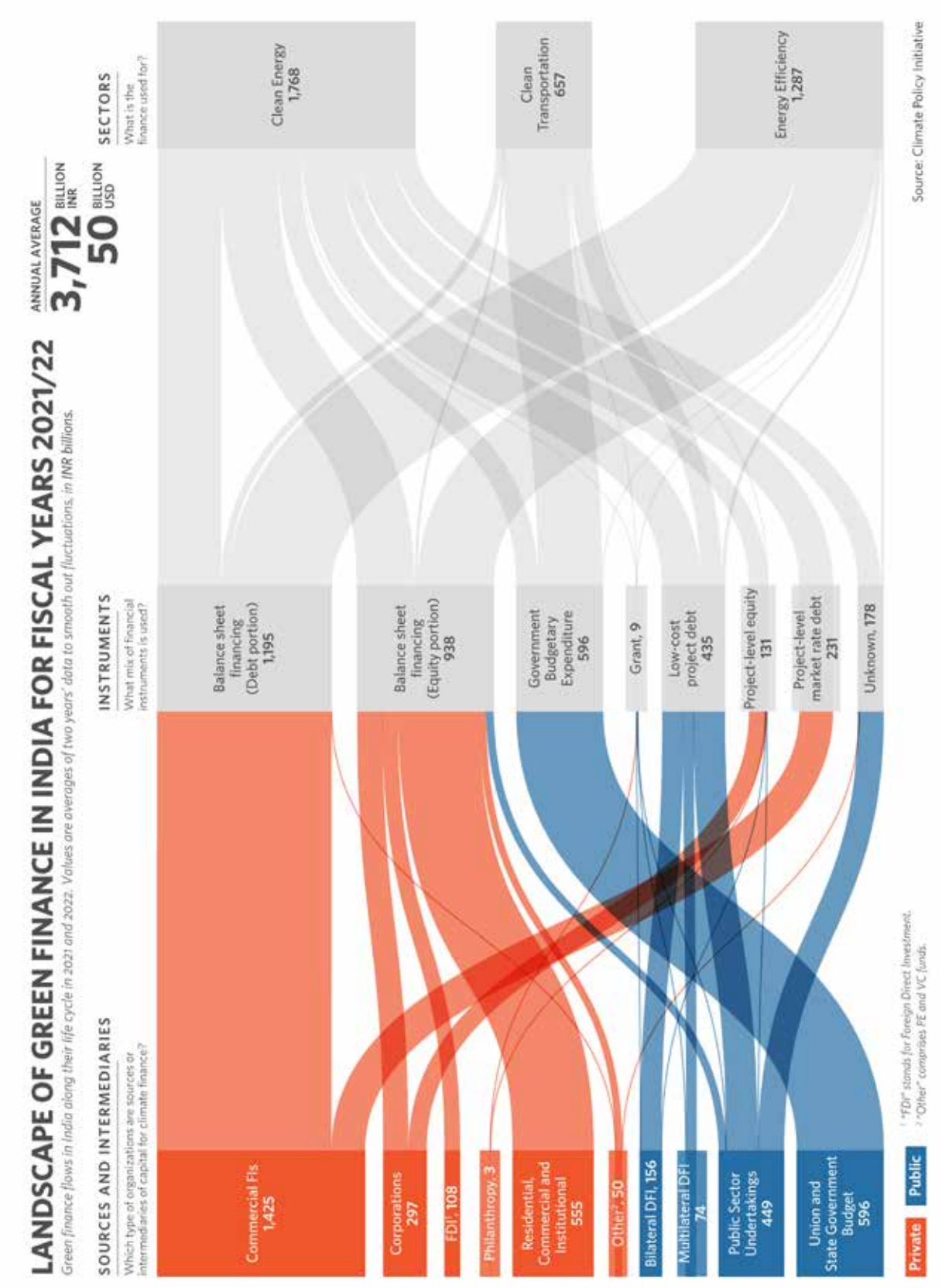


Figure 2.6: Composition of green finance flows in India, FY 2020–22 (annual average, Billion INR)

***Source** : Landscape of Green Finance in India, CPI, 2024.*

High Cost of Capital in India and the Role of De-risking for Climate Investments. India faces a persistently high cost of capital for low-carbon projects, driven by its low sovereign credit ratings and high technology and project risks. In 2025, S&P Global Ratings upgraded India's sovereign rating to BBB from BBB–[26] reflecting improvements in macroeconomic fundamentals. However, the rating remains at the lower end of the investment-grade spectrum, continuing to influence foreign debt financing costs for climate-related projects, despite strong underlying credit fundamentals, including robust economic growth, improving fiscal metrics, and a stable macroeconomic outlook, underscoring the disconnect between sovereign risk profile and sovereign rating.

To address these challenges, blended finance approaches have become an essential tool. Public capital, though limited, can be deployed strategically through grants, concessional loans, or junior equity to absorb early-stage risks, offsetting perceived risks and enhancing project credit profiles. Such approaches lower the overall cost of capital, making projects commercially attractive especially for private institutional investors like Sovereign Wealth Fund (SWF), Pension Fund (PF), Private Equity and Venture Capital (PE/VC), etc. Multilateral Development Banks (MDBs) and Development Financial Institutions (DFIs) also play a crucial role in de-risking climate investments. By offering risk-mitigation instruments such as partial credit guarantees and subordinated equity, MDBs/DFIs strengthen investor confidence and mobilise private capital at scale. These instruments provide downside protection without immediate capital outlay, stabilise returns, and attract long-term financing from both domestic and foreign markets.

Going forward, scaling finance for climate action will require a combination of blended finance, expanded de-risking mechanisms, stronger domestic institutions, and greater mobilisation of international capital across instruments and sectors. These measures will be critical to closing the financial gap and aligning investment flows with India's long-term climate ambitions.

2.2.2 Recent Initiatives Strengthening India's Climate Finance Architecture

In May 2025, India's Ministry of Finance released the draft National Climate Finance Taxonomy, a dynamic framework that categorises economic activities into climate-supportive, adaptation, and transition-aligned sectors, including power, mobility, buildings, agriculture, and hard-to-abate industries[25]. Following a hybrid, phased approach, starting with qualitative principles and gradually introducing quantitative technical screening criteria (TSC), the taxonomy emphasises inclusivity, simplified reporting, and staggered thresholds for MSMEs, aiming to prevent greenwashing while supporting India's Net Zero and low-carbon transition goals.

The Carbon Credit Trading Scheme (CCTS) has progressed from policy design to regulatory implementation, with the Ministry of Environment, Forest and Climate Change (MoEFCC) issuing GHG Emission Intensity (GEI) targets for the first four sectors – Aluminium, Cement, Chlor-Alkali, and Pulp & Paper in October 2025, covering 282 obligated entities. Obligated entities must meet GEI targets or purchase carbon credits, with financial penalties for non-compliance, creating a structured market that incentivises emission reductions and mobilises private capital.

India has also strengthened sustainability disclosures through SEBI's Business Responsibility and Sustainability Reporting (BRSR) framework and the RBI's Draft Disclosure Framework on Climate-

related Financial Risks, which require reporting on governance, strategy, risk management, and metrics. Complementing these measures, India's first National Adaptation Plan (NAP) targets nine priority sectors, including agriculture, water, health, forests, and infrastructure resilience, to enhance climate resilience, integrate adaptation into development planning, and promote a science-based approach to strengthening adaptive capacity[27].

In conclusion, India's climate finance landscape reflects both strong ambition and proactive policy action to bring down the substantial financing gaps across sectors. Ambitious national targets, policy support in the form of subsidies, VGF, etc., and a growing suite of supportive instruments like taxonomies, carbon markets, disclosure frameworks, etc., lay the institutional foundation for mobilising capital for climate action at scale. Yet financial flows remain concentrated in mature sectors through conventional instruments, with limited concessional and international finance to offset high capital costs or support emerging technologies. Going forward, the priority will be to expand de-risking mechanisms, diversify financial instruments, and strengthen institutional capacity so that public and private finance can operate synergistically to deliver India's climate and development goals.

3

MODELLING METHODOLOGY

Modelling Methodology

3

The methodology is structured into two components:

1. Estimating investment requirements across key mitigation sectors, and
2. Projecting capital supply from domestic and foreign financial sources.

3.1 ESTIMATION OF INVESTMENT REQUIREMENTS

This study adopts an integrated assessment modelling (IAM) approach to develop Net Zero pathways for India. As reported in India's ***Biennial Update Reports (BURs)***, the analysis covers Greenhouse Gas (GHG) emissions from energy, Industrial Process and Product Use (IPPU), waste, agriculture, Land Use, Land-Use Change and Forestry (LULUCF). The methodology employs a suite of analytical tools to project emissions and investment requirements across these sectors.

3.1.1 Macroeconomic Projections using the Long-Term Growth Model (LTGM)

The process begins with macroeconomic projections generated using the World Bank's Long-Term Growth Model (LTGM)[28], an Excel-based tool grounded in the Solow-Swan Growth Model. The LTGM estimates GDP growth rates based on key economic drivers such as savings, investment, and human capital productivity.

For this study, the LTGM model produces GDP growth trajectories and sectoral value-added shares that align with the *Viksit Bharat* vision. These projections rest on the assumptions that India's human capital will converge with developed economy standards by 2047, and that Total Factor Productivity (TFP) growth and investment rates will remain elevated until 2047 and moderate thereafter.

The outputs from LTGM formed the foundation for sectoral Inter-Ministerial Working Groups (IMWGs) to assess useful energy demand across various sectors of the economy. Further details on the LTGM methodology are provided in a separate report on ***Scenarios towards Viksit Bharat and Net Zero: Macroeconomic Implications (Vol. 2).***

Energy system models

For the energy and IPPU sectors, emissions are estimated using two energy system models: the TIMES model, an optimisation-based tool, and the India Energy Security Scenarios (IESS), a scenario-building platform. In contrast, emissions from the agriculture and waste sectors are

projected separately using an Excel-based model. Throughout the process, the methodological approaches and input assumptions were refined in consultation with stakeholders from government, industry, and academia to ensure analytical robustness and policy relevance.

Within the energy system models, the analysis starts with a detailed assessment of useful energy demand. For example, in the transport sector, useful demand is expressed as billion passenger-kilometres for passenger transport and billion tonne-kilometres for freight. These metrics are derived from macroeconomic indicators such as GDP growth, sectoral value-added shares, and population projections provided by the LTGM. Similarly, in the industrial sector, activity levels such as steel production measured in million tonnes are projected using macroeconomic parameters and form the basis for energy demand estimates. Sector-specific methodologies and assumptions underlying these projections are detailed in the respective sectoral working group reports.

Computable General Equilibrium (CGE) model

Once sectoral energy demand estimates are established, the results are integrated into a Computable General Equilibrium (CGE) model to assess the macroeconomic implications of India's energy transition. The model used in this study is a recursive-dynamic, single-country CGE framework, in which economic growth is driven by three key factors: capital accumulation, labour force dynamics, and productivity growth. For each sector, production is represented through a nested Constant Elasticity of Substitution (CES) structure, enabling the model to capture varying degrees of substitutability among capital, labour, energy, and intermediate inputs.

The model is underpinned by a Social Accounting Matrix (SAM) constructed using the latest 2019 Supply and Use Tables (SUT) from the Ministry of Statistics and Programme Implementation (MoSPI). This SAM integrates current, fiscal, and debt accounts, populated with data from the National Accounts Statistics (NAS) and cross-verified with the Macro Poverty Outlook (MPO) Databank. It is subsequently macro-updated to 2022 using key macroeconomic indicators from NAS.

To better represent GHG emission dynamics, the SAM has been expanded to include a highly disaggregated energy sector. The resulting 251×251 SAM comprises 74 activities and 148 commodities, including seven distinct power generation sectors: coal, gas, solar, wind, hydro, nuclear, and other sources. It distinguishes three primary factors of production (labour, capital, and land) and four labour categories, differentiated by skill level and formal or informal employment status.

On the household side, the SAM identifies 10 household types, segmented by rural and urban areas across income quintiles. It also includes seven separate tax and subsidy categories covering production taxes, commodity taxes, direct taxes, subsidies, and tariffs and accounts for three types of investment: public gross fixed capital formation, private gross fixed capital formation, and changes in inventories. Finally, it features a dedicated debt account to track the government's financing of its fiscal deficit.

Further details on the macroeconomic modelling framework are available in the report on ***Scenarios towards Viksit Bharat and Net Zero: Macroeconomic Implications (Vol. 2)***

3.1.2 Scenario Framework for Investment Estimation

Investment requirements are estimated for two distinct scenarios in the energy system models:

- **Current Policy Scenario (CPS):** The Current Policy Scenario represents a level of effort that is realistically achievable based on historical trends and continuation of current policies (as of 2023), thereby projecting ongoing trends in low-carbon technology deployment.
- **Net Zero Scenario (NZS):** The Net Zero Scenario reflects an ambitious pathway aligned with India's commitment to achieve Net Zero Greenhouse Gas (GHG) emissions by 2070. It incorporates both existing and additional policy measures to accelerate demand electrification, enhance circularity, improve energy efficiency, promote rapid development of low-carbon technologies/fuels and encourage behavioural shifts.

The following section provides a detailed description of the methodology used to estimate the investment requirements in the power, transport, and industry sectors.

Caveat: The study estimates India's investment needs and projected capital availability across three key mitigation sectors, namely power, transport, and industry. The estimates presented are indicative in nature and are contingent on underlying assumptions and specific modelling choices, including technology pathways, policy trajectories, and cost parameters. The results should be interpreted as directional rather than definitive. Other mitigation-relevant sectors, including buildings, waste, etc., are not included in the current investment estimation but are included for energy and emission estimation. These sectors will be analysed and incorporated in subsequent iterations of the study.

Transport

The capital investment requirements for decarbonising India's transport sector can be broadly grouped into three major components.

- **Investments by Original Equipment Manufacturers (OEMs):** These cover capital expenditure for expanding the manufacturing capacity of electric and alternative fuel vehicles across all modes, including two-wheelers, three-wheelers, passenger cars, buses, and trucks.
- **Investments in battery manufacturing:** This includes capital outlays for establishing domestic production facilities for lithium-ion and other advanced battery chemistries.
- **Investments in Public Charging Infrastructure (PCI):** These cover the deployment of both slow and fast chargers, with capacities determined by charger-to-vehicle density targets for each vehicle segment.

Methodology and Assumptions

Investment projections are based on NITI Aayog's India Energy Security Scenarios (IESS) 2070 and the TIMES model, particularly the projected vehicle sales for select milestone years. Based on these projections, the following key assumptions inform the computation of sectoral investment requirements:

i. Capital expenditure (CAPEX) per million vehicles by OEMs for manufacturing expansion.

ii. CAPEX per GWh of mobility-related battery storage capacity added.

iii. CAPEX per charger, specified separately for slow and fast charging points.

Total battery storage demand is calculated as the product of new vehicle sales and per-vehicle battery capacity. Similarly, the required number of chargers is derived from vehicle-to-charger density norms for each segment (***All cost assumptions are detailed in Annexure 1***).

Limitations

Exclusion of infrastructure investment costs: It is important to note that the estimated investment cost includes vehicle costs in terms of cost to the automobile industry, and cost of batteries and EV charging infrastructures. The cost of infrastructure for road/rail expansion, aviation, metros, LNG facilities, and hydrogen filling stations is not included in the model, understating total sectoral capital needs.

Industry

The investment demand for the industrial sector can be broadly categorised into three components:

- **Investment required for expanding production capacity,** needed to meet the growing energy demand of India's industrial sector. In estimating this requirement, the analysis accounts for the technological configuration of new plants. For example, in the steel sector, the model incorporates multiple technology pathways, including Blast Furnace–Basic Oxygen Furnace (BF–BOF), coal-based Direct Reduced Iron (DRI)–Induction Furnace (IF), coal-based DRI–Electric Arc Furnace (EAF), gas-based DRI–EAF, green hydrogen-based DRI–EAF, and scrap-based EAF.
- **Investment required for green hydrogen production.**
- **Investment required for establishing carbon capture facilities.**
- **Investment required for captive fossil and non-fossil power plants.**

Methodology and Assumptions

Investment projections are derived from outputs of NITI Aayog's India Energy Security Scenarios 2070 and the TIMES model, with a focus on the projected demand for key industrial commodities. For each industry considered namely steel, cement, aluminium, fertiliser, caustic soda, soda ash, textiles, paper and pulp, refining, and petrochemicals, the projected demand is converted into the required plant capacity, assuming an 80% utilisation rate. A uniform plant lifetime of 35 years is applied across all industrial sectors. The model also determines the technology mix necessary to meet this demand.

Using these outputs, sectoral investment requirements are estimated based on the following key assumptions:

- CAPEX per million tonnes (MT) of industrial commodity demand met through each technology pathway.
- CAPEX per million tonnes (MT) of green hydrogen consumed in industrial applications. Green hydrogen as fuel is considered for the steel, fertiliser, and refinery sectors.
- CAPEX per million tonnes (MT) of CO_2 captured from industrial processes. Carbon capture is considered for the steel, cement, and petrochemical sectors.

The CAPEX assumptions outlined above are detailed in ***Annexure-2***. It is important to note

that these investment estimates carry certain limitations. The current analysis does not include investment for the utilisation of captured carbon. In addition, the estimates exclude costs associated with efficiency upgrades within industrial facilities. Furthermore, no future changes, either increases or decreases, in investment costs are assumed for the identified technologies; all estimates are based on constant cost prices over the assessment period and adjusted to 2025 price levels.

Limitations

- Technology cost trends: Cost trends for emerging technologies such as green hydrogen electrolysers, Carbon Capture, Utilisation, and Storage (CCUS), and Limestone Calcined Clay Cement (LC3) are derived based on current best knowledge and stakeholder consultations. However, these estimates may vary significantly in the future as markets evolve and economies shift due to factors like scale-up effects, policy incentives, and supply chain maturation. Industry sector modelling thus faces limitations in projecting long-term investment needs accurately.
- Investment required for energy efficiency measures: In this study, detailed energy efficiency improvements in a specific sector, identified via industry stakeholder consultations, are accounted for to estimate future Specific Energy Consumption (SEC). However, the related capital investments required for these measures are not explicitly modelled.
- Stranded assets non-accountability: With the transition in industry sectors, particularly under Net Zero Scenario, certain assets may become stranded, including their capacity and associated costs. This study does not account for such stranded assets or their economic implications.

Power

The capital requirements in the power sector are broadly categorised into three categories:

- **CAPEX expenditure for various electricity generation technologies**
- **CAPEX for stationary energy storage systems**
- **CAPEX for Transmission and Distribution (T&D) infrastructure**

Methodology and Assumptions

Capacity requirements for electricity generation are estimated using TIMES, an optimisation-based energy system model. The optimisation balances cost while ensuring reliability, subject to constraints such as renewable energy potential, build-out rates, technology lifetimes, and operational flexibility.

The modelled technology portfolio covers a wide range of generation options, including:

- Thermal: coal-based generation (subcritical, supercritical, and ultra-supercritical), natural gas (open-cycle and combined-cycle),
- Renewable and alternative sources: biomass, waste-to-energy, nuclear, hydropower (large and small), and renewables (solar PV, onshore wind, and offshore wind).

To address renewable intermittency, the model explicitly incorporates battery storage and pumped hydro, with cost trajectories for both technologies factored into the optimisation.

Per-megawatt (MW) cost trajectories for all generation technologies are provided in ***Annexure-3***.

For estimating transmission expansion costs, this study applies a simplified rule of thumb based on proportional cost allocation. Under typical conditions in a conventional power system, transmission expansion costs are assumed to be half of the total generation cost, while distribution expansion costs are taken as one-fourth of the generation cost. This results in a cost ratio of Generation: Transmission: Distribution to be 4:2:1. The same assumption is applied for infrastructure planning for future coal, nuclear, and hydropower generation. In contrast, power systems with Variable Renewable Energy (VRE) require significantly higher transmission costs. This is mainly due to the need for additional infrastructure such as Flexible Alternating Current (AC) Transmission Systems (FACTS), DC-to-AC conversion equipment, harmonic filters, and advanced systems for smart grid operation and management. To capture this added complexity and cost, the ratio is adjusted to 4:3:1 for infrastructure expansion in solar and wind power generation. This approach offers a practical estimation method for planning purposes, particularly when detailed project-specific transmission routing and costing data are unavailable.

3.2 ESTIMATION OF SUPPLY OF FINANCE

The supply of finance is considered from both domestic and foreign sources to estimate the capital available for India's low-carbon energy transition. For projecting domestic capital supply, a top-down approach is applied, beginning with financial savings in the economy, which are intermediated through various financial institutions and subsequently allocated to different sectors, including for financing low-carbon transition.

The methodology for projecting foreign capital supply mirrors that for domestic capital, except that flows to low-carbon transition are estimated directly, without intermediation through domestic financial institutions. The following subsections outline (i) the overall methodological framework and (ii) the assumptions applied to domestic and foreign sources of capital.

3.2.1 Estimation of Domestic Financial Flows using the Asset Flow Model

The supply of finance for low-carbon transition sectors originates from key outputs of the CGE model, specifically, GDP and gross savings, which serve as the base for estimating financial flows within the economy.

Gross savings are divided into two components: households and corporations. Government investment has been excluded from this analysis, as the government's contribution occurs through schemes and subsidies rather than direct capital allocation. Moreover, the government is a net borrower in India's financial system.

Domestic savings are expected to play a crucial role in meeting India's investment needs associated with Viksit Bharat 2047 vision. Gross domestic savings are projected to rise from about 30% of GDP in 2023[29] to around 33% by 2035, driven by rising per capita income and financial literacy. Beyond 2035, the savings rate is expected to gradually decline and reach 29% of GDP by 2047 and 25% by 2070 as India transitions to a high-income status, consistent with trends observed in other advanced economies ***(Annexure-4)***.

During FY2019-23, households have contributed an average of approximately 64% of total gross savings, with the remaining share contributed by corporates[29]. For this analysis, household contribution to total gross savings is assumed to remain constant at 64% till 2070.

Household Sector

Within total household savings, financial savings accounted for an average of around 60% during FY2019-23[30]. This share is projected to rise to 68% in 2047 and further increase to 75% by 2070, driven by the financialisation of the economy and the success of government-led financial inclusion programs. A similar pattern is observed in advanced economies like the United States[31] and Japan[32], where financial savings constitute 60-65% of total household savings.

Historically, bank deposits have been the dominant financial savings instrument for households. Going forward, however, gradual diversification is expected as households allocate more savings to insurance and mutual funds, which offer higher returns and diversified risk profiles. India's insurance penetration, currently around 4% of GDP in 2023[33], remains below that of upper-middle and high-income economies. As India moves towards high-income status, insurance depth is expected to converge towards global average of 5-6% of GDP, with the OECD average at ~6.2% (e.g., Germany ~6%, Sweden ~7%)[34]. For this analysis, we assume the share to rise to 6% by 2047 and increase gradually to 7% of GDP by 2070, converging with global benchmarks.

Despite this diversification, banks will remain the dominant source of capital throughout the projection period (2026–2070). *(Figure 3.1)*

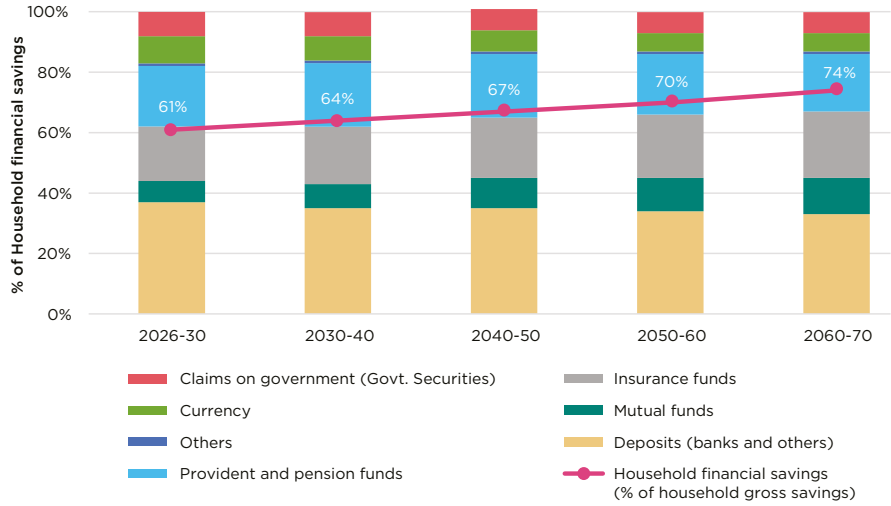


Figure 3.1: Projected household financial savings allocations (2026-2070)

Corporations

Corporations, comprising both non-financial firms and financial firms, invest their capital through balance sheet financing to expand business operations, as well as in financial assets such as bank deposits and mutual funds. Historically, during FY2019-23, the share of non-financial corporations in total gross savings ranged between 34% and 37%[30]. For projections, it is assumed that their share will remain close to the 5-year historical average (FY2019-23) of 36% through 2070. Similarly, the share of financial corporations in total gross savings is also expected to remain steady at around 9%[ii].

ii During FY2019–23, households, non-financial corporations, and financial corporations contributed an average of 64%, 36%, and 9%, respectively, to gross savings. The total exceeds 100% because the government (which is excluded from this analysis, as government's contribution occurs through schemes and subsidies rather than direct capital allocation) is a net borrower, accounting for an average of around 9% of gross savings.

It is assumed that 100% of corporate savings take the form of financial savings, reflecting the sector's stronger intermediation capacity and preference for reinvestment through financial markets.

3.2.2 Capital Intermediation, Instruments, and Allocation

Capital from household savings and corporates can be channelled into the real economy, either directly through corporate investment or indirectly via financial intermediaries such as banks, Non-Banking Financial Companies (NBFCs), insurance companies, pension funds, and mutual funds. Additional sources of finance include foreign investment : Foreign Portfolio Investment (FPI), Foreign Direct Investment (FDI), multilateral and bilateral financial institutions, and private equity funds. These financial intermediaries also reinvest the net returns on their existing capital stock, thereby expanding the pool of investable funds.

Moreover, a portion of this existing capital can be reallocated toward low-carbon technologies, supporting India's goal of achieving Net Zero by 2070.

The following figure explains the modelling framework for capital intermediation.

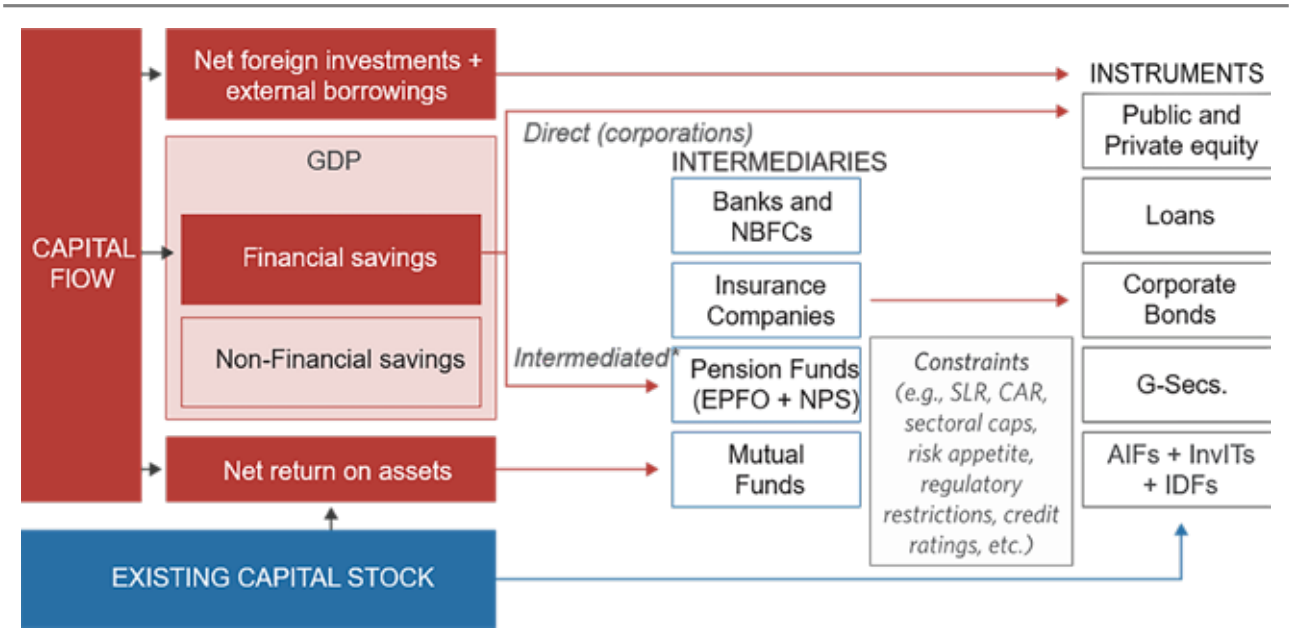


Figure 3.2: Total supply of finance in the economy: Modelling framework

**Considering net household financial savings. Part of household savings held as currency, government securities, and Public Provident Fund (PPF) are excluded.*

Note: *NBFCs = Non-Banking Financial Companies; EPFO = Employees' Provident Fund Organisation; NPS = National Pension Scheme; SLR = Statutory Liquidity Ratio; CAR = Capital Adequacy Ratio; G-Secs = Government Securities; AIFs = Alternative Investment Funds; InvITs = Infrastructure Investment Trusts; IDFs = Infrastructure Debt Funds.*

Financial intermediaries deploy capital through a range of financial instruments, including loans, public and private equity, bonds, Alternative Investment Funds (AIFs), infrastructure investment Trusts (Invits), and Infrastructure Debt Funds (IDFs).

Once the total capital available with each financial intermediary is estimated, it is allocated across key sectors, namely power, transport, and industry through both debt and equity channels.

The sector-wise estimated capital availability is then compared with the capital requirements for each sector to determine whether a financing shortfall or surplus exists. The bottom-up approach calculates the gap (or surplus) for each sector individually, based on its specific capital requirements and available finance, and then aggregates these to derive the total financing shortfall or surplus for the economy *(Figure 3.3)*.

The financing gap thus represents the difference between the capital required and capital available for climate mitigation.

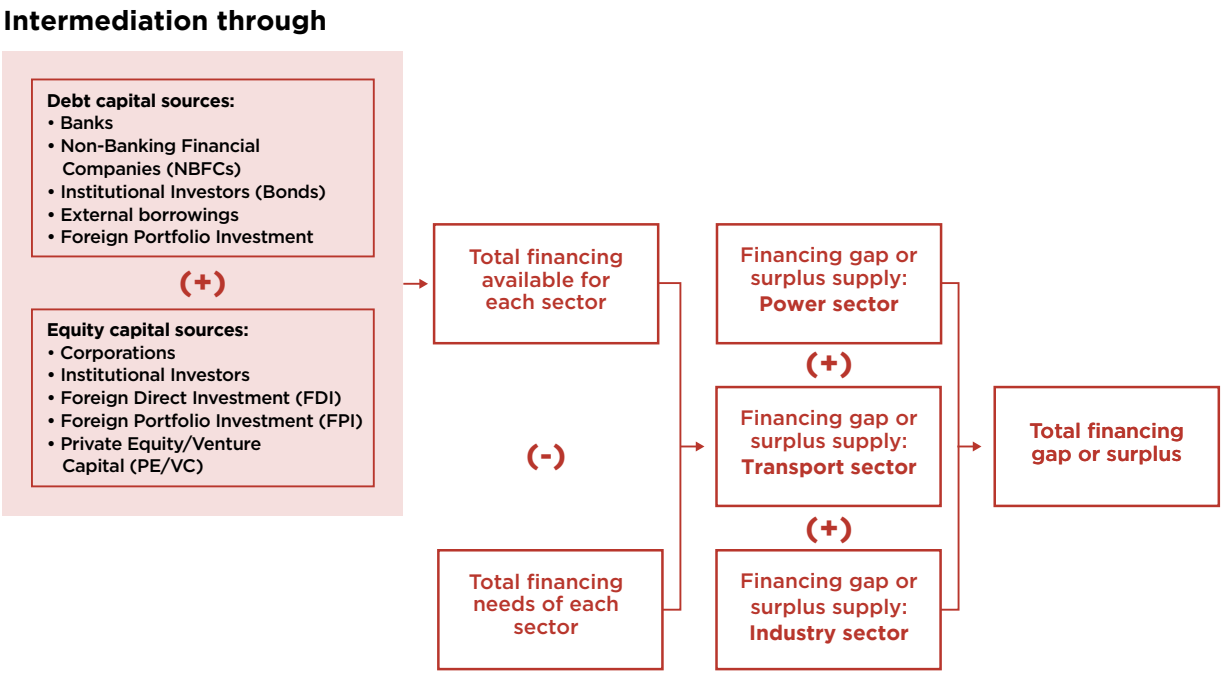


Figure 3.3: Mitigation finance supply and gap: Modelling framework

The methodology for capital mobilisation and intermediation, covering the roles of various financial sources, intermediaries, and instruments, as well as the deployment of funds across sectors, is outlined below.

Domestic Sources

Domestic sources and intermediaries that channel capital from households and corporations include both debt and equity financing. Debt financing is primarily provided through banks, Non-Banking Financial Companies (NBFCs), and corporate bonds, while equity financing comes from institutional investors, corporations, and Private Equity/Venture Capital (PE/VC) funds.

1. Debt Capital

Banks

As India remains a bank-driven economy, banks and NBFCs are expected to play a central role in financing India's Net Zero transition. The methodology to project credit flows to low-carbon transition sectors from banks is outlined below.

Capital Intermediation

The total bank credit outstanding is projected as a share of Net Demand and Time Liabilities (NDTL) minus Statutory Liquidity Ratio (SLR). Detailed step-wise methodology is described below:

- **Step 1: Calculation of NDTL**

  NDTL = Aggregate deposits + RBI borrowings + Inter-bank liabilities + Other demand/time liabilities – RBI balances.

- **Step 2: Estimation of Deposits, Borrowings, and Liabilities**

  Bank deposits are projected based on their historical share (%) in household financial savings. This share is expected to decline from current 37% in 2023[35] to 33% by 2070. The decline reflects financialisation of household savings, as rising incomes and financial literacy shift households away from low-yield bank deposits towards higher-return, market-linked instruments like mutual funds, equities, bonds, sovereign securities, etc.

  The remaining components of the equation, RBI borrowings, inter-bank liabilities, other demand/time liabilities are projected using their five-year historical averages (FY2019-23) as a share of bank deposits, at 0.9%, 1.9%, and 4.3% respectively.

- **Step 3: Estimation of Bank Credit**

  Total bank credit is projected as a percentage of NDTL, after adjusting for SLR, which is computed as the historical average for the five-year period FY2019-23.

  Bank Credit Outstanding = (Historical Bank Credit Outstanding / (NDTL - SLR)) x (Projected NDTL - Projected SLR).

As of 2023, outstanding credit stood at INR 136 trillion[36], or 104% of NDTL minus SLR. The SLR, which stands at 28% as the historical average for the five-year period FY2019-23[37], is expected to gradually decline toward the RBI's minimum requirement of 18% by 2070. As SLR fall to RBI's minimum requirement, banks holding government securities in excess of regulatory requirements will gradually reallocate these funds toward corporate bonds and other market instruments, supported by the deepening of Indian financial markets.

Credit Allocation

Allocation of bank credit to different sectors is estimated using total bank credit outstanding and sectoral exposure. Repayments of outstanding bank loans are also incorporated to reflect the net flow of credit, with total credit flows augmented by the principal repayments over time.

The projection of credit allocation to the sectors is carried out through the following steps.

- **Step 1: Estimate Credit Exposure**

  Bank credit exposure to the financing for low-carbon transition = Total bank credit outstanding × Respective sector exposure (%)

- **Step 2: Repayment of Principal**

  Repayment of the principal amount is calculated assuming an average loan duration for the respective sector with the principal amortised annually over the loan period.

- **Step 3: Annual Credit Flow to the Sector**

  Projected credit flow to the sector in a year = Annual change in sector credit exposure (Current Year Sector Credit Outstanding – Last Year Sector Credit Outstanding) + Repayment of sector credit principal amount

  Details for each sector are provided in ***Annexure-5***.

Non-Banking Financial Companies (NBFCs)

Non-Banking Financial Company (NBFC) credit is projected in relation to total bank credit. NBFC lending over FY2019-23 stood at an average 24%[38] of total bank credit. This ratio is assumed to remain the same till 2070 as no major change is expected in lending practices of banks/NBFCs while absolute credit volumes are expected to expand. Hence, the formula:

NBFCs' Credit Outstanding = Projected bank credit outstanding × Projected % of NBFC credit to bank credit

The methodology for credit allocation across low-carbon transition sectors follows the same approach used for banks and is elaborated in ***Annexure-6***.

Corporate Bonds

Although India has a bank-driven credit market, corporate bonds will be crucial in providing long-term debt capital for infrastructure and other capital-intensive sectors, including those essential for achieving Net Zero emissions.

The projection of corporate bond issuance in this study follows a three-step methodology:

- **Step 1: Estimation of Corporate Bonds Outstanding**

  Corporate bonds outstanding are projected as a percentage of GDP. As of FY2023, India's outstanding stock stood at 15.7% of GDP[39], well below other countries such as China (~38%), Japan (~30%), etc.[40]

  With India's growing economy, regulatory reforms, greater financialisation, and rising institutional participation, the corporate bond market is expected to deepen gradually. It is assumed that the stock of corporate bonds will rise to 30% of GDP by 2070.

- **Step 2: Estimation of Annual Corporate Bond Issuance**

  Annual bond issuance is calculated as the difference between the current year's and the previous year's outstanding stock, accounting for maturities, assuming an average bond maturity of five years.

- **Step 3: Sectoral Allocation of Corporate Bonds**

  Sectoral allocation of corporate bonds is projected based on sector's percentage in total annual issuance of corporate bonds. As of FY 2023, 4.4% of corporate bonds were issued in the power sector, while transportation and industrial sector accounted for much smaller shares of approximately 0.05% and 1.7%, respectively. These shares are projected based on historical patterns and sector-specific assumptions (details are provided in Annexure-7).

2. Equity Capital

Institutional Investors (Equity)

Institutional investors, such as pension funds, insurance companies, and mutual funds, play a pivotal role in providing long-term equity capital for India's low-carbon transition. They primarily invest in corporate bonds and equities, and their growing asset base represents a major potential source of financing for low-carbon technologies.

The methodology for projecting institutional investors' equity allocation to low-carbon transition sectors involves three phases. The first phase estimates the Assets Under Management (AUM) of institutional investors. The second phase explains the allocation of this projected AUM to equity investments and the third phase further disaggregates the equity allocation across low-carbon transition sectors, namely, power, transport, and industry.

Phase 1 – Projecting Assets Under Management (AUM)

Institutional investors manage large pools of AUM that can be mobilised towards financing technologies for achieving India's Net Zero goal. The projection of AUM is based on the following steps:

- **Step 1: Projection of AUM**

  The AUM for each institutional investor is projected by using the following formula:

  Projected AUM = Previous year's AUM + Premiums/Contributions + Investment Income – Benefits/Claims – Expenses

- **Step 2: Premiums and Contributions**

  Insurance companies: Premiums[iii] (life and general insurance) are modelled as a share of GDP, increasing from 4% in 2023[33] to 7% in 2070, reflecting growing income levels and deeper insurance penetration. This assumption is consistent with trends observed in OECD countries averaging ~6.2% in 2024 (Germany ~6%, Sweden ~7%[34]).

  Mutual funds: Fresh investments are projected as a share of household financial savings, rising from 6% in 2023[35] to 12% in 2070, as households are expected to increasingly shift towards instruments that offer higher returns than traditional bank deposits.

  Pension and provident funds: Contributions are linked to household financial savings. Approximately 19% of household financial savings in FY2023[35] were directed toward provident and pension funds. This share is expected to rise to 21% by 2050 and gradually decline to 19% by 2070, reflecting reduced propensity to save for pensions as India's population ages. ***(details on premium and contribution are provided in Annexure-8.1).***

- **Step 3: Investment Income**

  The percentage of returns is applied to various asset classes in the portfolio, using historical data from FY2019-23 ***(details on investment income are provided in Annexure 8.1).***

iii The data on premium/contribution received is extracted from Annual Reports of Pension Fund Regulatory and Development Authority (PFRDA), Employees' Provident Fund Organisation (EPFO), Insurance Regulatory and Development Authority of India (IRDAI), and various public and private insurance companies.

Portfolio allocations[iv] are assumed to gradually evolve over time. The share of government securities is projected to decline from 55–60% at present to around 50% by 2070 for most institutional investors.

For mutual funds, allocation to equity-oriented schemes is expected to increase in line with the rising risk appetite of investors.

A higher allocation to corporate bonds and equity will enhance capital flows to sectors and technologies critical for achieving India's Net Zero goals.

- **Step 4: Benefits/Claims and Expenses**

  For all institutional investors, benefits and claims paid are projected based on the historical data from FY2019-23 (calculated as Benefits or Claims ÷ Premiums or New Funds Mobilised). ***(Benefits/claims and expenses projections are detailed in Annexure 8.1).***

  Operating expenses are estimated using historical data from the past five years (FY2019-23), with the assumption that improved asset management efficiency and economies of scale will gradually reduce costs over the long-term ***(Annexure-8.1)***.

Phase 2: Allocation to Equity

A portion of the AUM of institutional investors is allocated to public equity, projected based on historical allocation patterns and also considering the potential for higher equity allocations resulting from financial sector reforms and an increased risk appetite among these classes of investors.

Capital allocation to public equity is projected as a percentage of AUM. In FY2023, the equity allocation of AUM across institutional investors ranged from 15% to 20% (except for mutual funds, which stood at 53%). The detailed breakdown of public equity allocation across different institutional investors is given in ***Annexure-8.2.***

Phase 3: Equity allocation to financing low-carbon transition in various sectors

Equity capital estimated in phase 2 is further allocated across sectors, including financing low-carbon transition activities across power, transport, and industry. Since institutional investors are typically passive investors, the NIFTY50 index is used as a proxy for their equity capital allocation across sectors, with the historical trends of weights (% of total NIFTY50 market capitalisation) of sectors forming the basis for projections.

The methodology for allocating equity capital to each low-carbon transition sector is outlined below.

- **Step 1:** Projection of sectoral allocation of total equity capital using the sectors' weights in the NIFTY50. The details of sectoral allocation are given in ***Annexure-8.2***.
- **Step 2:** Projection of equity capital flow for sectors in a particular year = Current year's AUM equity allocation in a sector - Previous year's AUM equity allocation in a sector

iv The data on portfolio allocation is extracted from Annual Reports of Pension Fund Regulatory and Development Authority (PFRDA), Employees' Provident Fund Organisation (EPFO), Insurance Regulatory and Development Authority of India (IRDAI), and various public and private insurance companies.

Corporate Equity

Corporate equity is another important source of capital for financing low-carbon technologies. Corporations typically reinvest a significant portion of their retained earnings into capital expenditure (CAPEX), acquisitions, and working capital. The following three-step approach is used to estimate corporate equity that can be deployed in low-carbon transition.

- **Step 1: Estimation of Sectoral Capital Expenditure**

  The portion of retained earnings used for CAPEX by corporations is estimated for each sector, i.e., power, transport, and industry. Data on free cash flow to equity (FCFE) and CAPEX data[v] for power, transport, and industry corporations were analysed over the past seven years.

- **Step 2: Projection of Future Sectoral Capital Expenditure**

  The historical (FY2017-23[vi]) allocation of total direct corporate investment (excluding investments in financial assets) to CAPEX for each sector is calculated, i.e., CAPEX for each sector/total direct corporate investments (%). This ratio is used for projecting future sectoral CAPEX

- **Step 3: Projection of Corporate Equity Investment in Sectors**

- Corporate equity investment is projected by multiplying the historical rate of CAPEX/ total direct corporate investments by total projected corporate direct investments ***(details are provided in Annexure-9).***

Private Equity and Venture Capital (PE/VC)

Private Equity and Venture Capital (PE/VC) play a significant role in financing technologies by supporting start-ups and emerging businesses in enabling low-carbon transition across sectors. For projecting PE/VC funding to these technologies, the following approach is adopted:

- **Step 1: Estimation of Total PE/VC Funding**

  Total PE/VC funding is projected as a percentage of GDP. The five-year historical average for FY2019-23 stands at 2% of GDP[41] and this is assumed to remain constant through 2070. The projections adopt a conservative approach, taking into account the uncertainty related to the pace and magnitude of PE/VC ecosystem growth and lack of credible long-term forecasts.

- **Step 2: Estimation of PE/VC funding for low-carbon transition sectors**

  PE/VC funding directed towards low-carbon transition sectors[vii] is approximately 2% of total PE/VC funding in FY2023. This share is projected to rise to 6.5% by 2035, driven by growing market opportunities and a favourable policy environment. This trajectory mirrors trends in countries such as China, South Africa, the Philippines, and Brazil,

v The data for free cash flows to equity and capital expenditure has been extracted from the ProwessIQ/CMIE database.

vi A seven-year period is considered for projecting percentages due to fluctuations observed in free cash flow to equity caused by events such as COVID-19.

vii PE/VC funding directed toward enabling the low-carbon transition across sectors is calculated as the sum of PE/VC funding to Energy, Transport, Industry and Building, based on data extracted from the Tracxn database.

which are also undergoing energy transitions. However, beyond 2035 PE/VC funding for low-carbon transition sectors is expected to gradually decline to 2.5% of total PE/VC funding by 2070 as the attractiveness of early-stage green technology investment decreases once several technologies mature beyond the start-up phase.

- **Step 3: Sectoral Allocation of PE/VC Funding**

  Within technologies, PE/VC funding is allocated across power, transport, and industry sectors using the following formula, guided by historical data and sector-specific assumptions ***(details are provided in Annexure-10)***

  PE/VC funding in a sector = % of sectoral allocation x Total PE/VC for low-carbon transition sectors as calculated in step 2

Foreign Sources

Foreign capital is invested directly into technologies that support the Net Zero transition, rather than being channelled through domestic intermediaries. It is deployed through both debt and equity, using instruments such as loans, bonds, and equity. The key tracked foreign sources, along with the methodology used, are discussed below:

Foreign Direct Investment (FDI)

FDI in the form of direct equity is considered a key source of capital available for low-carbon transition sectors.

- **Step 1: Estimation of FDI**

  FDI equity inflows are projected based on five-year (FY2019-23) historical trends of FDI as a percentage of GDP. In FY2023, total FDI inflows into India stood at INR 5.7 trillion[42], equivalent to 2.1% of GDP. For comparison, OECD average FDI-to-GDP ratio stands at 2.2-2.4% with countries like Sweden at 3.1%, Canada at 1.9%[43], indicating potential for India to attract higher FDI inflows. Based on these benchmarks, the FDI-to-GDP ratio is assumed to gradually increase to 3% by 2070.

- **Step 2: Sectoral Allocation of FDI**

  FDI equity inflows for each year are distributed across the power, transport, and industry sectors ***(see Annexure-11 for details)***. The following approach is used:

  - ***Step 1:*** Project annual FDI inflows up to 2070 using the FDI-to-GDP ratio assumption outlined above.
  - ***Step 2:*** Allocate FDI to low-carbon transition sectors based on historical sectoral FDI patterns (FY2019-23) supplemented with sector-specific assumptions.

Foreign Portfolio Investment (FPI)

FPI, comprising both equity (stocks) and debt (bonds), is included in the overall capital projections. FPI inflows are estimated using the year-on-year change in Assets Under Custody (AUC). The methodology is outlined below:

Step 1: Estimation of AUC

AUC is projected as the sum of the previous year's AUC, net FPI investments during the year, and returns on investment.

Step 2: Estimation of Net Investments and Return on Investment

Net investments are calculated as % of GDP. In FY2024, total net FPI investments amounted to INR 3.4 trillion[44], equivalent to 0.5% of GDP. This share is projected to increase to 1.5% of GDP by 2047, after which it is assumed to remain constant as India transitions into a developed economy. The return on investment is projected based on the historical average (FY2019-23) of rates of return earned by institutional investors.

Step 3: AUC Allocation to Bonds and Equity

AUC allocation across financial instruments (bonds and equity) is projected based on the five-year (FY2019-23) historical average asset allocation (***Annexure-12***).

Step 4: Sectoral Allocation of FPI

The sectoral allocation of Foreign Portfolio Investors' (FPI) AUC (both debt and equity) across the power, transport, and industry sectors is estimated as follows:

- FPI equity allocation to power, transport, and industry is projected in proportion to the sectoral weights of these sectors in the NIFTY50 Index ***(details are provided in Annexure-12.1)***.
- FPI debt portion allocation to power, transport, and industry is projected based on the share of these sectors in total corporate bond issuance ***(details are provided in Annexure-12.2)***.
- The annual FPI inflow is estimated as the year-on-year change in sectoral equity and debt investments.

External Borrowings

The estimation of India's total external borrowings and the share of debt raised in low-carbon transition sectors is carried out in three steps:

Step 1: Estimation of Total External Borrowing

Total external borrowings are estimated as a percentage of GDP. India's external debt stood at USD 664 billion at the end of FY2024[45], equivalent to 17% of nominal GDP. For projections, the external debt-to-GDP ratio is assumed to remain at the five-year historical (FY2020-24) average of 18.5%, consistent with observed external debt shares in peer emerging markets such as Brazil (~17% of GDP), China (~13% of GDP), and Russia (~13% of GDP)[46].

Step 2: Gross Debt Outstanding of Non-financial Corporations

The share of external debt held by non-financial corporations is estimated as a proportion of total external outstanding debt, recorded at 10.5% in FY2024[47], This ratio is assumed to remain constant at historical four-year average (FY2021-24)[viii] of 10.7%.

viii Due to limited data availability, a four-year period has been used for estimation.

Gross debt outstanding of non-financial corporations is projected using the following relationship:

Gross Debt outstanding (non-financial corporations) = Trailing four-year average share of external debt held by non-financial corporations × Total external debt

- **Step 3: Gross Debt Issuance by Non-financial Corporations**

  Gross external debt issuance in a year by non-financial corporations is projected based on their outstanding external debt (calculated in step 2), assuming an average five-year maturity for external borrowings.

  Total external debt issuance by non-financial corporations = Gross debt outstanding by non-financial corporations/5

- **Step 4: Sectoral Allocation of External Borrowings**

  For projections of sectoral allocation of external debt of non-financial corporations, the sectoral allocation percentages of FDI are used[ix] as proxy combined with sector-specific assumptions (***Annexure-13***).

International Public and Private Climate Finance

Other international climate finance sources, such as Development Financial Institutions (DFIs), Global Climate Funds (GCFs), and Sovereign Wealth Funds (SWFs), are also tracked[x] as part of total foreign capital flows.

Estimation of International Public Finance Flows: According to Climate Policy Initiative's (CPI) India green finance tracking, international climate finance through bilateral and multilateral institutions (including GCF flows) increased from USD 1.72 billion in FY2016–17 to USD 3.6 billion in FY2021–22[9].

In line with the New Collective Quantified Goal (NCQG) objective of tripling global climate finance flows by 2035 from public and private sources (COP29)[48], it is assumed that bilateral and multilateral public finance inflows to India also scale up proportionately over this period. As India transitions to developed country status by 2047, these inflows are assumed to stabilise, reflecting patterns observed in other developed economies, specifically China, which has now emerged as a net provider of finance.

Estimating Finance Flows from Sovereign Wealth Funds (SWFs): As of FY2023, SWFs collectively held USD 13.2 trillion in AUM, with USD 217 billion in annual deal activity. India received approximately 8% of the deal value in FY2023[49]. SWF AUM is projected to grow to USD 18 trillion by 2030[50]. India is well-positioned to attract a larger share of this expanding capital pool, consistent with the share experienced in developed economies like UK (12%), Italy (11%), etc.[49]. For allocation to low-carbon transition sectors, SWFs are expected to follow patterns similar to FDI, owing to their shared long-term investment characteristics.

ix Due to the unavailability of sectoral data, sectoral allocation percentages of FDI are used as a proxy, considering it to be a comparable foreign source.

x These sources do not form part of the analysis to estimate supply of finance (except SWF), as they currently account for only a small share of total flows.

4

RESULTS AND ANALYSIS

Results and Analysis

4

This chapter presents estimates of India's investment needs and projected capital availability across key mitigation sectors, power, transport, and industry under Current Policy Scenario (CPS) and Net Zero Scenario (NZS). It builds on modelling exercises that link macroeconomic projections with sectoral energy demand, investment requirements, and domestic and foreign financial flows until 2070. The results highlight the magnitude and timing of financial needs, the role of domestic versus international capital, and potential financing gaps.

4.1 INVESTMENT REQUIREMENT FOR NET ZERO

4.1.1 Estimates of Investment Requirements

Several studies have estimated India's investment requirements to achieve Net Zero by 2070, with total needs ranging between USD 10 to 20 trillion, reflecting differences in scope, and methodology. Similarly, certain estimates include only technology deployment costs, whereas others also account for manufacturing capacity, system integration, and associated overheads. These variations explain the spread across studies.

Despite the variation in absolute numbers, the sectoral pattern is broadly consistent: the power sector dominates, accounting for more than 50% of investment, driven by renewables; the transport sector accounts for roughly 20%, focused on electric vehicles (EVs), charging infrastructure, and emerging hydrogen applications; and industry represents a quarter, with most investments expected post-2045 in hard-to-abate sectors such as steel, cement, and chemicals. The study estimates **total mitigation sector investment at around USD 22.7 trillion for Net Zero** underscoring the need for urgent, massive, and long-term capital mobilisation *(Figure 4.1).*

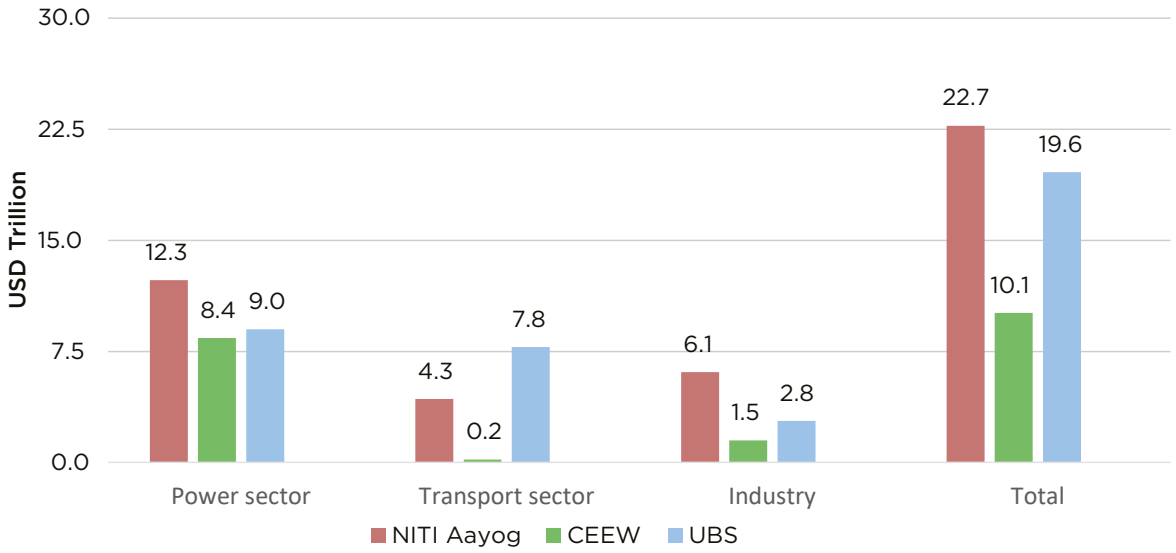


Figure 4.1: Sector-wise estimates of cumulative investment requirements for Net Zero across various studies

Note: *UBS estimates include Power–Renewable CAPEX for utilities, Solar PV Manufacturing, Storage CAPEX from utilities, Transmission CAPEX, overheads; Transport – EV battery CAPEX from OEMs, EV battery manufacturing, overheads; Industry – Storage battery manufacturing, Associated equipment and systems, Green hydrogen, Electrolysers manufacturing, overheads.*

Caveat: The study estimates India's investment needs and projected capital availability across three key mitigation sectors, power, transport, and industry. The estimates presented are indicative in nature and are contingent on underlying assumptions and specific modelling choices, including technology pathways, policy trajectories, and cost parameters. The results should be interpreted as directional rather than definitive. Other mitigation-relevant sectors, including buildings, waste, etc., are not included in the current investment estimation but are included for energy and emission estimation. These sectors will be analysed and incorporated in subsequent iterations of the study. The limitations of the study are further elaborated in the methodology section (See section 3.1).

4.1.2 Estimates of Incremental Investment Requirements

Net Zero requires USD 8.1 trillion more than current policy trajectory through 2070: India's energy transition has been modelled under two scenarios, the Current Policy Scenario and the Net Zero Scenario. Under Current Policy Scenario, assuming continuation of existing policies and slower uptake of new clean technologies compared to Net Zero Scenario, total investment needs are estimated at around USD 14.7 trillion. The Net Zero Scenario requires approximately USD 22.7 trillion, underscoring the additional financing requirement of about USD 8.1 trillion needed to achieve Net Zero emissions by 2070. This incremental capital reflects the cost of accelerated low-carbon technology deployment, policy interventions, and system-level investments essential for aligning with the Net Zero pathway.

At a sectoral level, the power sector dominates investment needs in both Current Policy and Net Zero Scenarios, reflecting the centrality of renewables, transmission, and storage to low-carbon transition.

The power sector accounts for the largest share of the incremental investment demand (about USD 4.5 trillion), followed by industry (USD 2.7 trillion), and transport (USD 0.9 trillion), *(as shown in Figure 4.2).* This pattern indicates that while enabling low-carbon transition in heavy industry and transport remains challenging, the bulk of India's additional financing challenge lies in front-loading power sector transformation, which will, in turn, enable low-carbon transition in other sectors through electrification.

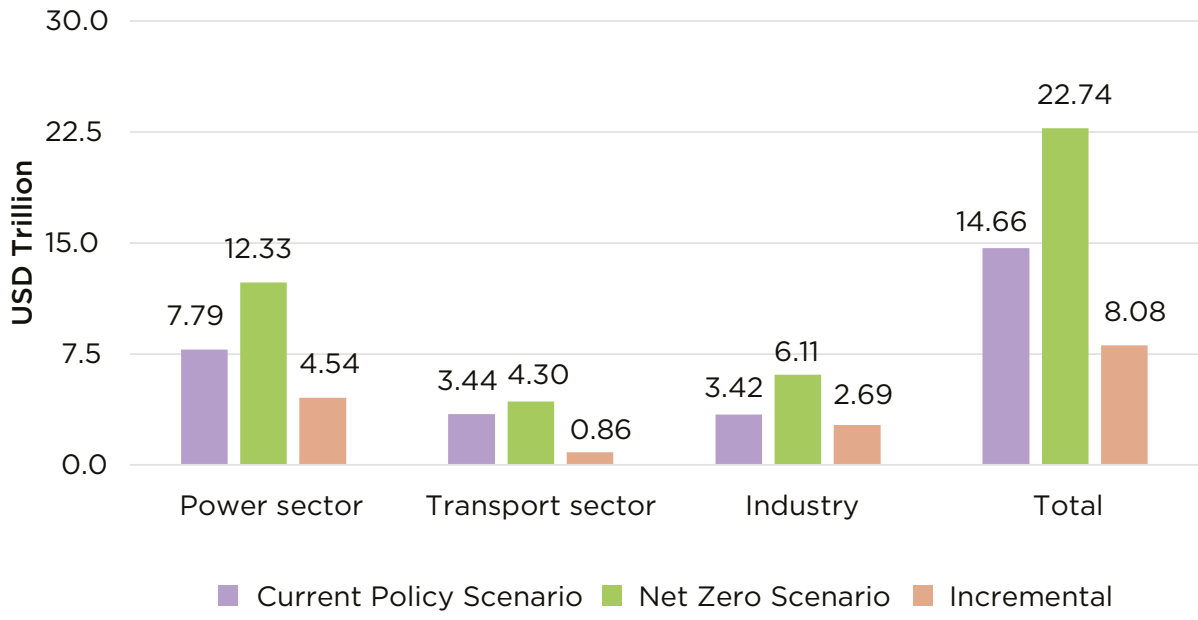


Figure 4.2: Sector-wise estimates of cumulative and incremental investment requirements for Net Zero

Over the course of India's Net Zero transition, investment requirements rise sharply, reflecting both the scale and urgency of low-carbon transition. In the near to medium term (2026-2050), Current Policy Scenario calls for USD 5.8 trillion in investments, while the Net Zero pathway demands USD 8.1 trillion *(Table 4.1)*, reflecting an incremental gap of USD 2.3 trillion, about USD 90 billion annually, equivalent to about 2-2.5% of India's GDP in 2025. These early years are the most challenging, as investments must be front-loaded in renewable capacity, grid expansion, and industrial decarbonisation technologies.

Table 4.1: Total investment requirement (USD trillion)

	Current Policy Scenario	Net Zero Scenario
Medium Term (2026-2050)	5.80	8.05
Long Term (2050-2070)	8.86	14.69
Total (2026-2070)	**14.66**	**22.74**

Over the long-term horizon (2050–2070), Current Policy Scenario investments total USD 8.9 trillion, compared with USD 14.7 trillion under Net Zero Scenario *(Table 4.1)*. The incremental gap widens to USD 5.8 trillion, with incremental annual needs climbing to around USD 290 billion during 2050-70. Although the absolute financing requirement peaks in this period, its

share of GDP becomes more manageable as India's economy expands. The near term remains the harder test, given the urgency of accelerating clean energy and enabling infrastructure.

After 2050, the Net Zero pathway shifts from scaling proven technologies to deploying risk-heavy technologies. Green hydrogen becomes central for hard-to-abate sectors, while CCUS and DAC, negligible before 2050, scale up. Although investments in renewables and T&D continue, their relative share declines as frontier technologies absorb a larger portion of capital, explaining the higher long-term investment requirement.

4.1.3 Technology-wise Investment Requirements

Up to 2050, India's Net Zero Scenario (NZS) remains anchored in electrification and transmission network build-out. The largest incremental differences with Current Policy Scenario arise from higher investments in transport electrification, grid storage, and enabling infrastructure, reflecting the need to scale charging networks and system flexibility earlier. By contrast, investment in frontier solutions such as green hydrogen, Carbon Capture, Utilisation, and Storage (CCUS), Direct Air Capture (DAC), offshore wind, and nuclear remains limited in Net Zero Scenario, underscoring that the near-term transition is driven primarily by scaling proven technologies *(Figure 4.3).*

By 2070, the Net Zero Scenario investment profile diverges sharply from Current Policy Scenario, marking a structural shift towards enabling low-carbon solutions. Green hydrogen (including renewable capacity dedicated to electrolysers) emerges as a core pillar of the Net Zero pathway, absorbing a materially larger share of capital than under Current Policy Scenario and signalling its central role in promoting low-carbon transition in steel, refining, fertilisers, and long-distance transport. Carbon Capture, Utilisation, and Storage (CCUS) and Direct Air Capture (DAC), negligible before 2050, scale meaningfully only in the later decades, highlighting their role as backstop solutions for residual emissions rather than early levers. While investments in mature renewables and Transmission and Distribution (T&D) networks continue, their relative share declines as the transition increasingly depends on technology and risk-heavy solutions, underscoring why post-2050 financing challenges are fundamentally different from those of the near term *(Figure 4.4).*

The financing profile of these technologies mirrors their current Technology Readiness Level (TRL) and risk-return dynamics. Mature renewables and Transmission and Distribution (T&D) infrastructure, being high TRL and commercially proven, can access debt through green bonds, infrastructure bonds, and bank lending. In contrast, low TRL solutions such as grid-scale storage, hydrogen electrolysers, and CCUS face higher perceived risks, requiring blended finance, concessional loans, strategic equity, and risk-sharing mechanisms to attract investment.

The sharp escalation in total investment in the Net Zero Scenario between 2050 and 2070 highlights the need for institutional mechanisms that can absorb technological and market risks while maintaining cost efficiency. Ultimately, India's Net Zero challenge is not just about scaling mature renewables, it is about unlocking finance for next generation, high-impact technologies. Achieving this will require a dual finance strategy:

- Deploying low-cost debt for mature, bankable segments; and
- Using equity, venture, and blended finance instruments to de-risk and scale emerging technologies.

Mobilising both domestic and international capital will be essential to bridge the financing gap and ensure timely deployment of transformative low-carbon technologies.

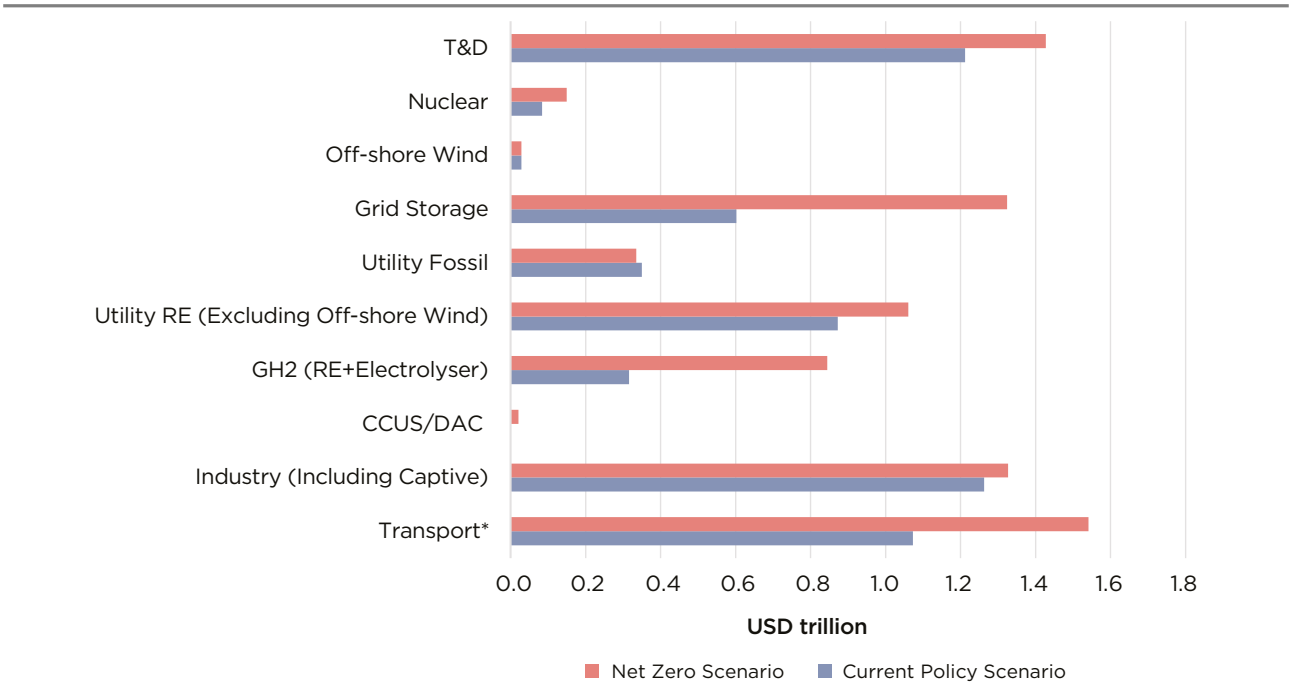


Figure 4.3: Technology-wise split of Cumulative Total Investment required till 2050

** Transport CAPEX includes Charging Infrastructure, OEM investment and Battery. Industry CAPEX includes investment by OEMs.*

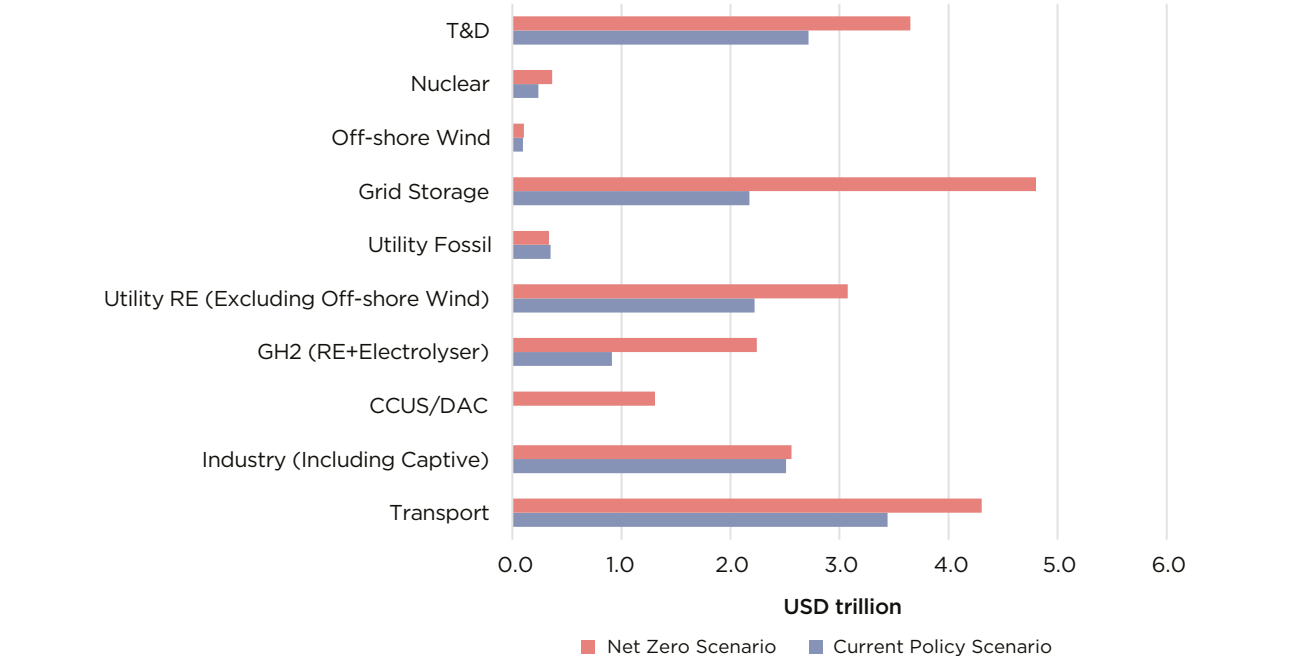


Figure 4.4: Technology-wise split of Cumulative Total Investment required till 2070

4.2 AGGREGATE FLOWS ANALYSIS

The previous sections estimated that India needs USD 22.7 trillion of investment for Net Zero pathway by 2070. It also estimated that there is an incremental finance need of USD 8.1 Trillion over the Current Policy Scenario. This section looks at the availability of finance from both domestic and international sources.

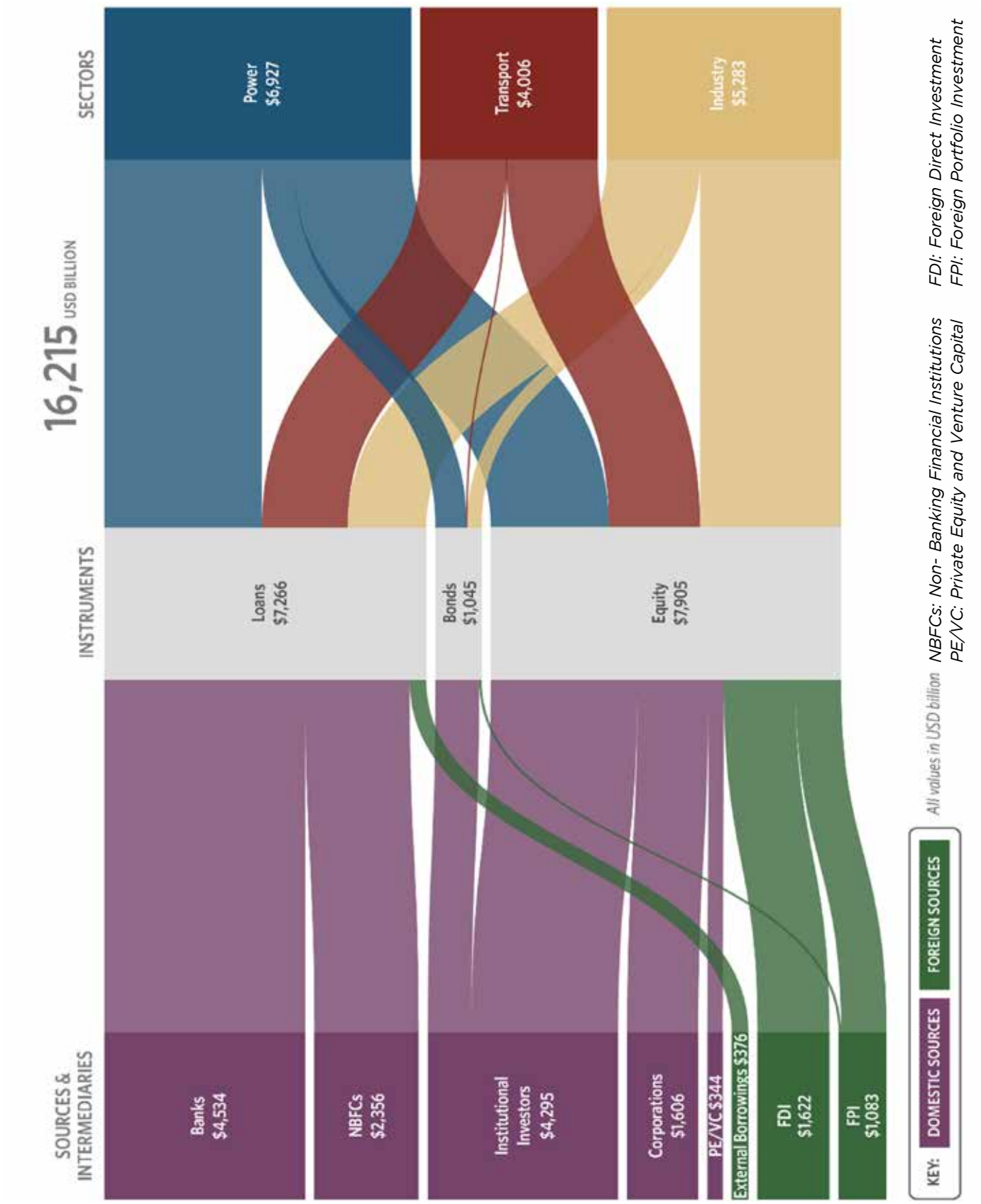


Figure 4.5: Projections of the sources and end use of finance supply for Net Zero (2026-70, USD billion)

With coordinated reforms across domestic and external fronts, this study estimates that India can credibly mobilise around USD 16.2 trillion towards its Net Zero transition by structurally expanding the scale, depth, and efficiency of capital. Domestically, this requires deepening the corporate bond market from ~16% of GDP in 2023 to ~30% by 2070, increasing the financialisation of household savings from about 60% in 2023 to 75% by 2070, and enabling institutional funds such as pensions, Employee Provident Fund (EPF), and insurance to reduce their exposure to government securities from 55–60% to around 50% by 2070 while protecting investor returns through diversified, high-quality corporate and green assets. Externally, scaling Foreign Direct Investment (FDI) to 3–4% of GDP and tripling Foreign Portfolio Investment (FPI) participation by 2047, supported by credible transition roadmaps, a strong pipeline of bankable projects, and deeper financial markets will anchor sustained foreign capital inflows, together enabling the mobilisation of USD 16.2 trillion by 2070 for India's Net Zero pathway.

The total capital available for technologies across the power, transport, and industry sectors to achieve India's Net Zero target is estimated at USD 5.5 trillion during 2026-50 and USD 10.7 trillion during 2050-70. The allocation of available capital from various sources and financial intermediaries to the power, transport, and industry sectors through different financing instruments is presented in *Figure 4.5* and discussed in detail in the subsequent section.

4.2.1 Instruments and Overall Sectoral Allocations

Loans are projected to remain the primary financial instrument, followed by public equity. Loans from banks, Non-Banking Financial Companies (NBFCs), and external borrowings together account for approximately 45% of total capital available. Public equity led by institutional investors and foreign portfolio investors, contributes around 37%, while private equity financing through Foreign Direct Investment (FDI) and Private equity/Venture Capital (PE/VC) makes up nearly 12%, adding to a total equity of 49%. Corporate bond financing remains the smallest contributor at around 6%.

In terms of overall sectoral allocation, the power sector is expected to receive about 43% of aggregate capital available for technologies aimed at achieving Net Zero, followed by industry at 32% and transport at 25%. Given its higher investment requirements, the power sector will remain the primary recipient of Net Zero capital. Renewable electricity and associated technologies such as energy storage and transmission infrastructure have already reached commercialisation. Consequently, they are likely to attract a larger share of capital inflows in the near to medium term.

Capital flows to transport sector technologies are expected to accelerate over the next decade, as several segments, particularly electric two-wheelers cars, and short-range trucks, approach commercial readiness. In contrast, commercialisation of Carbon Capture, Utilisation, and Storage (CCUS), Direct Air Capture (DAC) and other clean technologies in the industrial sector will take longer, and the majority of capital mobilisation is expected between 2050-70.

Debt Capital

Banks and Non-Banking Financial Companies (NBFCs) will continue to dominate debt financing for low-carbon transition technologies, though capital market reforms could unlock significant new flows through bonds. Over the period FY2026-70, commercial banks (USD 4.5 trillion) and NBFCs (USD 2.4 trillion) are expected to remain the two largest providers of debt

capital for Net Zero aligned investments. Commercial banks are projected to account for ~55% of total debt financing, followed by NBFCs (28%), and institutional investors (12%), including pension funds, insurance companies, and mutual funds. This mirrors the current structure of India's debt market, dominated by banks and NBFCs (81%).

However, financial sector reforms could enable companies in the low-carbon transition sectors to raise a larger share of debt directly from capital markets, particularly through green and infrastructure bond issuances. As institutional investors gradually allocate a higher portion of their portfolios to fixed-income securities, the availability of long-term debt for green technologies is expected to expand substantially.

Equity Capital

Institutional investors are expected to be the largest source of equity capital, providing around 42% of total equity financing, followed by Foreign Direct Investment (FDI) at 21% and corporate balance-sheet financing at 20%, while Foreign Portfolio Investment (FPI) and Private Equity/Venture Capital (PE/VC) funding contribute relatively smaller shares, at approximately 13% and 4%, respectively. As institutional investors' AUM expands, driven by higher domestic savings being channelled through capital markets, they are expected to become the dominant suppliers of equity capital. The long-term liability profile of pension funds and insurance companies aligns well with the long-duration investment needs of Net Zero technologies. However, higher allocations from these institutional actors need to be undertaken with due consideration to the protection of pensioners' and policyholders' interests, including fiduciary responsibilities, risk–return expectations, and prudent asset allocation norms.

These investors are expected to participate primarily through public equity markets, given their preference for liquidity and lower exposure to private placements. By reorienting their portfolios towards low-carbon sectors, institutional investors can also hedge climate-related transition risks while supporting India's Net Zero goals.

4.2.2 Sectoral Analysis

Power

Domestic sources hold the majority share of capital supply in the power sector. Around 86% of the finance available for the power sector is expected to come from domestic sources, with banks and Non-Banking Financial Companies (NBFCs) expected to contribute nearly half, followed by equity flows from institutional investors and corporations. Among international sources, Foreign Direct Investment (FDI) is expected to play the most significant role, accounting for about 53% of total foreign finance, followed by Foreign Portfolio Investment (FPI) (33%), and the remaining coming from external borrowings (14%).

Bank and NBFCs dominate power sector financing. Debt capital for the power sector is heavily reliant on banks and NBFCs, which together contributed 74% of total debt financing in FY2023. Historically (FY2019-23), banks have allocated on average around 5% of their total credit portfolios to the power sector, while NBFCs have maintained a significantly larger exposure, around 27–30% of their overall lending. Key public sector NBFCs, including the Power Finance Corporation (PFC), Rural Electrification Corporation (REC), and the Indian Renewable Energy Development Agency (IREDA), remain the largest institutional lenders to the power sector.

As the energy sector becomes increasingly electrified, credit flows to non-electric energy segments (such as oil and gas, and thermal heat) are expected to decline, allowing a larger share of debt capital to shift toward the power sector. Consequently, the share of bank credit directed to the power sector is projected to rise gradually from the current average of 5% of total credit outstanding to 8% in 2050 and 9% in 2070.

Corporate bonds and External Commercial Borrowings (ECBs) can play a larger role in financing the power sector. As India's capital markets deepen and mature, a greater range of bond financing (rising from INR 769 billion in FY2023 to 23 trillion by 2070) is expected to be channelled toward the power sector.

Institutional equity is poised to expand in line with the sector's growing representation in benchmark indices such as NIFTY50. Among the equity sources in the power sector, institutional equity currently contributes the maximum (37%) and is expected to expand over time. In 2023, institutional equity investment in the power sector totalled INR 152 billion.

The total institutional equity AUM is allocated across low-carbon transition sectors using their relative weights in the NIFTY50 as a proxy. The power companies' share in NIFTY50 ranges between 2-2.3% of total market capitalisation over FY2019-23, and assuming the share gradually rises to 5% by 2070, driven by the ongoing electrification of the energy system and benchmarking with countries that have more advanced electrification, investors could unlock upto INR 49.8 trillion by 2070. (For context, the utilities sector accounts for approximately 4.8% of the Shanghai Composite Index in China[51] and around 4.3% to 4.8% of the S&P/TSX Composite Index in Canada[52]). Investments in renewable energy is also expected to increase steadily as renewable energy's share in the energy mix expands.

Corporate equity contributions to the power sector remain low but are set to grow significantly. Corporate equity investment in the power sector has averaged at 3% (FY2017-23) of the total financial savings of non-financial corporations. This share is projected to increase to around 5% by 2070, reflecting stronger participation by domestic firms in renewable and clean power generation.

Foreign Direct Investment (FDI) inflows to the power sector are projected to increase gradually. Currently, FDI inflows to the overall energy sector constitute about 5% (INR 173 billion in 2023) of total FDI, of which around 51% is directed toward non-conventional energy sources. As global investors continue to expand their allocations to clean energy, FDI inflows to the power sector are expected to rise to around 6% of total FDI flows by 2070, keeping in consideration that banks and public sector NBFCs will be the major source of finance for the sector (as observed in other countries, like China, where there is domestic capital dominance in power sector and FDI flows in power sector are around 3-4% of total FDI flows[53]).

Private Equity and Venture Capital (PE/VC) funding in the energy sector is expected to grow steadily. Historically, PE/VC investment activity in the energy sector has been expanding, particularly in clean tech and emerging renewable energy solutions, reflecting growing investor interest in innovation and new technologies. In FY2022-23, PE/VC investments in mitigation sectors was around USD 868 million. As this channel plays a crucial role in financing early-stage, tech-driven solutions, initial investments are expected to remain concentrated in the power sector (around 50% of total PE/VC investments in mitigation sectors). Over time, however, PE/VC funding is likely to diversify toward other emerging green technologies, such as Direct Air Capture (DAC) and other carbon-removal solutions, as these areas mature and scale.

Transport

Similar to the power sector, domestic sources are expected to provide the majority of capital in the transport sector. Around 76% of total financing is projected to come from domestic sources during FY2026-70, with banks and Non-Banking Financial Companies (NBFCs) accounting for the largest share. On the international side, Foreign Direct Investment (FDI) is expected to be the primary source of capital.

Banks and Non-Banking Financial Companies (NBFCs) dominate debt financing for transport, while corporate bonds and external commercial borrowings (ECBs) represent untapped potential. Banks and NBFCs together are expected to contribute over 95% of total debt capital in the transport sector during FY2026-70. Historically (FY2019-23), an average of around 6% of total bank credit was directed toward the sector (including both manufacturing and services). This share is expected to increase to 8% by 2070 with the expansion of transport-related lending.

Historically (FY2019-23), NBFCs had an exposure of around 15% of their total credit in the transport sector, a share projected to increase gradually to 17% by 2070, resulting in capital availability of INR 20.2 trillion.

Corporate bond represents an untapped potential and are expected to expand to mobilise around INR 271 billion by 2070 (from INR 16 billion in 2023) and external borrowings expected to unlock INR 3.4 trillion by 2070 (from INR 74 billion in 2023).

Given that clean transportation technologies have higher upfront capital requirements compared to Internal Combustion Engine (ICE) vehicles, they will require a larger share of debt financing. However, because the operating cost of EVs are lower, banks and NBFCs are expected to be more comfortable extending larger loans per vehicle provided the issues with electrical vehicle ecosystem are addressed, leading to higher allocation of debt capital to the transport sector over time.

Institutional investors lead equity financing in the transport sector, while Foreign Direct Investment (FDI) emerges as a growing secondary source. As of 2023, institutional equity investment in transport sector stood at INR 224 billion. The total institutional equity AUM is allocated across low-carbon transition sectors using their relative weights in the NIFTY50 as a proxy. Based on transportation companies' share in NIFTY50, which is on average 5.3% of total market capitalisation during FY2019-23 and assuming it remains stable, investors could deploy upto INR 52.8 trillion by 2070.

After institutional equity, FDI will be the second most important source of equity capital for the transportation sector. FDI inflows are projected to rise from INR 198 billion in 2023 to INR 18.5 trillion by 2070, in line with broader growth in FDI equity flows.

Industry

Industry sector financing remains largely domestic, while Foreign Direct Investment (FDI) anchors international capital inflows. The industry sector is also expected to raise the majority of finance through domestic sources (77%), with banks and Non-Banking Financial Companies (NBFCs) providing 39% of the domestic funds, complemented by significant contributions from institutional investor equity. Among international sources, FDI is anticipated to be the dominant channel, accounting for roughly half of all international finance mobilised for the sector.

Banks and Non-Banking Financial Companies (NBFCs) lead industrial debt financing. Banks and NBFCs accounted for about 80% of total debt flows to the sector in FY2023. Their combined share is projected to decline to 74% by 2070, as other financing sources expand.

Corporate bond issuances in the sector currently make up only 1.7% of total corporate bond issuance but are expected to rise modestly to about 2% by 2070, unlocking an estimated INR 11.6 trillion in additional capital. External borrowings, currently (FY2023) at INR 0.1 trillion are expected to increase to approximately INR 6.3 trillion in 2070, accounting for nearly 10% of the total debt capital over the 2026-70 period.

Institutional investors will anchor equity financing in the industry sector, supported by corporates, Foreign Direct Investment (FDI) and Private Equity/Venture Capital (PE/VC). As of 2023, institutional equity investment in the industry sector stood at INR 672 billion. The total institutional equity AUM is allocated across low-carbon transition sectors using their relative weights in the NIFTY50 as a proxy. Based on industry's share in NIFTY50, which on average stood at 6.2% of total market capitalisation in 2023, and assuming it remains stable, institutional investors could deploy upto INR 62.7 trillion by 2070.

Corporate equity is expected to be the second largest equity source in the industry sector with exposure of average 3% of total investment by corporations. It is expected to grow to 5.5% until 2047 before declining as India transitions to developed economy status. FDI inflows are also expected to increase from INR 226 billion in FY2023 to INR 21 trillion by 2070.

PE/VC funding are projected to gain traction, increasing their share from 25% of total PE/VC flows toward enabling the low-carbon transition across sectors in 2023 to about 45% by 2070, reflecting growing investor appetite and industrial innovation and green manufacturing.

Table 4.1 summarises the split between domestic and foreign sources across the three low-carbon transition sectors, Power, Transport, and Industry, highlighting the dominant sources of finance and financial instruments deployed.

Table 4.2: Composition of Aggregate flows across Power, Transport, and Industry Sectors

Sector	Sectoral Allocation (USD Trillion)	Domestic vs Foreign	Dominant source of Finance	Instruments
Power	$6.93 tn	~86% Domestic; $5,980 bn ~14% Foreign; $946 bn	Domestic: Banks and NBFCs (58%); $3,462 bn Foreign: FDI (53%); $502 bn	Loans (51%); $3,557 bn Equity (39%); $2,664 bn Bond (10%); $706 bn
Transport	$4.01 tn	~76% Domestic; $3,061 bn ~24% Foreign; $945 bn	Domestic: Banks and NBFCs (60%); $1,839 bn Foreign: (55%) FDI; $523 bn	Equity (51%); $2,059 bn Loans (48%); $1,938 bn Bonds (0.2%); $9 bn

Industry	$5.28 tn	~77% Domestic; $4,093 bn ~23% Foreign; $1,190 bn	Domestic: Banks and NBFCs (39%); $1,589 bn followed by Institutional Investors (38%); $1,575 bn Foreign: FDI (50%); $597 bn	Equity (60%); $3,182 bn Loans (34%); $1,771 bn Bonds (6%); $329 bn
Total	**16.22 tn**			

4.3 ASSESSING INDIA'S NET ZERO FINANCING GAP

4.3.1 Total Financing Gap

The Net Zero Scenario (NZS) reveals a USD 6.5 trillion financing gap; international sources could account for 42%[xi] of total capital needs by 2070 if the gap is bridged externally. India's pathway to Net Zero by 2070, as per this study, requires unprecedented levels of capital mobilisation, and the analysis shows that while reforms ease pressure, a sizeable financing gap persists throughout. The overall financing gap is estimated at USD 6.5 trillion by 2070 with the power sector accounting for the majority share of the financing gap (~82%), followed by Industry (~13%), and Transport (~5%).

By 2050, the financing gap is estimated at USD 2.5 trillion or USD 100 billion per year. The power sector remains the primary driver of this gap (~USD 80 billion per year), accounting for the bulk of unmet investment requirements in renewable energy, transmission, and storage infrastructure. Industry and transport sectors also contribute to the financing gap as they enter more capital-intensive phases of low-carbon transition.

By 2070, the overall financing gap expands to USD 6.5 trillion or USD 145 billion per year of additional investment needed *(Figure 4.6),* with total financing needs rising to USD 22.7 trillion against USD 16.2 trillion in available flows. Power sector financing gap rises from USD ~80 billion to 120 billion per year. The escalation reflects the intensification of low-carbon transition efforts across all sectors, led by the power sector's transition toward full renewable integration and large-scale storage. Industry faces growing costs from advanced technologies such as Carbon Capture, Utilisation, and Storage (CCUS) and green hydrogen, while transport's financing demand increases with the full rollout of EVs, clean freight, and sustainable fuels. The scale of this gap highlights the need to mobilise additional large-scale domestic and foreign investment through innovative instruments and deeper capital market participation to sustain India's Net Zero transition.

xi 42% is calculated by dividing the financing gap (USD 6.5 trillion) and the expected capital available from international sources during 2026-70 (USD 3.1 trillion) by the total capital requirement (USD 22.7 trillion).

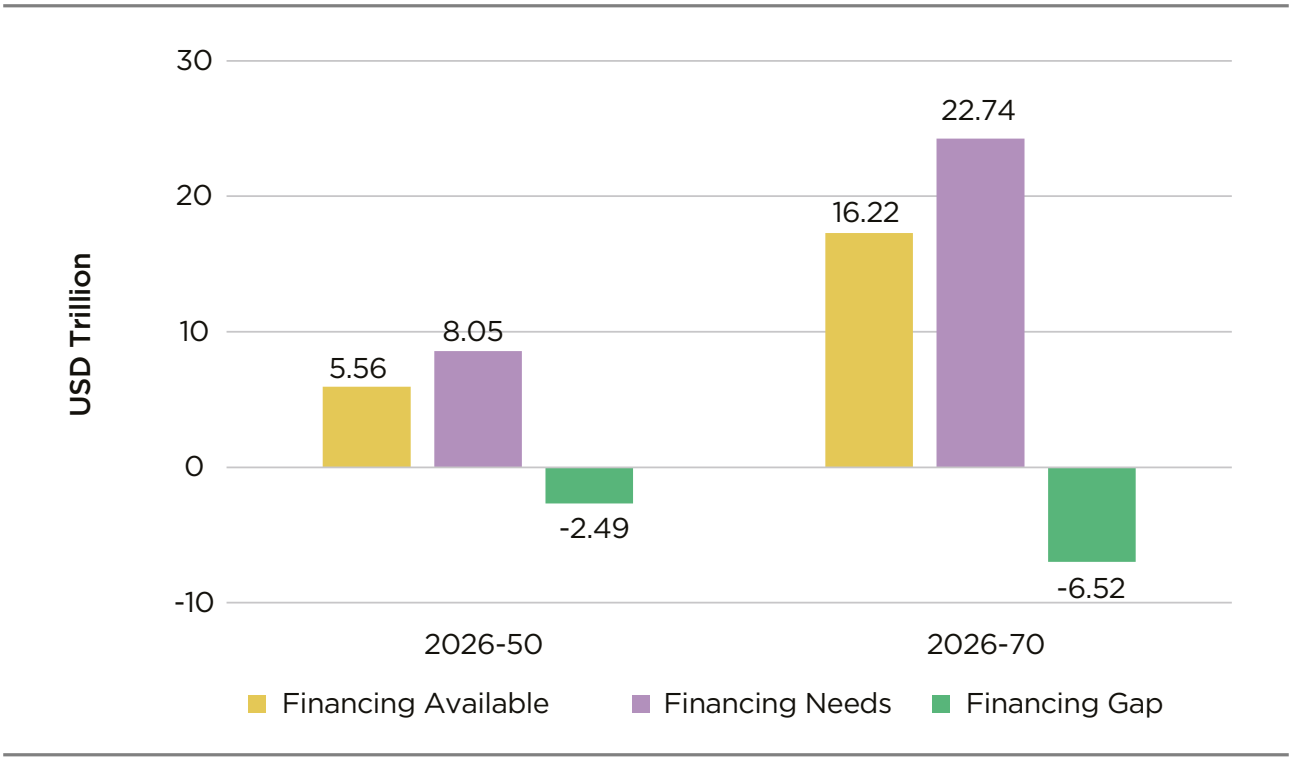


Figure 4.6: Projections of total needs, availability and gap (USD trillion)

International climate finance will be crucial in bridging the financing gap for Net Zero. Against the investment need of USD 22.7 trillion for the Net Zero Scenario and estimated aggregate flows of USD 16.2 trillion, a financing gap emerges at USD 6.5 trillion, even with enabling measures on both the domestic and foreign fronts. Given that domestic finance remains scarce and that higher demand for domestic finance can crowd out investment and raise interest rates, thereby impacting economic growth, this financing gap is expected to be bridged by external sources, which raises the contribution of international sources to 42% of total capital needs by 2070, compared to 17% of flows from international sources in FY2020–22[9]. Foreign capital therefore has a crucial role to play in India's Net Zero transition, especially in the form of concessional capital and grants to support technologies which are needed for Net Zero but remain commercially unviable.

4.3.2 Sectoral Analysis

Power

The clean power sector has already moved from an early-stage industry to a mainstream component of the electricity system and has largely become commercially viable. Public capital support is now limited and primarily needed in specific segments of the sector such as long-duration storage and newer sources of renewable energy such as geothermal, ocean tidal, etc. However, commercially viable renewable energy and its enabling technologies such as transmission and energy storage require large-scale, long-term, and low-risk capital, as these are highly capital-intensive businesses with long asset lives. Ensuring access to affordable, long-term debt is essential for maintaining competitive tariffs and providing clean energy to all.

The analysis reveals a significant and widening financing gap in India's power sector as the country advances toward its net zero 2070 target. By 2050, financing needs for mitigation in the power

sector are estimated at USD 4.32 trillion, while available finance is projected at USD 2.34 trillion, resulting in a funding shortfall of USD 1.98 trillion. This gap more than doubles by 2070, reaching USD 5.4 trillion, as financing requirements rise sharply to USD 12.33 trillion against an availability of USD 6.93 trillion *(Figure 4.7)*. The expansion of this gap underscores both the scale of investment required for the low-carbon transition and the structural challenges in mobilising long-term, low-cost capital for renewable energy, grid modernisation, and storage technologies.

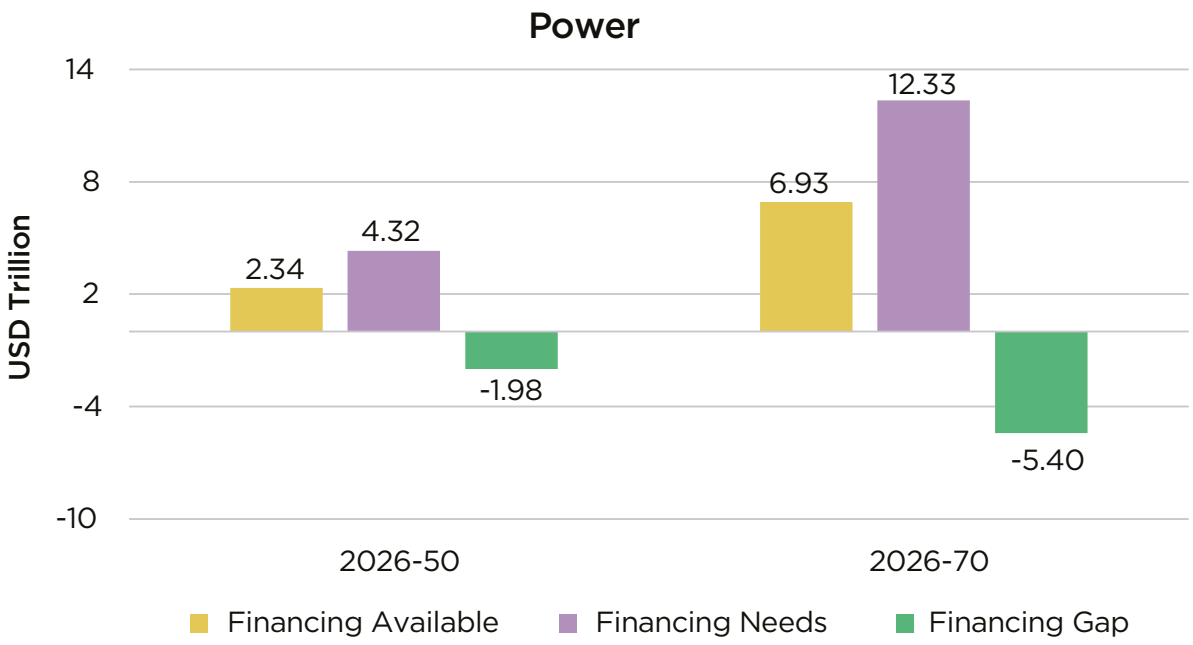


Figure 4.7: Power sector: Projections of total needs, availability and gap (USD trillion)

This substantial and growing gap highlights the sector's heavy dependence on banks and Non-Banking Financial Companies (NBFCs) for debt financing, which are likely to face their own capital and exposure constraints over time. To meet its long-term financing needs, the power sector will need to diversify funding sources and increasingly tap bond markets and other capital market instruments to secure scalable, long-term debt capital. In addition, mobilising external sources of patient capital such as global sovereign wealth funds, pension funds, and other long-term institutional investors will also be critical to bridge the financing gap.

Transport

While EVs are becoming increasingly commercially viable, hydrogen based vehicles and blended/low-carbon fuels vehicles (Flex fuel vehicles, range extended vehicles, etc.) are still in an early stage of development. EVs involve higher upfront costs compared to fossil-fuel vehicles but offer lower fuel and maintenance costs over their operational life (however, true cost competitiveness depends on accounting for battery degradation, replacement, and end-of-life recycling and disposal). Beyond vehicle purchases, capital investment is required for fuelling infrastructure (charging, LNG/Ethanol dispensing stations, etc.), establishing EV and battery manufacturing plants, and supply chain development. Establishing such infrastructure demands large-scale, upfront capital, and many of these components, particularly charging networks and standalone EV manufacturing units, are not yet commercially viable without policy or financial

support. Clean transportation technologies therefore require substantial investment to achieve cost competitiveness, supported by financing mechanisms across the supply chain, including technology development, fuelling/charging infrastructure, etc.

The transport sector shows a comparatively modest financing gap relative to other sectors, but its magnitude and implications are still significant given the sector's projected rapid growth trajectory. By 2050, mitigation finance needs are projected at USD 1.54 trillion, against USD 1.32 trillion in available financing, implying a shortfall of USD 0.22 trillion. This gap widens slightly by 2070, reaching USD 0.29 trillion, with financing needs increasing nearly threefold to USD 4.3 trillion, while available capital grows to USD 4.01 trillion *(Figure 4.8).* Although the proportional gap narrows with time, the absolute financing requirements for low-carbon transition in India's transport system expands, reflecting the scale-up required in electric mobility, biofuels, hydrogen infrastructure, and electrification.

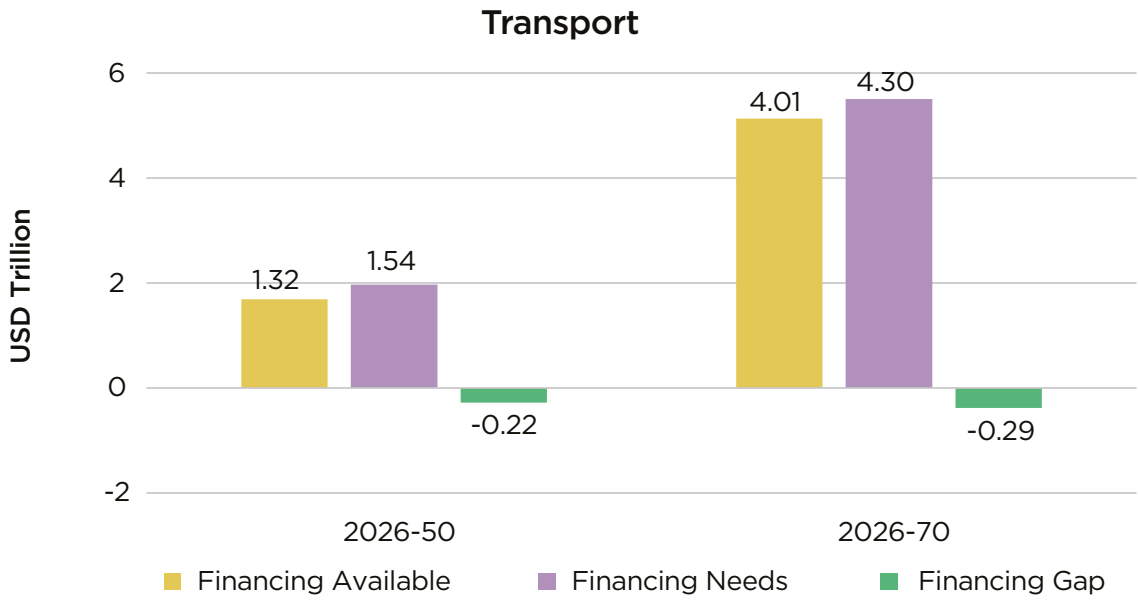


Figure 4.8: Transport sector: Projections of total needs, availability and gap (USD trillion)

Industry

The asset-heavy hard-to-abate industries such as iron, steel, cement, etc., have high sunk costs in existing facilities and operate on long investment cycles, often extending up to 30 years. The transition to enable low-carbon transition in these sectors involves significant capital requirements to retrofit or replace existing plants improving energy efficiency or promote electrification, and promote the use of green hydrogen where electrification is not possible. Achieving this transformation will require large-scale investments in both capital expenditure for infrastructure upgrades and Research and Development (R&D), for emerging technologies like Carbon Capture, Utilisation, and Storage (CCUS), Direct Air Capture (DAC), etc.

The industrial sector exhibits a growing financing shortfall as the low-carbon transition intensifies. By 2050, financing requirements are estimated at USD 2.19 trillion, compared with USD 1.9 trillion in available finance, implying a financing gap of USD 0.29 trillion. However, by 2070, financing needs rise sharply to USD 6.11 trillion, while available capital reaches USD 5.28 trillion, widening

the gap to USD 0.83 trillion *(Figure 4.9).* This increasing shortfall reflects the mounting costs of transitioning India's hard-to-abate industries such as steel, cement, chemicals, etc., toward low-carbon technologies like green hydrogen, Carbon Capture, Utilisation and Storage (CCUS), Direct Air Capture (DAC) and electrified industrial processes.

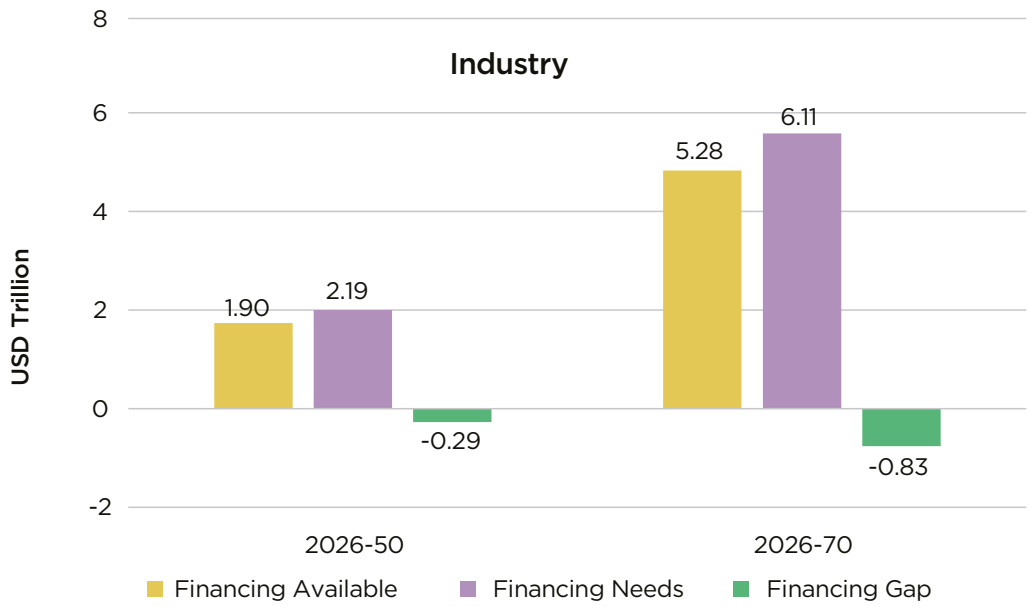


Figure 4.9: Industrial sector: Projections of total needs, availability and gap (USD trillion)

The key challenges in mobilising both domestic and international finance, along with actionable suggestions to bridge the gap and accelerate India's Net Zero transition are discussed in detail in the next chapter.

5

CHALLENGES & POLICY SUGGESTIONS TO BRIDGE THE FINANCING GAP

Challenges and Policy Suggestions to Bridge the Financing Gap

5

5.1 STRENGTHEN DATA TRANSPARENCY AND REPORTING TO BUILD A CREDIBLE CLIMATE FINANCE ECOSYSTEM

Tracking finance flows for climate action, establishing emissions baselines, and capturing life-cycle impacts continue to depend on transparent, accurate, and verifiable financial and emissions data.

On the corporate side, SEBI has strengthened disclosure requirements through the Business Responsibility and Sustainability Reporting (BRSR) framework[54], now mandated for the top 1,000 listed companies. The framework requires reporting across nine Environmental, Social and Governance (ESG) dimensions, including emissions, energy use, circularity, and diversity. The introduction of BRSR Core, which mandates third-party assurance for about 150 companies in FY2023–24 (expanding to all 1,000 by FY2026–27), enhances data credibility.

Similarly, the Carbon Credit Trading Scheme (CCTS) represents a major advance in institutionalising emissions transparency. The scheme establishes a domestic compliance carbon market across four emission-intensive sectors: Aluminium, Cement, Chlor-Alkali, and Pulp & Paper, using FY2023–24 data to set baselines. It relies on robust Monitoring, Reporting, and Verification (MRV) system, overseen by Accredited Carbon Verification Agencies (ACVAs), to ensure independent third-party validation[55].

Complementing these measures, India is advancing a Climate Finance Taxonomy[56] as a 'living framework' to guide capital flows toward mitigation and adaptation. Its tiered structure maps economic activities across power, mobility, buildings, agriculture, food and water security, and hard-to-abate industries. By setting clear criteria and transition thresholds, the taxonomy aims to reduce greenwashing and direct finance towards verifiable, sustainable investments.

Together, these initiatives signal important progress. A unified and verifiable data backbone is essential to strengthen transparency and improve investor confidence. However, analytical reviews reveal inconsistencies in reporting quality, particularly in areas such as water and energy use, underscoring the need for consistency within national frameworks and rigorous verification[57].

Key suggestions:

i. **Establish a unified national climate finance data platform** that tracks SEBI BRSR disclosures, CCTS registry entries, and public & private flows for climate action. This will enable coherent tracking, facilitate cross-verification, and close persistent information gaps.

ii. **Mandate independent third-party assurance at scale** by expanding the BRSR Core

verification framework, enforcing high-quality Monitoring, Reporting, and Verification (MRV) protocols under the CCTS, and encouraging external audits for Climate Finance Taxonomy compliance.

iii. **Develop a robust sectoral life cycle analysis (LCA) repository** to establish science-based emission baselines for key industries, support taxonomy thresholds, and reinforce CCTS reporting credibility.

By closing these data and disclosure gaps, India can build transparent and credible climate finance architecture, one that attracts larger pools of green capital, and supports evidence-based policymaking for a resilient and finance-driven transition. The proposed climate finance data platform should be anchored by DEA, supported by an inter-ministerial working group comprising relevant line ministries and NITI Aayog to ensure methodological rigour, enable cross-agency coordination, and provide timely updates.

5.2 ENSURE REGULATORY COHERENCE ACROSS FINANCIAL SECTOR INSTITUTIONS TO CHANNEL CLIMATE FINANCE EFFICIENTLY AND AT SCALE

While India's Climate Finance Taxonomy is under development, achieving regulatory coherence across financial sector institutions is essential to channel climate finance efficiently and at speed to meet the 2070 Net Zero target.

India's financial sector is regulated by several autonomous bodies, each responsible for a specific domain of the financial market: the Reserve Bank of India (RBI), Securities and Exchange Board of India (SEBI), Insurance Regulatory and Development Authority of India (IRDAI), Pension Fund Regulatory and Development Authority (PFRDA), and International Financial Services Centres Authority (IFSCA).

All these institutions, in varying capacities, contribute to advancing finance for climate action. However, they have largely operated in silos, creating a fragmented and sometimes inefficient regulatory environment that poses systemic risks. A unified strategy would ensure consistency, provide clear signals to the market, and help mobilise the large volumes of capital required for India's transition to a low-carbon economy by 2070.

Currently, each regulator is addressing climate change from its own perspective, which creates several challenges in harnessing available finance from domestic and international sources. A lack of alignment can lead to regulatory arbitrage, where financial institutions choose to operate in sectors with less stringent climate norms, thereby undermining the overall effectiveness of the regulatory framework. This fragmentation also contributes to data and disclosure inconsistencies, for example, SEBI mandates ESG-related disclosures for listed entities and the RBI is developing guidelines for banks. The absence of harmonised data and reporting standards limits a system-wide assessment of climate-related risks and opportunities.

Fragmentation further extends to capital mobilisation. Domestic sources account for 81% of India's total climate finance flows expected during FY2026-70, with the balance coming from international sources. Further these domestic flows are heavily dominated by banks, NBFCs, together representing 52% of total domestic flows, while corporate bond market and institutional investors, account for 33%. Within institutional investors, domestic pension funds and insurance

companies contribute a minimal in domestic capital flows, at 0.9–1.2% and 2.5–3.1%, respectively, despite holding large asset bases that could be channelled toward climate-aligned investments.

As of 2025, the Life Insurance Corporation of India (LIC), reported AUM of INR 54.52 lakh crore[58] (USD 654 billion), while private insurers collectively hold an additional INR 14 lakh crore (USD 168 billion). The National Pension System (NPS) alone manages INR 13.98 lakh crore (USD 168 billion), with other pension funds, including those managed by mutual funds, adding INR 31,973 crore (USD 3.8 billion). Combined, insurance and pension funds represent an AUM of nearly USD 990 billion, which is expected to surpass USD 1 trillion in the coming years due to demographic and technological shifts, increased financial literacy, and the growing financialisation of household savings. Harnessing this vast pool of long-term capital can ease the burden on banks and NBFCs and accelerate India's Net Zero transition.

To ensure a coherent and effective climate finance ecosystem, Indian financial regulators must align around a shared vision for financing climate action.

Key suggestions:

i. **Manage Systemic Financial Risk:** Climate change poses a systemic risk across all financial sectors. A severe climate event such as floods or cyclones can affect banks' lending portfolios, reduce insurers' asset values, and erode listed companies' market capitalisation. A shared regulatory vision would enable data exchange, coordinated stress testing, and unified risk frameworks to prevent spillover effects and safeguard financial stability.

ii. **Enable Efficient Capital Mobilisation:** India requires trillions of dollars to meet its Net Zero targets. A coordinated regulatory environment would build investor confidence, reduce uncertainty, and prevent regulatory arbitrage. Joint action by regulators would also help create a seamless ecosystem for domestic and international investors to fund green projects.

iii. **Harmonise Data and Disclosure Standards:** While some regulators, such as SEBI, already mandate climate-related disclosures (for example, through BRSR reports), the quality and format of reporting vary significantly across sectors. A common vision among regulators would help establish consistent data and disclosure standards, improving the collection, evaluation, and comparison of climate risk exposure across financial institutions and companies. Such consistency is essential for policymakers to make informed decisions and for investors to accurately assess climate-related risks and opportunities.

    As a starting point, the draft Climate Finance Taxonomy prepared by the Department of Economic Affairs (DEA) may be adopted as the common reference framework, aligning rules, disclosures, and prudential treatment across all regulators such as RBI, SEBI, IRDAI, PFRDA, and IFSCA. However, given the taxonomy's evolving nature, its adoption should be gradual and phased, with appropriate transition timelines and periodic updates. This harmonised approach must also be aligned with the capacities of domestic players, particularly Micro, Small and Medium Enterprises (MSMEs), ensuring proportionality through phased compliance, simplified templates, and materiality-based reporting where appropriate.

iv. **Enable a Just Transition in the Indian Context:** A 'just transition' ensures that the shift to a low-carbon economy does not unfairly affect vulnerable communities or industries that are difficult to decarbonise. Regulators with a shared vision can collaborate to develop policies that support this shift, for example, by designing financing mechanisms for Small and Medium-sized Enterprises (SMEs) in high-emission sectors. Such measures would help these businesses transition smoothly without major economic disruption. This coordinated approach makes the transition both green and fair, promoting inclusion and long-term resilience.

The existing working group mechanisms such as Finance Stability and Development Council (FSDC) and Sustainable Finance Group housed in RBI can be strengthened to address climate change and climate finance issues. Leveraging these established platforms would support coordinated actions, improve data sharing, and strengthen policy coherence. These platforms would provide a structured mechanism for collaboration across regulators and institutions, ensuring a unified, efficient, and resilient financial response to India's Net Zero transition.

5.3 EXPAND THE PIPELINE OF BANKABLE, DE-RISKED PROJECTS TO ACCELERATE CLIMATE INVESTMENT

India's climate goals call for a significant expansion in the pipeline of investment-ready projects. Strengthening project preparation, aggregation, and risk management mechanisms will be critical to improving investor confidence, crowding in private finance, and accelerating implementation.

In many countries, particularly for mature clean technologies such as solar and wind, the main constraint is not the availability of finance but the bankability of projects[59]. Investors classify a project as "bankable" when it demonstrates clear and predictable revenue streams, operates under a stable regulatory framework, and offers attractive risk-adjusted returns. Without these elements, even large pools of climate capital remain underutilised.

This concern has also been echoed domestically by the RBI Governor, who observed that "one of the oft-cited constraints to adequate flow of climate-related finance has been the lack of bankable projects[60]". Limited appraisal capacity and the short operational track record of many green technologies amplify perceived risks around reliability and efficiency.

For emerging economies like India, the challenge is compounded by sovereign credit ratings that systematically understate repayment capacity. *The Economic Survey 2024-25*[61] highlights that global rating methodologies often penalise countries on narrow parameters, overlooking strong fundamentals and a consistent record of external debt servicing. This distortion inflates the cost of capital. Climate Policy Intiative (CPI) estimates that investors expect returns of nearly 17.2% on clean energy projects in India, almost double the 8.3% in Germany[62].

Yet India does not need to look elsewhere for solutions. Its own infrastructure financing models offer valuable lessons. The National Infrastructure Pipeline (NIP), a first-of-its-kind, whole-of-government initiative with a projected investment of around INR 111 lakh crore during FY 2020–25, provided a transparent, forward-looking pipeline of greenfield and brownfield infrastructure projects each costing over INR 100 crore[63]. In parallel, the National Monetisation Pipeline (NMP) operationalised the principle of "asset creation through monetisation," unlocking private capital worth INR 6 trillion by leveraging existing government assets[64]. Both initiatives demonstrate that structured pipelines and project preparation facilities can attract scaled capital, lower risk,

and accelerate implementation.

In the energy sector, the Solar Energy Corporation of India (SECI), through instruments such as the Payment Security Mechanism (PSM), has played a pivotal role in de-risking renewable energy projects. SECI's function as an aggregator and off-taker has been central to investor confidence. PSM addresses counterparty risks linked to power distribution companies (DISCOMs). SECI's adoption of hybrid annuity models in solar parks has become an international reference point for de-risking and scaling renewable investments.

Building on this playbook, NITI Aayog's ASSET (Accelerating Sustainable State Energy Transition) platform seeks to prioritise, prepare, and structure green infrastructure projects for financing. Extending ASSET to climate mitigation sectors such as clean energy, storage, grids, EV infrastructure, and hard-to-abate industries, can replicate the success of India's infrastructure models to mobilise global climate capital. However, since ASSET is a recent initiative, its expansion should be phased, with ASSET targetting early wins in areas where aggregation and standardised contracting can quickly improve bankability such as Urban Local Bodies (ULB) water pumping efficiency upgrades, high-efficiency cooling programmes, and electrification of municipal fleets (which are discussed below). Any scale-up should be guided by a clear performance assessment framework and follow-on actionable recommendations, to avoid premature expansion and strengthen credibility with financiers.

i. **Urban Local Bodies (ULB) Water Pumping Upgrades**: Electricity is often the second-largest expense in municipal budgets after staff salaries, with 30–60% of energy bills attributed to water pumping operations[65]. Rising electricity costs strain local finances, delay payments to DISCOMs, and affect service reliability. ASSET can intervene through:

   a. **Promoting demand aggregation via audits:** Standardised energy audits across municipalities to identify inefficiencies and pool demand for efficient pump-sets, lowering procurement costs.

   b. **Energy Service Companies (ESCO)/Renewable Energy Service Companies (RESCO)-led financing:** Energy Service Companies (ESCO) can replace and operate efficient pumps without upfront municipal investment. To mitigate payment risks, ASSET could establish a PSM (e.g., pooled fund or escrow) to ensure timely payments and attract private participation.

ii. **Scaling Air-Conditioner Efficiency through Replacement & Real Estate Integration:** Air conditioning is emerging as India's largest driver of incremental residential electricity demand. With only 8% household penetration today, cooling needs are expected to rise tenfold by 2050, straining grids and driving up peak demand. In Andhra Pradesh, summer cooling loads are projected to reach 245 million kWh per day, requiring costly new generation and transmission capacity[66]. This presents a dual opportunity:

   a. **Legacy stock:** Replacing inefficient ACs with 5-star inverter models can reduce energy use by upto 60%[67]. ASSET can aggregate demand across housing societies and states for bulk procurement, with incremental costs recovered through tariff innovations such as differential pricing.

   b. **New housing stock:** Developers can integrate efficient appliances at the construction stage, locking in long-term energy savings at minimal incremental cost. ASSET could scale this through:

- Incentives such as green/concessional finance or property tax rebates for builders;
- Regulatory nudges, including improved adoption of efficiency codes;
- Green mortgages offering lower EMIs for buyers in certified energy-efficient housing.

Together, these measures can reduce peak load pressures, lower consumer bills, and catalyse private investment in efficiency.

iii. **Electrification of Municipal Garbage Truck Fleets:** Municipal waste fleets are diesel-intensive, high-Operating Expense (OPEX) assets. The national Municipal Solid Waste (MSW) guidelines identify collection and transport as a major cost driver for cities, with efficiency upgrades a key priority under Swachh Bharat Mission (Urban) (SBM-U)[68]. Yet, the shift to electric trucks has been slow due to high upfront cost of heavy-duty electrification. A NITI Aayog's report highlights the reasons for adoption lag: e-trucks cost 2–3 times that of diesel trucks and elevated financing rates (~15–18% vs. 10–12%) due to technology and resale risks.[69]

Pilots projects demonstrate viability: Indore Municipal Corporation has added electric waste-collection vehicles to its fleet for door-to-door garbage collection, replacing diesel trucks in its sanitation operations, showing one pathway for municipal electrification.[70] Under ASSET, scale-up can be achieved through demand aggregation and General Conditions of Contract (GCC) style contracts where operators invest in vehicles and charging infrastructure and ULBs pay per kilometer or per hour backed by a Payment Security Mechanism (PSM) modelled on PM-eBus Sewa. This approach mitigates counterparty risk and creates a replicable pipeline for municipal fleet decarbonisation.

These illustrations are not exhaustive. They are intended as demonstrators of a broader point: India's transition will not be financed through volume alone, but through sector-specific financing architectures that match the risk profile and revenue model of each segment. The next section focuses on specific financing hurdles in four major pillars of India's growth and emissions profile namely transport, industry, power, and buildings and sets out targeted instruments, risk-sharing mechanisms, and institutional reforms needed to make investments bankable and scalable.

Transport

India's transport transition requires mode-specific financing architectures from Transit-Oriented Development (TOD) driven metros and InvIT-backed rail assets to fleet-anchored EV finance rather than one-size-fits-all subsidies. Transport contributes over 10.9% of India's total emissions[71], dominated by road sector, but financing barriers vary sharply across modes. The proposed measures to increase financing for climate action include:

i. **Financing Metro Systems through TOD and Value Capture**: Despite more than 900 km in operation and another 900 km under construction[72], most metro systems remain dependent on public funds and multilateral loans. Early ridership levels often fail to justify a heavy capital cost, while TOD and other value-capture mechanisms remain underutilised. The way forward is to de-risk early revenues through anchor ridership commitments and systematically integrate value-capture financing, allowing private capital to participate in expansion.

ii. **Unlocking Private Capital in Railways:** India's rail network is key to shifting freight and passengers to low-carbon transport, yet financing remains dominated by budgetary allocations. Private operators remain locked out due to legacy procurement and risk-sharing structures. Public-Private Partnership (PPP) concessions for operations and pooling freight assets into InvITs could unlock long-term institutional capital while improving operational efficiency.

iii. **Scaling Electric Mobility through Innovative Financing Models (Buses, Trucks, EVs):** Electrification in road transport is advancing through PM E-Drive (FAME-III) and state EV policies, but high upfront costs, absence of secondary markets for batteries, and fragmented demand deter private finance. Battery-as-a-service (BaaS) models, anchor fleet contracts with logistics and e-commerce firms, and route-based project aggregation can generate predictable revenue streams, making these assets bankable for blended finance.

iv. **Decarbonising Shipping and Maritime Infrastructure:** The maritime sector, India's trade backbone remains largely overlooked. Retrofitting vessels and building bunkering infrastructure for green fuels face steep costs and limited financing. Blended finance models supported by anchor fuel buyers, alongside PPP-led Green Maritime InvITs, can help crowd in institutional investors. The National Green Hydrogen Mission[73] explicitly includes pilot projects for green shipping fuel, positioning India to develop early bunkering and retrofitting pathways for green ammonia and hydrogen, directly linking transition finance to India's trade backbone.

Industry

The industrial sector contributes nearly 24% of India's GHG emissions (2020)[74], excluding emissions from electricity use. Energy transition in these hard-to-abate segments is central to India's Net Zero ambitions. Yet, the financing landscape remains underdeveloped characterised by high upfront technology costs, uncertain price signals, and limited institutional engagement. A key barrier is that many industrial decarbonisation projects such as green hydrogen pilots, or Carbon Capture, Utilisation, and Storage (CCUS) are capital-intensive with long and uncertain payback periods.

Micro, Small and Medium Enterprises (MSMEs), which form the backbone of Indian industry, face even steeper challenges: weak balance sheets, dependence on informal credit, and limited capacity to navigate complex financing instruments. As a result, viable technologies often remain under-deployed despite clear climate and productivity benefits. Possible solutions to finance transition measures in industry sector include:

i. **Scaling Energy Service Company (ESCO) and Renewable Energy Service Company (RESCO) Models:** One solution is to scale Energy Service Company and Renewable Energy Service Company models, which allow industries to adopt efficiency or renewable solutions without upfront capital expenditure. However, small contract sizes and uncertain cash flows deter lenders. Pooling multiple contracts under a special-purpose vehicle (SPV), combined with partial risk guarantees from public institutions or Multilateral Development Banks (MDBs), can create bankable project pipelines that attract blended finance. Fast-track dispute resolution and annuity-style repayment models would further improve investor confidence.

ii. **Expanding Access to Working Capital for MSMEs:** For MSMEs, access to working capital is as critical as project finance. A promising innovation is green bill discounting, where verified 'green invoices' for instance, for efficiency equipment or renewable procurement, are financed through platforms like the Trade Receivables Discounting System (TReDS) regulated by the RBI. Between FY2020 and FY2024, TReDS enabled over INR 75,000 crore in SME financing; embedding a green certification layer could extend this mechanism to low-carbon projects at scale.

iii. **De-Risking Industrial low-carbon Investments:** Blended finance platforms also hold strong potential for waste heat recovery, low-carbon process electrification, and energy-efficient motors, where credit and performance risks currently deter mainstream investors. Carefully designed credit guarantees, Viability Gap Funding (VGF), and performance-linked incentives can lower perceived risks and unlock institutional capital.

iv. **Financing the Circular Economy and Carbon Aggregation:** Finally, scaling the circular economy in industrial sectors such as metals, plastics, electronics, and construction remains largely untapped. Aggregation platforms that pool projects and tie payments to verified outcomes (e.g., tonnes recycled, emissions avoided) can make recycling and material efficiency investable at scale. Similarly, India's emerging carbon credit framework can be leveraged through an Industrial Carbon Aggregation Platform housed under the BEE to pool carbon credits from MSMEs and offer forward-offtake agreements with buyers.

Power

The power sector is both the engine of India's Net Zero pathway and its most investment intensive link. Accounting for over 40% of total GHG emissions (2020)[75] and nearly half of the USD 22.7 trillion investment requirement, it will determine whether India can triple electricity's share in final energy demand from 21% in 2025 to nearly 60% by 2070, in line with deep electrification pathways. Despite rapid growth in renewable capacity and achievement of 50% non-fossil capacity target[76], financing bottlenecks persist, threatening to slow progress. The proposed measures to increase financing for climate action include:

i. **Strengthening DISCOM Finances and Reducing Counterparty Risk**: The most persistent challenge lies with DISCOMs. Many DISCOMs remain financially distressed despite the Revamped Distribution Sector Scheme (RDSS), which provides INR 3.04 trillion in performance-linked grants[77]. Structural inefficiencies such as high Aggregate Technical and Commercial (AT&C) losses and weak billing and collection systems continue to erode balance sheets.

   Even with the Late Payment Surcharge (LPS) Rules reducing legacy dues, contractual insecurity remains a deterrent for investors in power generation projects. Without deeper market reforms such as privatisation or franchise models for loss-making utilities, and stronger legal enforcement of Power Purchase Agreements (PPAs), DISCOM fragility will continue to raise the cost of capital for the sector.

ii. **Financing Emerging Technologies and Diversifying beyond Solar:** While solar and wind have achieved cost competitiveness, offshore wind, green hydrogen, and battery storage continue to face financing constraints due to limited operational track records

and commodity price volatility. Banks remain hesitant to underwrite these projects, restricting the flow of mainstream commercial finance precisely when diversification is critical.

To address this, risk-mitigation facilities, including partial risk guarantees and first-loss cover, and credit enhancement instruments supported by Multilateral Development Banks (MDBs) and Development Financial Institutions (DFI), can be offered to reduce perceived risks and enable banks to extend credit at lower provisioning requirements.

iii. **Building Market Mechanisms and New Revenue Streams**: The sector currently lacks mature market mechanisms for ancillary services such as frequency balancing and ramping reserves, which limits revenue opportunities for storage and flexible generation assets. Establishing a structured ancillary services market similar to U.S., which generated around USD 8.24 billion in 2024[78], would enable storage operators to earn a significant share of revenues from grid services, improving project bankability.

Similarly, Green Open Access reforms are beginning to unlock corporate renewable demand, but harmonised tariffs, banking provisions, and uniform regulatory implementation across states are needed to make bilateral PPAs a robust driver of renewable expansion.

iv. **Mobilising Capital for Frontier Technologies:** Emerging technologies such as offshore wind, and hydrogen electrolysers require long-term, low-cost capital that is currently unavailable at scale in India. With one of the highest costs of capital in the world for infrastructure, the deployment of concessional climate finance, blended finance structures, and VGF will be indispensable to make these technologies investable until commercial maturity is achieved. The government's VGF scheme for 4,000 MWh of battery storage capacity is a step in the right direction, providing an example of how targeted financial innovation can accelerate deployment.

Buildings

The buildings sector already consumes nearly one-third of India's electricity[79] and will be the fastest-growing demand segment as appliance penetration and urbanisation rise. With above 80% (considering demolition and retrofitting) of India's 2050 building stock yet to be constructed, this sector represents not just a major climate challenge but a once-in-a-century opportunity to lock in energy-efficient growth. Yet, financing remains the Achilles heel: fragmented, small-ticket projects, long payback horizons, split incentives between builders and occupants, and weak enforcement of codes keep efficiency upgrades and retrofits far from mainstream finance. The proposed measures to increase financing for climate action include:

i. **Unlocking Retail Finance through Green Mortgages and Securitisation:** The Indian Green Building Council (IGBC) has registered over 15,410 projects spanning 13.26 billion sq ft.[80], demonstrating clear water and energy savings. But to move beyond isolated success stories, incentives should be provided to bring low-carbon lending into mainstream retail finance.

Housing loans represent nearly 16.5% of total bank advances in India, with outstanding amounts of around INR 30.6 lakh crore (June 2025), making them a foundational component of retail credit[81]. Embedding focused lending towards low-carbon buildings through preferential interest rates or higher loan-to-value (LTV) ratios for certified

low-carbon buildings can turn this vast retail finance engine into a purposeful lever of energy-efficient growth. Lower operating costs of Net Zero buildings also enhance repayment capacity, reducing lenders' credit risk[82].

Beyond individual loans, securitisation and Real Estate Investment Trusts (REITs) offer scalable models. Bundling pools of low-carbon housing loans or commercial mortgages into low-carbon asset-backed securities can attract ESG-aligned investors. Likewise, REITs already managing over INR 1.5 lakh crore in India's commercial real estate can evolve to include portfolios of certified low-carbon buildings, offering investors exposure to sustainable projects while recycling capital for developers[83]. Together, low-carbon mortgages, securitisation, and REITs can transform retail lending into a systemic driver of the transition.

ii. **Scaling Building Retrofits through Energy Service Company (ESCO) and Renewable Energy Service Company (RESCO) Models:** Energy Service Company and Renewable Energy Service Company can finance retrofits through performance-based contracts, repaid from verified energy savings. Globally, ESCOs have channeled billions into building retrofits, but uptake in India remains limited due to weak contract enforcement, small project sizes, and low awareness among financiers and clients[84]. To move from niche to mainstream, India needs:

   a. Standardised contracts and dispute-resolution mechanisms, ensuring lender confidence in performance-based repayment structures.

   b. Aggregation platforms to pool retrofit projects into SPVs large enough to attract institutional capital.

   c. Credit enhancement from DFIs and multilaterals to mitigate first-loss risks.

   If designed well, ESCOs and RESCOs can unlock a multi-billion dollar retrofit market, bridging the gap between fragmented demand and large-scale institutional finance[85].

iii. **Financing Urban Efficiency through Green Municipal Bonds:** Municipal green bonds are emerging as powerful tools for financing urban sustainable infrastructure including efficient buildings, lighting and waste systems, and efficiency improvements. According to Council on Energy, Environment and Water - Green Finance Centre (CEEW-GFC), green-labelled bonds enjoy coupon spreads around 50 basis points lower than conventional issuances (1.11% vs. 1.63%)[86]. Despite this, only about 40% of eligible municipal projects have been labelled green representing a major missed opportunity for accessing low-cost climate-aligned capital. Trailblazing examples include:

   a. Pimpri-Chinchwad Municipal Corporation (PCMC): Raised INR 200 crore for sustainable mobility, that was oversubscribed fivefold, earning a 25% central grant[87].

   b. Vadodara Municipal Corporation: Issued Asia's first certified green municipal bond to fund wastewater treatment[88].

   c. Ahmedabad, Indore, and Ghaziabad: Issued bonds for solar and resilience projects.

   With reforms in municipal accounting, credit ratings, and bond structuring, this market could mobilise USD 2.5–6.9 billion over the next decade**,** strengthening financing for low-carbon urban infrastructure[86].

iv. **Strengthening Code-to-Capital Linkages:** India's Energy Conservation Building Code (ECBC), introduced in 2007, has proven capable of cutting energy use by up to 50% in compliant buildings. Yet, the adoption of ECBC remains patchy, 13 states and UTs have not yet notified it, and enforcement remains weak across others.

Innovative state models offer replicable solutions. Telangana's online ECBC compliance portal conducts audits at both design and occupancy stages, while Madhya Pradesh ties permanent electricity connections to ECBC certification. Linking such compliance frameworks with preferential green finance can create a powerful "comply to qualify" incentive loop.

v. **Promoting Product Transparency through Environmental Product Declarations:** Energy-efficient buildings depend not just on design but also on the materials used. Yet India currently lacks a unified framework for assessing embodied carbon or lifecycle environmental performance of building materials. Developing a national framework for Environmental Product Declarations (EPDs) would enable investors and builders to assess, compare, and reward low-carbon materials.

EPDs disclose environmental performance metrics such as thermal properties, embodied carbon, recycled content, and circularity potential. International frameworks such as EN 15804 in the EU already use EPDs to align procurement decisions with climate goals. Establishing a national EPD methodology, with material-specific rules, would enable: i) Investors to assess lifecycle carbon footprints across construction portfolios ii) Builders to make informed, competitive choices in favour of low-carbon alternatives and iii) Green finance taxonomies to reward projects using certified low-carbon materials. By linking EPD-backed materials to preferential green lending and municipal procurement, India could accelerate both low-carbon transition and market transformation in construction supply chains.

Taken together, these sectoral stories reveal a common thread: India's energy transition is constrained not by the absence of technology but by the financial architecture that supports it. Transport requires mode-specific financing structures that can de-risk demand and attract long-term capital; industry needs pooled mechanisms to make hard-to-abate sectors investable; the power sector depends on discom creditworthiness, risk-mitigation facilities, and new market instruments to channel institutional funds; and buildings demand a blend of retail housing loans, REITs, ESCO contracts, municipal green bonds, and building code standards such as ECBC and EPDs to scale efficiency.

Beyond project pipelines, India must also strengthen the financial sector's capacity to mainstream climate lending. Many banks, NBFCs, and institutional investors lack the technical expertise to appraise emerging technologies, assess transition risks, or structure blended finance instruments. This limits their ability to scale proven pilots. Targeted capacity-building programmes delivered through the RBI, SEBI, IFSCA, and MDB partnerships can equip financiers with skills in climate risk assessment, sectoral transition pathways, and sustainability-linked instruments. Building this knowledge base is essential to ensure that once projects are prepared, finance can flow at the speed and scale required.

5.4 BRIDGE THE FINANCING GAP THROUGH TAILORED FINANCIAL ARCHITECTURES

Current financial flows towards India's energy transition fall well short of the scale required to meet future demand. The present study estimates that India will need approximately USD 22.7 trillion[xii] in cumulative investment to achieve a successful transition covering both fossil and non-fossil sources. Of this, about USD 20 trillion is required specifically for the low-carbon transition, translating to USD 450 billion annually, almost nine times higher than the current flow of around USD 50 billion (annual average of FY2020-22)[9].

These estimates align broadly with other benchmarks. A UBS study projects USD 19.6 trillion[89] of investment is required between 2022 and 2070, though it excludes capital requirements from OEMs in the transport and industrial sectors. Similarly, McKinsey & Company's analysis, which runs to 2050, estimates investment needs of USD 7.2 trillion[90], closely aligned with this study's projection of USD 8.05 trillion for the same period.

The power sector alone accounts for nearly half of total investment requirements, underscoring the need for large-scale investment not only in generation but also in transmission, distribution, and energy storage. This concentration highlights both the challenge and the opportunity: India's ability to finance its transition will depend on mobilising long-tenor, capital-intensive flows far beyond current trajectories.

This becomes even more significant when viewed against India's energy demand trajectory. Under a Net Zero scenario, electricity's share in final energy demand is expected to triple from 21% in 2025 to nearly 60% by 2070. Such deep electrification makes large-scale investment in the power sector unavoidable. However, not all technologies require the same financing profile. Renewable energy generation typically demands high upfront capital but low operating costs, whereas efficiency measures, grid upgrades, and demand-side technologies require sustained credit access and policy-driven incentives.

To translate these high-level requirements into an actionable view of the financing challenge, Inter-Ministerial Working Group 3 (INWG3) developed an asset–flow model to estimate the likely availability of climate finance across sectors under a plausible set of enabling reforms. This helps distinguish between (i) what can be mobilised through market deepening and policy improvements, and (ii) the residual gap that will require additional institutional mechanisms. Mobilising USD 16.2 trillion will require several enabling reforms across domestic and external sources of finance, summarised below:

Boosting Domestic Capital

i. Deepen the corporate bond market from ~16% of GDP today to ~25% by 2047 and ~30% by 2070, driven by:

   a. ***Lower primary-market friction:*** streamline regulatory processes, harmonise disclosures, and digitise issuance/listing/compliance to cut time and cost.

   b. ***Build liquidity:*** expand bank participation through Held-to-Maturity (HTM) flexibility (with calibrated eligibility below AAA credit ratings), scale corporate bond market while institutionalising market-makers.

xii Investment for Climate action is estimated only for three sectors namely power, industry, and transport. The detailed assumptions and limitations may be referred to in the methodology section.

c. ***Broaden investors + credibility:*** grow insurers/pensions and retail investors via demat access, bond savings accounts/pooled products, and financial literacy, while extending issuance beyond AA/AAA using credit enhancement and stronger CRA discipline.

ii. Reorient long-term institutional portfolios toward green assets: Reduce insurers' and pension funds' G-Sec concentration from ~55-60% today to ~50% by 2047, redirecting allocations into high-quality corporate and green debt through suitable vehicles, credit-enhanced green bonds, pooled/guaranteed structures, Green InvITs, and securitised green assets.

iii. Mobilise household savings through transparent, low-risk products digitally linked to infrastructure/green assets turning thrift into investment without overheating bank balance sheets.

iv. Gradually glide the Statutory Liquidity Ratio (SLR) back toward the 18% norm by 2070 and maintain it thereafter, freeing bank balance sheets and risk appetite to expand green and transition lending.

Boosting External Capital

i. Increase FDI from about 2.3% today to 3–4% by 2047 by combining stronger investor confidence with clear project pipelines and stable long-term policy certainity. This requires i) strategic technology partnerships with global leaders (EVs, batteries, green hydrogen, grid technologies, CCUS) to bring not just funding but technology transfer and manufacturing depth ii) credible, time-bound transition roadmaps (akin to China's Five-Year Plans) with clear targets for renewables, EV penetration, storage, and industrial decarbonisation to anchor investor expectations and iii) a sustained pipeline of bankable projects built through standardised contracts, faster permitting, stronger offtake structures, and clearer risk allocation so foreign capital can deploy at scale without execution bottlenecks.

ii. Increase foreign portfolio capital (FPI) participation from ~0.5% to ~1.5% by 2047 by reducing currency risk through FX hedging and supportive regulatory access. Channel a larger share of these flows through GIFT City/IFSCA as a co-investment hub, offering standardised, taxonomy-aligned platforms where global investors can partner with domestic institutions in pooled green assets under consistent governance, disclosure, and risk-sharing structures.

Financing gap: Even with these domestic and external reforms, it is expected that India will be able to mobilise ~USD 16.2 trillion only, leaving a ~USD 6.5 trillion shortfall by 2070. If this financing gap is expected to be bridged from external sources, then the mix of domestic and international finance needed is 58% domestic and 42% international.

National Green Finance Institution:

India's financing gap is stark. This financing gap is not simply about the volume of capital but about channelling diverse financial pools into investable, risk-adjusted opportunities. Banks and NBFCs face asset–liability mismatches; institutional investors

are limited by regulatory caps; corporate bond markets are not deep; and high-risk premia deter foreign capital. At the same time, existing institutions show limited capacity for innovative instruments such as credit enhancement, FX hedging, and performance-based financing, and bankable project pipelines and blended finance mechanisms remain underdeveloped. Bridging these barriers requires a purpose-built institutional mechanism to crowd in private capital, de-risk emerging technologies, and coordinate fragmented financial actors. This is the role envisaged for a National Green Finance Institution (NGFI). NGFI is not intended to replace existing institutions, but to complement them by providing complementary measures such as credit enhancement, blended finance structuring, aggregation, and risk management at scale.

Comparable global models, such as Germany's KfW, the UK Infrastructure Bank, and Australia's the Green Investment Bank demonstrate how public financial institutions can mobilise private capital, mitigate risk, and accelerate technology diffusion. NGFI can serve as India's counterpart.

Core Objectives of NGFI:

- **Scale up capital for commercially viable technologies**: Provide refinancing windows, green credit lines, and aggregation facilities for established technologies such as solar and wind. These mechanisms can help projects move from bankable to scalable by easing capital bottlenecks.
- **De-risk emerging technologies:** Deploy concessional finance, Viability Gap Funding (VGF), and first-loss instruments to lower risk for offshore wind, hydrogen, and energy storage. By absorbing early-stage risks, NGFI can enable banks and institutional investors to step in at scale.
- **Support early-stage green innovation:** Incubate and channel venture capital into frontier technologies, preventing a 'valley-of-death' and maintaining India's competitiveness in next-generation green industries.

Strategic Value of NGFI:

- Acts as a central hub connecting diverse sources of capital, including banks, bond markets, institutional investors, and foreign capital, with sector-specific financing needs across transport, industry, power, and buildings.
- Brings standardisation and credibility, aligning domestic and international finance and setting benchmarks for climate-aligned investments.
- Serves as India's counterpart to global climate finance initiatives, enhancing investor confidence and signalling credibility to MDBs, DFIs, and private investors.

A dedicated white paper developed through structured consultation with regulators, financial institutions, industry, and investors should set out the NGFI's mandate, governance, eligible instruments, risk framework, and capitalisation plan.

5.5 STRENGTHEN TRANSITION FINANCE TO BRIDGE THE BROWN-TO-GREEN GAP

India's transition challenge is not limited to scaling "pure green" assets. The harder task lies in enabling transition in carbon-intensive incumbents: steel, cement, coal-linked power, refineries, and heavy transport without undermining growth. This is the purpose of transition finance: to fund credible, time-bound transition plan for emissions-intensive firms and assets.

Two complementary lenses illustrate the magnitude of India's financing need:

- **The Green/Low-Carbon Lens (Narrow).** CPI tracks flows into clean energy, transport and energy efficiency sectors. Its latest estimate for India is around USD 50 billion per year during FY2020–22[9], a useful indicator of "green plumbing," but one that excludes brown-to-green corporate CAPEX.
- **The Total Energy Lens (Broad).** IEA estimates that in 2024[3], clean energy investment in India was about USD 87 billion, while fossil energy investment stood around USD 48 billion, totalling USD 135 billion.

The message is clear: even as clean investment rises, a large share of emissions is embedded in long-lived, captial-intensive fossil systems that cannot be replaced overnight. Transition finance is the bridge: refinancing or retrofitting high-emitting assets against pre-committed retirement or transition plans; funding process shifts like clinker substitution, Hydrogen-based Direct Reduced Iron (DRI-H_2) pilots, and waste-heat recovery; and tying capital to science-based, independently verified pathways with penalties for non-performance.

A Regulatory Architecture Taking Shape: India has begun laying the foundation for credible transition finance, aligning with global practices while recognising its domestic context:

i. International Financial Services Centres Authority's (IFSCA) draft Framework for Transition Finance (2023)[91]: Defines the conditions for credibility wherein companies must publish time-bound transition plans, prove that financing is tied to emissions-reducing activities (not asset life-extension), and undergo third-party verification.

ii. SEBI's green debt framework[92]: Now explicitly recognises Sustainability-Linked Bonds (SLBs) and Transition Bonds tied to measurable Sustainability Performance Targets (SPTs), with step-up coupons if targets are missed, a direct way to align capital with entity-level decarbonisation plans (e.g., a steel producer modernising blast furnaces).

iii. Draft Indian Climate Finance Taxonomy (2025)[93]: Released by the Ministry of Finance Task Force, this is the first national taxonomy to formally recognise transition activities alongside green. By distinguishing between 'climate-supportive' and 'transition-supportive' activities, it legitimises investor participation in hard-to-abate sectors while guarding against greenwashing.

From Rules to Plumbing: Making Transition Finance Work Having rules and labels is necessary, but not sufficient. Transition finance will only scale if the 'financial plumbing' connects policy ambition with investable pipelines:

i. **Credible pathways:** NITI Aayog has launched sectoral roadmaps for the cement,

aluminium, and freight transport sectors. The Ministry of Steel has published both a decarbonisation roadmap and a dedicated steel taxonomy. These provide examples of credible pathways-benchmarks financiers can use to distinguish genuine transition from greenwashing.

ii. **Tailored instruments:** Transition bonds and Sustainability-Linked Bonds (SLBs) can channel capital into brown-to-green shifts at both asset and entity level, for instance, a cement producer issuing a transition bond to fund clinker substitution, or a freight operator issuing an SLB tied to fleet emissions intensity. Scaling these instruments requires robust verification frameworks and meaningful penalties for non-performance.

iii. **Risk-sharing mechanisms:** Transition assets often carry first-of-kind risks. Credit guarantees, first-loss capital, and foreign exchange (FX) hedging can catalyse private investment by improving risk–return profiles. Given limited fiscal space and competing development priorities, these mechanisms should be deployed selectively and supported by strong governance, transparency, and risk-management frameworks to monitor and manage contingent liabilities. Where feasible, MDB/DFI participation should be used to share risk and reduce pressure on domestic public balance sheets.

iv. **Monitoring and verification:** Transition finance depends on trust. Strengthening SEBI's BRSR framework to cover entity-level transition plans and post-issuance reporting would enhance transparency and provide investors with the confidence needed to scale participation. Any inclusion of Scope 3 disclosures should be phased and proportional starting with large entities in high-impact sectors to avoid disproportionate compliance burdens on MSMEs and smaller suppliers.

v. **Market infrastructure:** Deepening market liquidity and price discovery will be critical. Listing transition bonds on IFSC exchanges (GIFT City), developing repo facilities for green and transition debt, and piloting sovereign transition issuances could anchor credibility and attract institutional investors at scale.

Done right, transition finance is not a sidecar to green finance, it is the missing bridge between India's current emission trajectory economy and its Net Zero future. It is the channel through which trillions can flow to decarbonise incumbents, build investor confidence, and make India's energy transition both credible and inclusive.

ANNEXURES

Annexure-1: Assumptions for Transport Sector Investment Sizing

Capital costs for Vehicular Manufacturing: Capital expenditure (CAPEX) estimates are drawn from the Centre for Social Innovation (CSI) report[94]. CSI estimates the CAPEX required for producing one million vehicles as follows:

- Two-wheelers (2W): USD 11.7 million
- Three-wheelers (3W): USD 9.95 million
- Cars: USD 232 million
- Buses and Trucks: USD 394 million

The costs are projected to increase by 2.5% annually by 2040 and by 1.2% annually thereafter until 2070.

i. **Battery Life and Capacity:** Battery life is assumed to be **10 years**, while average battery capacities are summarised in the table below.

Average Battery Capacity across Vehicle Segment

Vehicle segment	Average battery capacity (kW)
Bus	200
Omni-bus	80
Car	40
2 Wheeler	3
3 Wheeler	5
Taxi	40
Vehicles' payload up to 3.5 tons	100
Vehicles' payload 3.5–12 tons	200
Vehicles with a payload above 12 tons	300

ii. **Battery cost per kWh:** The cost of batteries is projected to decline from INR 21,700 per kWh to INR 10,800 per kWh by 2050, after which it is expected to stabilise.

iii. **Charging infrastructure:** The penetration of slow and fast charging stations, along with charger density across vehicular segments, is summarised in the table below:

Penetration of Slow and Fast Charging Stations and Charger Density across Vehicular Segments

Vehicular segment	Penetration of charging infrastructure		Charger density (No. of chargers per million vehicles)
	Slow Charger (Life-12 years)	Fast Charger (Life-8 years)	
Bus	10%	90%	40,000
Omni-Bus	20%	80%	30,000
Car	50%	50%	25,000
2 Wheeler	80%	20%	10,000
3 Wheeler	75%	25%	15,000
Taxi	50%	50%	20,000
Light Commercial Vehicle	30%	70%	25,000
Medium Commercial Vehicle	20%	80%	30,000
Heavy Commercial Vehicle	10%	90%	40,000

Cost per Slow and Fast Charger (in INR Lakh) across Vehivular Segment

Vehicle segment	Slow Charger	Fast Charger
Bus	17.5	40
Omni-Bus	12.5	25
Car	4	12.5
2 Wheeler	0.75	2.5
3 Wheeler	1	4
Taxi	4	12.5
Light Commercial Vehicle	7.5	17.5
Medium Commercial Vehicle	12.5	25
Heavy Commercial Vehicle	17.5	40

Annexure-2: CAPEX Assumptions for Industrial Sectors

Investment cost – Million INR/Million tonnes – 2025 prices	
Steel	
Blast Furnace - Basic Oxygen Furnace (BF-BOF)	73,385
Coal-based Direct Reduced Iron - Electric Arc Furnace (DRI-EAF)	69,750
Natural Gas-based DRI-EAF	69,750
Coal-based DRI Direct Reduced Iron – Induction Furnace (DRI-IF)	10,000
100% Scrap Electric Arc Furnace (EAF)	6,000
Hydrogen-based DRI-EAF	69,750
Aluminium	
Integrated Aluminium Plant	2,75,000
Scrap-Based Aluminium Plant	12,000
Cement	7,500
Fertiliser	
Urea Fertiliser Production	6,800
DAP Fertiliser Production	6,800
Complex Fertiliser Production	6,800
Textile	19,000
Chemicals	
Naphtha-based Ethylene Production	1,80,000
Natural Gas-based Ethylene Production	4,00,000
Paper & Pulp	
Wood-Based Paper Production	1,20,000
Agro-Based Paper Production	1,50,000
RCF-Based Paper Production	80,000
Chlor-Alkali	
Membrane-Based Caustic Soda Production	75,000
Solvay process for Soda Ash Production	65,000
Refinery	14,000

Source: *Literature & Industry consultations*

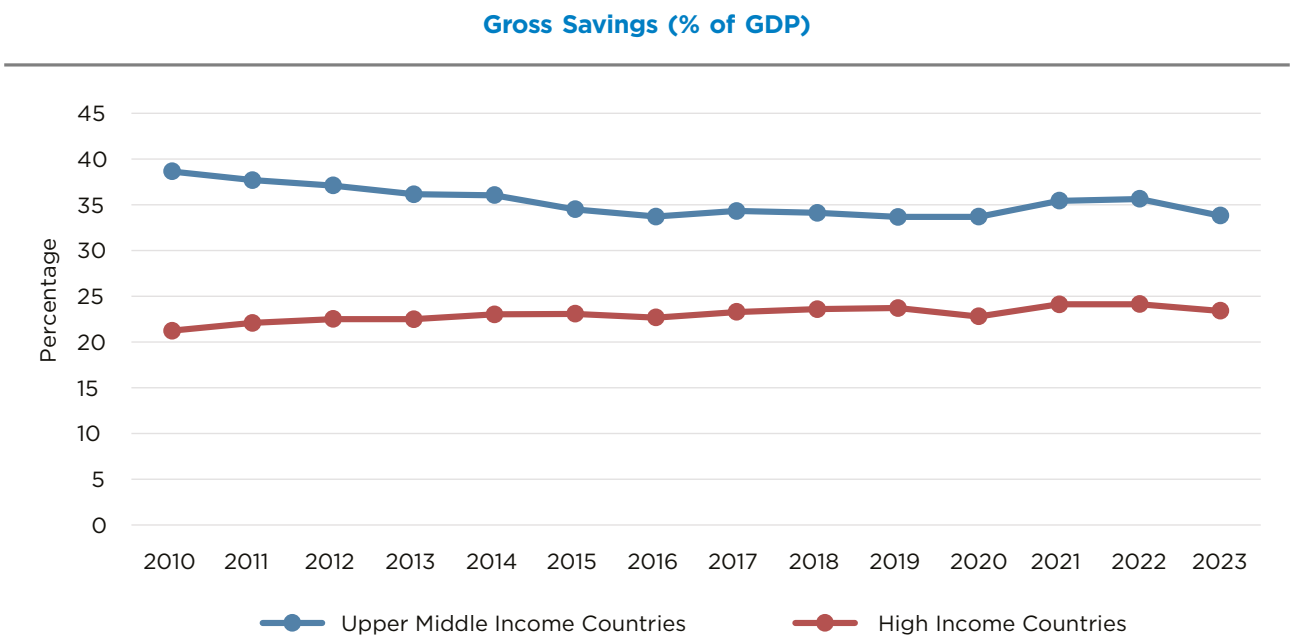
Investment Cost – INR Million/ Million tonnes	
CO_2 Capture	
Steel	12,960
Cement	11,000
Petrochemicals	16,670
Pipeline transport	1,360
Pure storage	3,330

***Source:** NITI Aayog CCUS report & Industry consultations*

Annexure-3: Assumptions for Power Sector Investment Sizing

Investment Cost - INR Crore / MW					
S.No.	**Technology**	**2030**	**2040**	**2050**	**2070**
1	Coal (Supercritical)	11.5	11.5	11.5	11.5
2	Gas	6	6	6	6
3	Biomass plant	6	5.9	5.8	5.7
4	Onshore Wind	7.6	7.0	6.6	6.4
5	Offshore Wind	15.4	14.8	14.0	13.7
6	Solar PV	4.2	4.0	3.75	3.5
7	Hydro RoR	11.3	11.1	11.1	11.5
8	Hydro RoR (P)	12.3	12.2	12.2	12.5
9	Hydro Storage	14	13.9	13.9	14.5
10	Nuclear	14	14	14	14
11	Pumped Storage Plant (PSP) (on river)	6.4	6.3	6.3	6.7
12	PSP (closed loop)	6.2	6.1	6.1	6.5
13	Battery storage (6 Hr)	7.2	6.6	5.6	4.9

Annexure-4: Gross Savings (% of GDP) – Upper-middle-income, and High-income Countries



- India's current gross savings stand at 30% of GDP[29].
- Following trends observed in upper-middle-income economies and high-income economies[95], India's gross savings (% of GDP) is expected to rise (33% by 2035) as it transitions to an upper-middle-income category and gradually decline post-2045 (29% by 2047 and then 25% by 2070) as it moves towards high-income status.

Annexure-5: Assumptions for Sectoral Allocation of Bank Credit

Total bank credit outstanding is allocated to power, transport, and industry sectors using the following approach and assumptions:

Particulars	Power	Transport	Industry
Computation of bank credit outstanding to low-carbon transition sectors	**Total bank credit outstanding × Power sector exposure (%)**	**Total bank credit outstanding × Transportation sector exposure (including manufacturing and services (%)**	**Total bank credit outstanding × Industrial sector exposure (%)**
Total bank credit outstanding	As outlined in the methodology section, total bank credit outstanding is estimated as a share of Net Demand and Time Liabilities (NDTL) minus Statutory Liquidity Ratio (SLR), using the formula: **Bank Credit Outstanding = (Historical Bank Credit Outstanding / (NDTL - SLR))* (Projected NDTL - Projected SLR)**		
Sectoral exposure (FY2023)	~4.5%[96,36] of total bank credit outstanding	Transport manufacturing: ~0.8%[97,36] of total credit outstanding Transport services: ~ 5%[97,36] of total credit outstanding	~6.3%[97,36] of total bank credit outstanding
Projection assumption (up to 2070)	Gradually increases to ~9% by 2070, mainly due to the expected increase in renewable energy capacity	Transport manufacturing assumed constant at 0.8%; Transport services share expected to increase to ~7% by 2070	Assumed to remain constant at five-year (FY2019-23) trailing average of 6.4%

Particulars	Power	Transport	Industry
Credit flow in a year	Annual credit flow to the power sector =Annual change in power sector credit exposure (Current Year Power Sector Credit Outstanding – Last Year Power Sector Credit Outstanding) + Annual repayment of principal	Annual credit flow to the transport sector = Annual change in transportation sector credit exposure + Annual repayment of principal	Annual credit flow to the industrial sector = Annual change in industrial sector credit exposure + Annual repayment of principal
Repayment of principal	Calculated assuming an average loan duration of 18 years[xiii], with the principal amortised annually over the loan period	Calculated assuming an average loan tenure of 10 years[xiv], with the principal amortised annually over the loan period.	Calculated assuming an average loan tenure of 25 years[xv], with the principal amount amortised annually over the loan period.

xiii The average loan duration of 18 years for power sector is based on: Central Electricity Regulatory Commission. (2020, June 23). Central Electricity Regulatory Commission (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulations, 2020. https://cercind.gov.in/2020/regulation/159_reg.pdf

xiv The average loan duration of 10 years for transport sector is based on: Bank of Maharashtra. Maha MSME Project Loan Scheme. https://bankofmaharashtra.in/maha-msme-project-loan-scheme

xv Loans with a 25-year tenure are generally reserved for large-scale, long-gestation industrial infrastructure and public sector projects, where the repayment schedule is tied to the extended revenue-generation cycle of the asset. India Infrastructure Publishing Ltd. (2025, January 7). Project financing: Industry players discuss the changing funding landscape. India Infrastructure. https://indianinfrastructure.com/2025/01/07/project-financing-industry-players-discuss-the-changing-funding-landscape/

Annexure-6: Assumptions for Sectoral Allocation of NBFCs Credit

Total NBFC credit exposure to power, transport, and industrial sector is calculated using the following approach and assumptions:

Particulars	Power	Transport	Industry
Computation of NBFCs credit exposure to low-carbon transition sectors	**Total NBFC credit outstanding × Industry exposure (%) × Power sector exposure (% within the industry)**	**Total NBFC credit outstanding × Transportation sector exposure (%) (including manufacturing and retail loans)**	**Total NBFC credit outstanding × Industrial sector exposure (%)**
Total NBFC credit outstanding	As explained in the methodology section, NBFC credit is projected in relation to total bank credit: **NBFCs' Credit Outstanding = Projected bank credit outstanding × Projected % of NBFC credit to bank credit**		
Sector share in total NBFC credit outstanding (FY2023)	Industry share: ~37%[38] Within Industry, power sector exposure: ~75%[38]	Transport manufacturing loans share: ~ 1%[97] Transport Retail loans share: ~14%[98]	Industry share: ~10%[38] (industry exposure excluding power sector exposure)
Projection assumption (up to 2070)	Industry share to decline to 30% by 2030 and stabilise thereafter, as many large NBFCs are structurally oriented toward supporting the industrial sector. Within the industry, the power sector is expected to remain stable at 75% till 2070	Manufacturing: Assumed to remain constant at 1% Retail: Projected to increase to 17% by 2070. This is due to the improved credit potential of EV segment compared to combustion vehicles	Projected to decline gradually, reaching 7% by 2070, as NBFCs exposure will be mainly concentrated in the renewable power sector

Particulars	Power	Transport	Industry
Annual Credit flow	Annual change in NBFC credit exposure to the power sector (Current year Power sector NBFC credit outstanding - Last year Power sector NBFC credit outstanding) + Annual repayment of principal	Annual change in transportation sector (manufacturing and retail) NBFC credit exposure + Annual repayment of principal	Annual change in industrial sector NBFC credit exposure + Annual repayment of principal
Repayment of principal	Calculated assuming an average loan duration of 18 years[xvi], with the principal amortised annually over the loan period	Calculated assuming an average loan tenure of 10 years[xvii], with the principal amortised annually over the loan period.	Calculated assuming an average loan tenure of 25 years[xviii], with the principal amount amortised annually over the loan period.

xvi The average loan duration of 18 years for power sector is based on: Central Electricity Regulatory Commission. (2020, June 23). Central Electricity Regulatory Commission (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulations, 2020. https://cercind.gov.in/2020/regulation/159_reg.pdf

xvii The average loan duration of 10 years for transport sector is based on: Bank of Maharashtra. Maha MSME Project Loan Scheme. https://bankofmaharashtra.in/maha-msme-project-loan-scheme

xviii Loans with a 25-year tenure are generally reserved for large-scale, long-gestation industrial infrastructure and public sector projects, where the repayment schedule is tied to the extended revenue-generation cycle of the asset. India Infrastructure Publishing Ltd.. (2025, January 7). Project financing: Industry players discuss the changing funding landscape. India Infrastructure. https://indianinfrastructure.com/2025/01/07/project-financing-industry-players-discuss-the-changing-funding-landscape/

Annexure-7: Assumptions for Sectoral Exposure of Corporation Bond Issuance

The total corporate bond issuance in a year is allocated to power, transport, and industrial sectors using the following approach and assumptions:

Particulars	Power	Transport	Industry
Computation of total corporate bond issuance to low-carbon transition secotr	**Total corporate bond issuance × Electricity sector's bond share (%)**	**Total corporate bond issuance × Transportation sector's bond share (%)**	**Total corporate bond issuance × Industrial sector's bond share (%)**
Total corporate bond issuance	As outlined in the methodology section, total corporate bond issuance is derived from the year-on-year difference in corporate bond outstanding, which is calculated as a % of GDP: The following formula is used: **Annual bond issuance = Current year's corporate bond outstanding - Previous year's corporate bond outstanding**		
Sector share in total corporate bond issuance in FY2023[xix]	~4.4%	~0.05%	~1.7%
Projection assumption (up to 2070)	Assumed at 4.6%, in line with the historical five-year average (FY2019-23)	Assumed at 0.05%, as the historical five-year average (FY2019-23)	Assumed at 2%, in line with the historical five-year average (FY2019-23)

xix Bloomberg database is used to extract the sectoral composition of corporate bond issuance in India.

Annexure-8: Assumptions for Institutional Investors' AUM calculation and sectoral allocation

ANNEXURE-8.1: COMPUTATION OF AUM OF INSTITUTIONAL INVESTORS

Calculation of Asset Under Management (AUM) of each institutional investor is discussed below:

Particulars	Life Insurance	General Insurance	Pension Fund	Employee Provident Fund	Mutual Fund
AUM Formula	**$AUM_t = AUM_{t-1}$ + Premiums + Investment Income – Benefits – Expenses**	**$AUM_t = AUM_{t-1}$ + Premiums + Investment Income – Benefits – Expenses**	**$AUM_t = AUM_{t-1}$ + Contributions + Investment Income – Benefits**	**$AUM_t = AUM_{t-1}$ + Contributions + Investment Income – Benefits**	**$AUM_t = AUM_{t-1}$ + Net Fund Mobilised + Investment Income – Expenses**
Premium/ Contribution Mobilisation	Calculated as % of GDP. In FY2023, life insurance premium stood at 3% of GDP[98]. Assumed to increase to 4% of GDP by 2070.	Calculated as % of GDP.In FY2023, general insurance premium stood at 0.97% of GDP[98]. Assumed to increase to 2.9% of GDP by 2070.	For pension fund and provident fund, total contribution is linked to the portion of household financial savings directed toward pension fund and provident fund. In FY2023, out of the total household savings directed to pension and provident funds, 75% is toward pension fund with Pension Fund Regulatory and Development Authority (PFRDA) (after excluding other schemes like NPS and Sukanya Samriddhi Yojna) and 25% is toward employee provident fund with EPFO. Historically (FY2019-23), household financial savings directed to PFRDA accounted for an average of 60% of the total contribution received by PFRDA[99]. For projections, this ratio is assumed remain constant till 2070. For EPFO, household financial savings directed to EPFO historically (FY2019-23) accounted for 45% of the total contribution received by EPFO[100]. It is assumed to remain constant till 2070.		Linked to portion of the household financial savings in mutual fund, which is expected to rise from current 6% in FY2023 to 12% by 2070 In FY 2023, household savings directed to mutual fund are 32% of the total fund mobilised[101]. For projections, the five-year historical (FY2019-23) average of 36% is used and is projected to increase to ~50% till 2070.

Particulars	Life Insurance	General Insurance	Pension Fund	Employee Provident Fund	Mutual Fund
AUM investment allocation	**AUM allocation in FY2023**[xx]: Govt securities - 60% Corporate bonds - 2% Equity - 19% Others - 19% **Assumed allocation till 2070:** Govt. Securities - gradually decrease to 52% Corporate bonds - Increase to 5% (expected more allocation to debt securities) Equity - Constant at 19% Others - Increase to 24%	**AUM allocation in FY2023**[xii]**:** Govt securities - 53% Corporate bonds - 6% Equity - 19% Others - 22% **Assumed allocation till 2070:** Govt. Securities - gradually decrease to 51% Corporate bonds - Increase to 8% Equity - Constant at 19% Others - Constant at 22%	**AUM allocation in FY2023**[100]**:** Govt. securities - 52% Corporate bonds - 27% Equity - 17% Others - 4%. **Projected allocation till 2070:** Govt. Securities - remain constant at five-year average of 51% (FY2019-23) Corporate bonds - Constant at an average of 34% (FY2019-23) Equity - Constant at an average of 14% (FY2019-23) Others - Constant at 1%	**AUM allocation in FY2023**[101]**:** Govt. securities - 70% Corporate bonds - 21% Equity - 9% Others - 3%. **Assumed allocation till 2070:** Govt. securities - gradually decrease to 65% Corporate bonds - increase to 23% Equity - Remain constant at 9%; Others constant at 3%	**AUM allocation in FY2023**[102]: Debt - 34% Equity - 53% Others - 13% **Assumed allocation till 2070:** Equity increases to 58%; Debt decreases to 34%; Others decrease to 8%.
Interest on Investment	**Government securities:** 5% (until 2047: Inflation + 1%), 4% (2047-2070) **Corporate bonds:** 8% (until 2047 – return on govt. securities + 3% risk premium), 7% (2047-2070) **Equity:** 11-13% (Corporate bond return% + 5% equity premium till 2040, 4% between 2040-2050, and then 3.5% thereafter)				**Debt:** 8% (until 2047) and 7% (2047–2070). **Equity:** 11–13% (Corporate bond return% + 5% equity premium till 2040, 4% from 2040 to 2050, and 3.5% thereafter).
Benefits (Calculated as % of premium/ contribution)	**FY2023:** 63%[98] of the premium **Assumed** to remain constant till 2070	**FY2023:** 58%[98] of the premium **Assumed** to remain constant till 2070	**FY2023:** 53%[100] of the contribution **Assumed** to gradually increase to 57% by 2070 with the ageing population	**FY2023:** 50%[100] of the contribution **Assumed** to gradually increase to 57% by 2070	Not applicable

xx Portfolio allocation data is extracted from annual reports of Insurance Regulatory and Development Authority of India (IRDAI) and various public and private insurance companies.

Particulars	Life Insurance	General Insurance	Pension Fund	Employee Provident Fund	Mutual Fund
Expenses (calculated as % of premium/ contribution)	**FY2023:** 17%[98] of the total premium **Projected** to gradually decline to 10% by 2070	**FY2023:** 29%[98] of total premium **Projected** to gradually decline to 18% by 2070	Distribution and AUM fees are almost negligible, so it is not included	Expenses are minimal. Not included in the model	**FY2023:** 0.5%[102] of the previous year's AUM **Assumed** to remain constant till 2070

ANNEXURE-8.2: ASSUMPTIONS FOR SECTORAL ALLOCATION OF INSTITUTIONAL INVESTORS EQUITY INVESTMENT

The institutional equity investment is allocated to power, transport, and industry based on their sectoral weights in the NIFTY50 index. The following table explains the approach and assumptions:

Particulars	Power	Transport	Industry
Computation of institutional equity investment to low-carbon transition sectors	**Total equity investment of institutional investor × % weight of sector in NIFTY50**	**Total equity investment of institutional investor × % weight of sector in NIFTY50**	**Total equity investment of institutional investor × % weight of sector in NIFTY50**
Total equity investment of the institutional investor	As outlined in the annex above (8.1), equity allocation as % of AUM is: Life insurance: 19%; General insurance: 19%; Pension Fund: 17%; Employee Provident Fund: 9%; Mutual Fund: 53% The sum of all these equity investments gives the total equity investment by the institutional investors: **Total equity investment of institutional investors = Life insurance AUM equity allocation + General insurance AUM Equity allocation + Pension Fund AUM equity allocation + Employee Provident Fund AUM equity allocation + Mutual Fund equity allocation.**		
Sectoral weight in NIFTY50 Index[103]	Power sector weightage in NIFTY50 market capitalisation ranged between 2-3% during FY2019-23	Transportation sector weightage in NIFTY50 market capitalisation ranged between 4.5-7% during FY2019-23	Industrial sector weightage in NIFTY50 market capitalisation ranged between 5-6.5% during FY2019-23
Projection assumption (up to 2070)	Historical five year average (FY2019-23) of 3% is assumed to increase to 5% by 2070 due to expected increase in renewable energy capacity	Assumed to remain constant at 5.3% as the historical five-year average (FY2019-23)	Assumed to remain constant at 6.3% as the historical five-year average (FY2019-23)
Equity capital flow in a year	Annual change in power sector equity investment	Annual change in transport sector equity investment	Annual change in industrial sector equity investment

Annexure-9: Assumptions for Sectoral Exposure of Corporate Equity Investment

Capital investment made by corporations in the power, transport and industry sectors is used to estimate corporate equity investment. The sectoral approach is explained as follows:

Particulars	Power	Transport	Industry
Computation of corporate equity investment	**Total direct investments by non-financial corporations × % share of power sector CAPEX**	**Total investments by non-financial corporations × % share of transport sector CAPEX**	**Total investments by non-financial corporations × % share of industry sector CAPEX**
Total investment by non-financial corporations	Represents the financial savings of non-financial corporations, excluding allocations towards bank deposits, insurance, pension funds, and provident funds.		
Sectoral CAPEX in total direct investment by corporations (i.e., CAPEX in a sector/total direct investment)[xxi]	Ranged between 1% to 6% during FY2017-23	Ranged between 1% to 2% during FY2017-23	Ranged between 1% to 7% during FY2017-23
Projection assumption (up to 2070)	Historical seven-year average[xxii] of 3% is taken and assumed to rise to 5% by 2070 due to expected increase in renewable energy capacity	Assumed to remain broadly stable at historical seven-year average of 1% over the projection period	From a historical seven-year average of 4.3%, projected to increase to 6% by 2047, then moderate to 3.5% by 2070

xxi For sectoral CAPEX, companies operating in the sector are considered, and their retained earnings used in capital expenditure are tracked. The data has been extracted from the ProwessIQ/CMIE database.

xxii A seven-year period is considered for projecting percentages due to fluctuations observed in free cash flow to equity caused by events such as COVID-19.

Annexure-10: Assumptions for Sectoral Exposure of PE/VC investment

PE/VC Investment in power, transport, and industrial sector is estimated based on the following approach and assumptions :

Particulars	Power	Transport	Industry
Computation of PE/VC investment in sectors	**Total PE/VC funding in enabling the low-carbon transition across sectors × % share of power sector**	**Total PE/VC funding in enabling the low-carbon transition across sectors × % share of transport sector**	**Total PE/VC funding in enabling the low-carbon transition across sectors × % share of industrial sector**
Total PE/VC funding toward enabling the low-carbon transition across sectors[xxiii]	Total PE/VC funding toward enabling the low-carbon transition across sectors is 2% of total PE/VC funding in FY2023. Projected to rise to 6.5% by 2035 and decline thereafter to 2.5% by 2070. Hence, **Total PE/VC funding toward enabling low-carbon transition sectors = Projected PE/VC funding (as % of GDP) x Projected share of enabling the low-carbon transition across sectors in PE/VC funding**		
Sectoral share in PE/VC funding toward enabling the low-carbon transition across sectors (FY 2023)	~50% (reflecting growing focus on the energy sector)	~20%	~25%
Projection assumption (up to 2070)	Gradually decline to 30% by 2070, as funding shifts toward emerging Net Zero technologies such as direct air capture	Gradually decline to 3% by 2070, with EV and charging infrastructure reaching maturity	Gradually increases to 45% by 2070, driven by investment in emerging low-carbon technologies such as green hydrogen and carbon capture

xxiii PE/VC funding toward enabling the low-carbon transition across sectors is calculated as the sum of PE/VC funding to energy, transport, industry, and building, based on data extracted from the Tracxn database.

Annexure-11: Assumptions for Sectoral Exposure of Foreign Direct Investment (FDI)

FDI equity inflows allocation to power, transport, and industrial sector are estimated based on following approach and assumptions:

Particulars	Power	Transport	Industry
Computation of FDI allocation to sectors	**Total FDI equity inflows × % share of power sector**	**Total FDI equity inflows × % share of transport sector**	**Total FDI equity inflows × % share of industrial sector**
Total FDI equity inflows	As outlined in the methodology section, FDI equity inflows are estimated based on GDP: **FDI equity inflows = Projected share of FDI in GDP x Projected GDP**		
Sectoral share in FDI equity inflows (FY 2023)[41]	~5%	~6%	~10%
Projection assumption (up to 2070)	Expected to increase gradually to 6% as foreign capital flows in power sector are expected to rise due to attractiveness of the RE sector	Assumed to be constant at 6% till 2070	Assumed to be constant at 10% till 2070

Annexure-12: Assumptions for Sectoral Exposure of Foreign Portfolio Investment (FPI)

ANNEXURE-12.1: FOREIGN PORTFOLIO EQUITY INVESTMENT

The foreign portfolio equity investment is allocated to power, transport, and industry based on the sectoral weights of the sectors in the NIFTY50 index. The following table explains the approach and assumptions:

Particulars	Power	Transport	Industry
Computation of FPI equity investment allocation to sectors	**Total FPI equity flows × % share of power sector**	**Total FPI equity flows × % share of transport sector**	**Total FPI equity flows × % share of industrial sector**
Foreign portfolio equity investment	**Total FPI Investment is calculated as: Current year's Asset Under Custody - Previous year's Assets Under Custody** This total FPI investment is allocated to equity, debt, and hybrid assets. Based on historical data, foreign portfolio investment in equity is estimated at 60%		
Sectoral share in foreign portfolio equity investment (based on sectoral weight in NIFTY50 Index)[103]	Power sector weightage in NIFTY50 market capitalisation ranged between 2-3% during FY2019-23	Transportation sector weightage in NIFTY50 market capitalisation ranged between 4.5-7% during FY2019-23	Industrial sector weightage in NIFTY50 market capitalisation ranged between 5-6.5% during FY2019-23
Projection assumption (up to 2070)	Historical five year average (FY2019-23) of 3% is assumed to increase to 5% by 2070 due to expected increase in renewable energy capacity	Assumed to remain constant at 5.3% as the historical five-year average (FY2019-23)	Assumed to remain constant at 6.3% as the historical five-year average (FY2019-23)
Foreign portfolio equity investment in a year	Annual change in power sector equity investment	Annual change in transport sector equity investment	Annual change in industrial sector equity investment

ANNEXURE-12.2: FOREIGN PORTFOLIO DEBT INVESTMENT

The foreign portfolio debt investment is allocated to power, transport, and industry based on the sectoral exposure of corporate bonds in India. The following table explains the approach and assumptions:

Particulars	Power	Transport	Industry
Computation of foreign portfolio debt investment allocation to sectors	**Total FPI debt investment × % share of power sector**	**Total FPI debt investment × % share of transport sector**	**Total FPI debt investment × % share of industrial sector**
Foreign portfolio debt investment	**Total FPI Investment is calculated as: Current year's Asset Under Custody - Previous year's Assets Under Custody** This total FPI investment is allocated to equity, debt, and hybrid assets. Based on historical data, debt accounts for approximately 35% of total FPI flows		
Sectoral share in foreign portfolio debt investment in FY2023 (based on corporate bond sectoral exposure[xxiv])	~4.4%	~0.05%	~1.7%
Projection assumption (up to 2070)	Assumed at 4.6%, in line with the historical five-year average (FY2019-23)	Assumed at 0.05%, as the historical five-year average (FY2019-23)	Assumed at 2%, in line with the historical five-year average (FY2019-23)
Foreign portfolio debt investment in a year	Annual change in power sector debt investment	Annual change in transport sector debt investment	Annual change in industrial sector debt investment

xxivBloomberg database is used to extract the sectoral composition of corporate bond issuance in India.

Annexure-13: Assumptions for Sectoral Allocation of External Borrowings

The sectoral allocation of external borrowings to different sectors is based on the share of these sectors in FDI. The assumptions are explained below:

Particulars	Power	Transport	Industry
Computation of External borrowings allocation to sectors	**Total debt issuance by non-financial corporation × % share of power sector**	**Total debt issuance by non-financial corporation × % share of transport sector**	**Total debt issuance by non-financial corporation × % share of industrial sector**
Total external debt issuance by non-financial corporations	As outlined in the methodology section, external debt issuance by non-financial corporations is estimated based on their historical share in total external outstanding debt, assuming an average five-year maturity for external borrowings: **Total external debt issuance by non-financial corporations = Gross debt outstanding by non-financial corporations / 5**		
Sectoral share in debt issuance by non-financial corporation in FY2023 (using FDI sectoral allocation[42] as proxy[xxv])	~5%	~6%	~10%
Projection assumption (up to 2070)	Expected to increase gradually to 6%	Assumed to remain constant at 6% till 2070	Assumed to remain constant at 10% till 2070

xxv Due to the unavailability of sectoral data, sectoral allocation percentages of FDI are used as a proxy, considering it to be a comparable foreign source.

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