



Managing Climate Risks through Green Finance Instruments: Industry Analysis

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ABSTRACT

The concept of sustainability or green principle in business activities is not only confined to creating green products, green supply chains, green business operations or simply developing green HR policies but the concept embraces the whole green culture of a firm, where it becomes necessary to create green capital as well and invest in green projects through green financial instruments the firms can achieve their green objectives. Green investment (i.e. investing in green projects) also fosters the steady and sustained growth of businesses.

Climate change is one of the most pressing challenges facing the global community. As governments, businesses, and individuals grapple with the urgency of reducing carbon emissions and the struggle for the transition to a sustainable future, green financing initiatives are inevitable. Managing climate transition risks through green financial instruments is an innovative and sustainable approach to financing projects that help mitigate climate change and adapt to its impacts. In the fiscal year 2023 budget of the Indian central government, there was a proposal to issue national green bonds valued at Rs 24,000 crore. The purpose of this bond issuance is to financially support public sector projects, with the ultimate goal of transitioning India into a low-carbon economy. Furthermore, this move is also expected to boost the growth of sustainable finance in the country.

In this paper, an analytical study highlighting the carbon emission contribution of various sectors has been done and contrasted against global standards. The paper also highlights the technological improvements towards decarbonization, documents sector-wise net zero goals and also gives an account of the capex committed to energy-conservative technologies and renewable energy to reduce climate transition risk. In the above context, the research study also provides insights into the hurdles faced in implementing ESG goals and ways to overcome these hurdles to manage the transition risks.

Keywords: Transition Risk, Hard-to-abate, Green Finance, Green Bonds, ESG, Climate Change

1.0 Introduction

The urgent need to address climate change and its profound effects on ecosystems, economies, and society has extensively acknowledged in past few years by the international community. Climate transition risks are connected to the shift to a low-carbon and sustainable economy, which is a key idea in this problem. The role of green finance instruments has emerged as a crucial facilitator of sustainable development as firms, governments, and financial institutions struggle with the challenges of this shift.

Numerous financial tools and systems are referred to as "green finance instruments" and are intended to direct funds toward ecologically friendly projects and endeavors. These instruments, which encourage and promote investments in renewable energy, include green bonds, green investment funds, sustainability-linked loans, green investment funds, and other pioneering financial tools that contribute to investment in climate-resilient infrastructure, renewable energy, and sustainable agriculture.

It is impossible to exaggerate the significance of green finance tools for controlling the danger of the climate shift. These tools are important for reducing the risks related to climate change because they synchronize financial flows with climate objectives and encourage sustainable investments. They facilitate the incorporation of environmental factors into the decision-making processes of investors, improve the transparency and disclosure of financial information connected to climate change, and stimulate the expansion of environmentally friendly technology and solutions. Adopting and disseminating green financing tools will be crucial in cutting emissions, attaining climate resilience, and protecting the environment for future generations as the world economy shifts to a low-carbon ambit.

This paper is an attempt to explore the circuitous relationship between climate transition risk and green finance in order to get the better understanding of how these tools can be used to promote sustainable growth, increase resilience, and lessen the negative effects of climate change. The purpose of this study is to offer practical suggestions to financial institutions, investors, policymakers and other parties participating in the shift to a low-carbon economy.

Also, this paper highlights a sectoral analysis of the emission profile of hard-to-abate industries in India and their gameplan for Net Zero emission and how India as an economy is performing against the global standards.

2.0 Meaning and Concept of Climate Risk

Climate risk is uncontrollable risk, i.e., systematic risk specially for financial institutions. These risks could cause pressing damages as they are very difficult to capture due to its intensity and are frequently occurring. So, exactly what is this risk? When the risk arises due to earth's changing climate and various social, economic, and environmental factors, this risk is called as climate risk, which potentially has adverse effects on the ecosystem, human society, and economies as well. Precisely, this covers effects on people's lives, means of subsistence, health and happiness, investments in economic, social, and cultural assets, infrastructure, the delivery of services, ecosystems, and species.

Practically, for businesses, climate risk can be explained as the magnitude to which they are vulnerable to financial consequences originating from climate-related events or changes that could affect various aspects of financial performance. These repercussions may differ from minor inconveniences to complete impairment of an asset's functionality or value. Minimizing the unpredictability of these outcomes is vital for businesses, considering the significant implications involved. The concept of climate risk encompasses two popular sub-types:

Physical Risks: It involves the effect of events linked to climate change such as utmost weather episodes (e.g., hurricanes, floods, heatwaves, droughts), rise in sea level, and changes in temperature patterns. These events can vandalize the infrastructure, disrupt supply chains, and threaten lives and livelihoods. Now, these risks could result in financial consequences for companies, including tangible harm to assets and secondary effects stemming from disruptions in the supply chain.

Transition Risks: What does transition mean? The literal meaning of transition is a change or shift from one state to another. Therefore, Transition Risk is probable loss or cost which a company or anybody has to incur to shift from one state to other. Transition risks emerge from initiatives aimed at combating climate change and transitioning towards a low-carbon economy. These risks encompass alterations in policies, advancements in technology, budge in consumer behaviour, and changes in market conditions. For instance, regulatory shifts like carbon pricing or emissions regulations can impact the profitability and sustainability of specific industries. Due to transition hazards, organizations could encounter different levels of reputational and financial jeopardy. Transition risk can be sub-categorized into four parts, which are: policy & legal risk, Technology risk, market risk and reputation risk.

(Erik Feyen, 2020) The economic repercussions of climate change significantly influence the stability and management of macro-financial systems. "Lower economic growth coupled with large climate-related financing needs and increased levels of uncertainty will have a detrimental impact on the balance sheets of all sectors – public, financial, corporate, and households."



Source: World Bank Group

3.0 Green Finance

Finance is nothing but an art and science of managing money. But the sources of these funds should be critically analysed. The statement- "Finance in company is very similar to as blood in human body and without blood human body is nothing similarly without proper funds any organization is nothing" need improvements as today's environmental scenario has changed. Just imagine blood in your body is toxic and impure, will you survive? Answer of course will be no. Therefore, to remain fit you need to consume healthy food. Similar case is with financing in business. Due to poor climate conditions and increasing climate risk, firms need to consume healthy finance, i.e., green finance so that business can endure for long period of time. This can simple be done by investing in green projects.

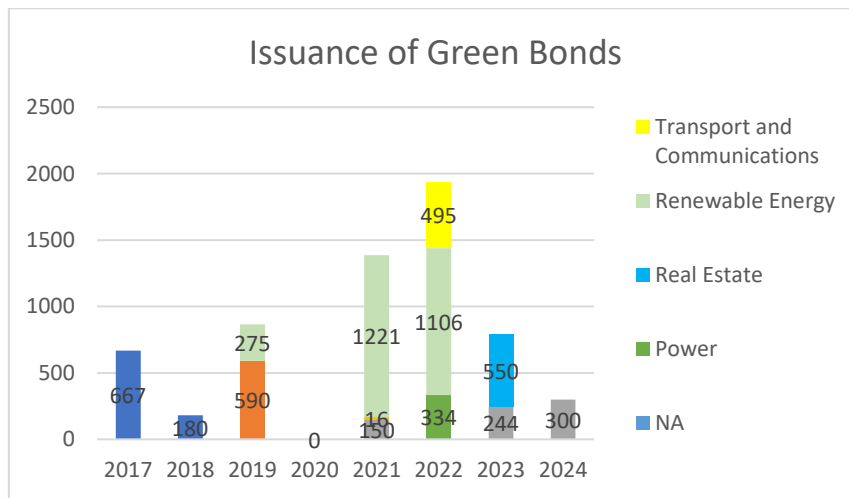
Green finance refers to financial products, services, investments, and initiatives that support environmentally sustainable projects and activities. Investing in green projects and acting sustainable does not mean companies is compromising its profitability and growth. Primary aim of green finance is to

encourage economic growth while mitigating environmental risks and contribute to the transition of a low-carbon, and sustainable economy as whole. Green finance encompasses various instruments and mechanisms that promote environmentally friendly practices and projects, such as green credits, green bonds, green insurance, green loans, green investment funds, and sustainability-linked financial products.

3.1 Green Finance Instruments

Green finance instruments encompass a variety of financial products and mechanisms designed to support environmentally sustainable projects and initiatives. Some of the key green finance instruments include:

Green Bonds: Bonds are the debt securities issued by governments, municipalities, corporations, or financial institutions to raise capital for specific environmentally beneficial projects. The development of sustainable initiatives like renewable energy, sustainable transportation, increased energy efficiency, and climate change adaptation, will benefit from the proceeds of green bonds. Issuance of green bond in India is gaining popularity but still it is not so good to support green projects and fulfil sustainability goals. The following figure shows the investment in green bonds by different sector from year 2017 till date.



Green Loans: This financial instrument provides funding specifically for environmentally sustainable projects. These loans can be disbursed by banks, financial institutions, or multilateral development banks and are structured with terms and conditions that incentivize or reward the implementation of green initiatives.

Green Investment Funds: The work of green investment funds is to pool the capital from investors and allocate it to a portfolio of environmentally responsible projects and assets. Green investment funds may focus on specific sectors such as renewable energy, sustainable infrastructure, or clean technology, providing investors with opportunities to support sustainability while potentially earning financial returns.

Sustainability-Linked Loans: Unlike traditional loans, sustainability-linked loans offer interest rate incentives tied to the borrower's achievement of predetermined sustainability targets or key performance indicators (KPIs). These loans encourage companies to improve their environmental and social performance by aligning their financial interests with sustainability goals.

Sustainability-Linked Derivatives- In light of the increasing application of ESG considerations in the financial sector, Sustainability Linked Derivatives, or "SLDs," are developing as a potent new tool in the toolbox of financiers worldwide. SDG-linked derivatives are a relatively new strategy of investment for those companies that are prioritizing ESG concerns. Sustainability-linked derivatives shift the risk of an SDG investment to a financial intermediary in the form of sustainability-linked bonds (SLBs) and loans (SLLs).

Green Insurance Products: Environmental risks and liabilities, those are related to the effects of climate change, natural catastrophes, and contamination of the environment, are covered by green insurance products. These insurance products help businesses and governments manage financial risks related to environmental events and encourage investments in resilience and adaptation measures.

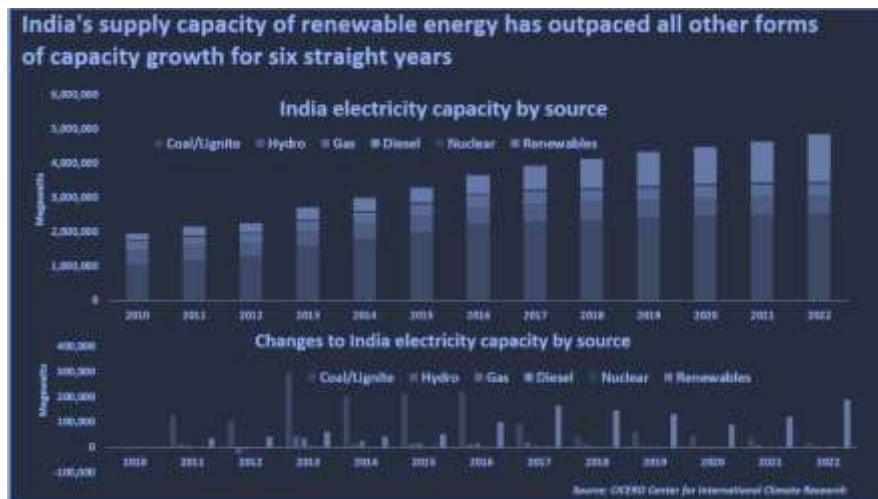
Green Equity Investments: Equity investments in companies or projects with strong environmental credentials are another form of green finance. Investors may acquire shares in renewable energy companies, sustainable agriculture projects, or green technology startups, supporting innovation and growth in environmentally friendly sectors.

Carbon Offsets: Carbon offsetting involves investing in projects that reduce or offset the emission of greenhouse gas. Therefore, actions towards reforestation, renewable energy generation, or energy efficiency initiatives are greatly focused. Investors purchase carbon credits generated by these projects to indemnify for their own carbon emissions, participating in international initiatives to reduce climate change.

Carbon Markets- Carbon markets reduce GHG emissions by allowing the trade of emission units, or carbon credits, which certify emission reductions. Higher-cost emitters can compensate businesses that can cut emissions more affordably through trading. These markets incentivize investors and consumers to choose lower-carbon options by pricing carbon emissions and highlighting the environmental and social impacts of carbon pollution.

Redesigning its Carbon Credit Trading Scheme (CCTS) in 2024, India took a bold move by allowing non-obligated organizations to take part in the market for trading carbon credits. In other words, businesses and people can choose to offset their GHG by using carbon credits. (L, 2024) Starting in 2026, India will launch a compliance carbon market, focusing on industries like iron, steel, chemicals, and cement, where emissions are difficult or costly to reduce with current technology. After hosting the G20 Summit in 2022, India emerged as a favorable destination for energy transition investments, adding 17 GW of capacity, with 13.8 GW coming from non-fossil sources.

In terms of the nation of South Asia's capacity to generate electricity, renewable energy has experienced the biggest rise.



The carbon markets hold enormous potential in bridging the emissions reduction gap required to move closer to a 1.5°C trajectory. The revamped Carbon Credit Trading Scheme (CCTS) implemented by India signifies a major advancement in the worldwide decarbonization drive. This adds to the robust expansion of the global carbon trading market, which reflects a positive trend in the direction of lower greenhouse gas emissions.

4.0 Review of Literature

This literature review aims to give a thorough examination of the function of green finance instruments in mitigating the risk concerned with the climate transition by identifying important frameworks, tools, data, possibilities, and difficulties.

(Roy, 2021) This paper accentuates the green finance instruments, often used in India that includes green banking, green bonds, green insurance, and green equity indices. Data collected from numerous secondary sources and the annual reports of the top 20 public and private sector banks in India suggested the introduction of new green financial instruments (GFIs) into the Indian financial system. These include green mutual funds, green ETFs, green hedge funds, green investment banks, green Sukuk, energy service companies, A/B loans or grants, green revenue bonds, green convertible bonds, and environmental impact bonds/pay-for-results green bonds. Author's opined, it is crucial to support environmental sustainability and draw in socially conscious investors by introducing new GFIs in India.

(Kumar D. S., 2023) The research highlights the significance of sustained advocacy and expansion of the green bond market in India in order to expedite the shift towards a more ecologically conscious and sustainable future. The government has taken diverse steps to promote green bonds such as introduction of Sovereign Green Bonds, recognizing their potential to contribute to achieve India's net carbon neutrality target by 2070. Additionally, it implies that India should take proactive measures to solve problems like low greenium, greenwashing, and the requirement for green bond audits by studying the experiences of Western nations. A thorough analysis of the body of research on green bonds and sustainable financing is demonstrated by the references listed in the article, which include papers from reputable sources like the Ministry of financing, RBI, World Bank Group, and IMF.

(Bloomberg, 2017) The research offers recommendations for revealing climate-related financial data in understanding and addressing the possible risks and opportunities associated with climate change, aiming for clear, comparable, and consistent disclosures to support informed decision-making. The main findings emphasize the necessity of organizations accepting the Task Force's recommendations, i.e., disclosing clear, comparable, and corresponding information about the exposures and opportunities displayed by change in climate, provide widely adoptable recommendations on financial disclosures with special reference to change in climate, which is applicable to different sectors and jurisdictions, structure suggestions of four thematic areas: "risk management, strategy, governance, and metrics & targets", and create a framework of guidelines to steer current and future development in climate related reporting.

(Neha Khanna, 2022) The report identifies a balanced approach to increasing green finance while managing financial risks concerning with climate change in India. For accomplishing these goals, it emphasizes the importance of market mechanisms, regulatory prescriptions, and policy interventions.

The study also made some recommendations include introducing carbon ratings, modifying credit rating methodologies, setting up a green bank, and relaxing external commercial borrowing norms. **Additionally, stress tests, scenario analysis, and regulations for additional bond offerings are suggested to attract more capital towards sustainable investments.** The document also highlights the importance of directing funds from insurance and pension funds towards green activities and implementing standardized disclosure frameworks for the financial sector.

(Chopra, 2023) The paper delves into the sustainability efforts by analyzing sustainability measures and initiatives of India's top 100 companies by market capitalization, focusing on capex, R&D spend, transparency, technologies invested, trends in emissions and energy consumption, inter-sectoral differences, and expecting improvements in disclosures with the introduction of Business Responsibility and Sustainability Reporting (BRSR) Core. Overall, the outcome of this report measured the emissions reduction and energy consumption reduction.

(Chengbo Fu1, 2024) The paper focuses on finding and developing inter-connections between climate change, decarbonization, and green finance, highlighting the role that green finance plays in halting global warming and advancing sustainable development. Various aspects related to green finance, including greenhouse gas emissions, environmental disclosures, climatic disaster risk, economic consequences of global warming, and the macroeconomic consequences of climate are been studies here. The report also emphasizes the growing interest in the role that finance can play in sustainable development given the difficulties posed by change in climate and the urgent need to decarbonize. The research methodology employed two distinct approaches to select green finance articles, focusing on identifying essential themes and conducting a systematic analysis using specific keywords.

(Egemen Eren, 2022) The paper summarizes the examination of transition and physical risks in financial markets, discussing concerns about pricing adequacy, challenges posed by uncertainty, evidence of pricing in certain markets, challenges for firms in high-carbon sectors, effectiveness of developed financial markets in hedging risks, and the development of insurance-linked securities and catastrophe bonds. Thus, this paper nicely gives the ways to meet the risk, which includes, the partial pricing of physical risks in certain markets, pricing of transition risks in equity markets, premium trading of green bonds, pricing of stranded assets, and the availability of effective hedging mechanisms in developed financial markets.

(Jean Chateau, 2023) This paper provides a foundation for mitigating the climate-change in India by reducing greenhouse gas emissions. It discusses the current climate policy landscape, sectoral mapping, and policy packages for accelerating the energy transition. The paper also emphasizes the India's aim of transition to net zero emissions by 2070. It also discusses India's emissions mitigation strategy in sectors such as power, industry, transport, agriculture, and residential. The document explores the challenges and opportunities for India in shifting to a greener and more sustainable economy, including the potential cost-benefit of different policy options.

(Thobhani, 2023) discussed the recent trends of green finance in India. The study highlights the importance of green finance in achieving sustainable economic growth and addresses the challenges and opportunities in this field and green finance trends in India are discussed, including the increase in financial flows from both the public and private sectors. However, the current flow of green finance falls short of the country's needs, with only about 25% of the needed finance being tracked. The study also provides insights on the sources of green finance, including green bonds, sustainable equity, green credit cards, solar investment trusts, and sustainable energy bonds.

5.0 Research Objective

1. To categorize and analyse existing green finance instruments that can be employed in managing climate transition risk.
2. To conduct a sectoral analysis of the emission profile of hard-to-abate industries in India and their game plan for Net Zero emission.
3. To identify the future growth opportunities and challenges for green finance in India
4. To critically analyse the current status of regulatory and supervisory policies in green finance and provide suggestions to improve it.
5. To analyse India's current Global performance in transitioning into a low-carbon economy.

6.0 Research Gap

Apart from a few studies conducted by IMF and CRISIL on sustainability, no proper researches were found in the Indian context that focuses on hard-to-abate industries in the context of carbon emission, their challenges and opportunities in achieving the NET ZERO target. It is thus important to document the current status and the possibility of inclusion of more green finance instruments within these industries to achieve sustainability targets.

7.0 Research Methodology

The current study is a review of past literature and the research design used in this study is an analytical research approach. The methodology of the paper is divided into three sections, firstly, the thorough analysis of statistical data from different secondary sources is being conducted. Secondly, an analysis of India's GHG emissions has been done in comparison with Global players. Thirdly, a brief explanation of India's current status on green financing has been touched, and lastly, a rigorous sectoral analysis has been conducted.

Data and facts used in this study has been drawn from diverse secondary sources. Broadly, this study includes information and data from websites, published reports, research papers, newspapers, articles, book chapters, and reliable government publications. Data was extracted and analysed from different Government sources and International Institutions like CEA, CCPI, CRISIL, RBI, SEBI, IMF, and UNFCCC.

8.0 India and Its Actions on Climate Change: A Global Landscape

India, one of the fastest-growing economies globally, can significantly impact global sustainability and decarbonization. With the sixth-largest economy and a population over 1.2 billion, India has experienced notable economic growth, especially in the service sector, which contributes about 57% of GDP. The shift from an agriculture-based economy to a service-oriented one began with 1990s reforms. While the manufacturing sector has also expanded, its growth is slower compared to regional peers like China. Despite economic progress improving living standards and job creation, concerns about its sustainability impacts persist.

As the world's third-largest energy consumer as of 2023, India is an important participant in the global shift to renewable energy. India is moving quickly to address its high carbon emissions and environmental difficulties as the need to expedite this transformation becomes increasingly critical in light of a rising tide of climate fatalities.

India's rapid economic expansion is causing an enormous rise in the country's energy demand, which calls for a move away from fossil fuels. Fossil fuels, however, continue to drive the world's energy consumption and drive up the emission of greenhouse gases. According to the CEA (CENTRAL ELECTRICITY AUTHORITY) committee, India has allocated ₹2.44 lakh crore, or ₹2.44 trillion¹, towards tripling its solar and wind capacity, surpassing 500 GW in renewable power output over the next ten years, in order to close the emissions gap. 92% of India's power generation capacity increases in 2022 came from solar and wind energy. India's January 2023 power use of 126.16 billion units increased by over 13% YoY, in line with the rate of increase in energy consumption.

The energy transformation entails significant investments: according to McKinsey, (Mekala Krishnan, 2022) \$9.2 trillion in average annual spending on clean energy assets must be increased by \$3.5 trillion from its current level by 2021 to 2050, or over \$275 trillion.

9.0 A Lens on India's Climate-Related Index

9.1 CLIMATE CHANGE PERFORMANCE INDEX:

India moved up from eighth place in the CCPI 2023 to seventh place in the CCPI 2024. India secured the highest CCPI score among G20 members in 2024, at more than 70 points. On the other hand, Saudi Arabia scored the lowest among the Group of 20.



As per CCPI data, it is interesting to note that India ranks fourth in terms of global climate performance because the top three spots were absent. India's GHG Emissions and Energy Use Scores and Rankings in Important Categories India's reduced per capita energy consumption, which improves its climate status, contributed significantly to its ranking of ninth among examined countries in the context of GHG emissions and tenth in energy consumption.

9.2 ENERGY TRANSITION INDEX:

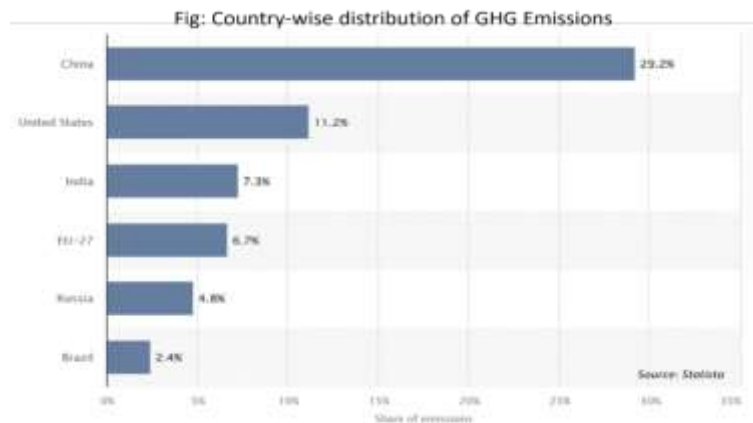
India is the only large country where the momentum for the energy transition is rising across all dimensions, as per the World Economic Forum, which ranked India 67th in the world on its Energy Transition Index on June 28, 2023. On the list of 120 countries, Sweden came in first, followed by Denmark, Norway, Finland, and Switzerland in the top five.

¹ CEA: https://cea.nic.in/wp-content/uploads/notification/2022/12/CEA_Tx_Plan_for_500GW_Non_fossil_capacity_by_2030.pdf

10.0 Country-Wise Distribution of GHG Emissions

In 2022, China accounted for 29% of the world's greenhouse gas (GHG) emissions, solidifying its position as the largest emitter globally (Tiseo, 2023). Following closely, the US contributed 11% of global emissions, ranking as the second-largest emitter. When considering the six largest GHG emitters collectively, they consist of 60% of the total emissions, which amounted to 53.8 billion metric tons of carbon dioxide equivalent (GtCO_{2e}) in 2022.

India produces a significant amount of greenhouse gas (GHG) emissions compared to the world because of its enormous population and burgeoning economy. It is one of the biggest emitters in the world, especially when it comes to carbon dioxide emissions. Despite that, India's emissions are much lower per person than those of many other affluent nations. This distinction highlights how difficult it is to strike a balance between environmental sustainability and economic growth.



In 2022, India's power sector contributed the most to its greenhouse gas emissions (second-largest contributor), accounting for around 32% (excluding LULUCF), with coal-fired power plants responsible for over 95% of these emissions. Agriculture is the second-largest contributor. India's emissions are categorized across sectors such as energy, agriculture, industry, transportation, waste, forestry, and buildings. To reduce emissions, India is focusing on energy efficiency, renewable energy, cleaner technologies, sustainable agriculture, waste management, afforestation, and improving public transportation, aligning with its Paris Agreement commitments and national goals to reduce emissions intensity and increase renewable energy use.

11.0 Economic Losses India Face Due to Climate Risk

It is well known that today India is facing many problems due to climate-change, whether it is an increase in landslides, average temperature, scanty monsoons, floods, droughts, and rising sea levels. So, there is a serious concern of economists and policymakers, to mitigate climate change as it is harming the sustainability of life, livelihood, and the ecosystem as it will directly or indirectly impact the Indian Economy. RBI estimates up to 4.5 percent of India's GDP could be at risk by 2030, due to lost labour hours from extreme heat and humidity.

"Climate change due to rising temperature and changing patterns of monsoon rainfall in India could cost the Indian economy 2.8 percent of its GDP and depress the living standards of nearly half of its population by 2050", RBI's Department of Economic and Policy Research (DEPR) says in its latest report on Currency & Finance 2022-23.

As per **World Bank** estimates, by 2030, India could potentially witness around 34 million job losses out of the projected 80 million globally due to productivity decline associated with heat stress. Due to rising global warming, (SULTANA, 2023) In 2019 alone, India lost nearly \$69 billion due to climate-related events, which is in sharp contrast to \$79.5 billion lost over 1998-2017.

"Preserving food and energy security amidst extreme climatic events while obtaining access to technology and critical raw materials required for successful green transition will, therefore, remain a key policy challenge for India," says Shaktikanta Das, governor, RBI.

To mitigate this risk various policies and approaches have been initiated by RBI and other regulators of financial sector, ***like introducing green bonds, incentivising green financing, and creating a market for carbon credits, encouraging green investment***, which will bring financial stability from climate change. However, the present initiatives to tackle the adverse effects of these risks are not up to a satisfying level. According to RBI's DEPR, The primary challenge for India lies in securing new investments, which are estimated to range from \$7.2 trillion in the baseline scenario to \$12.1 trillion in the accelerated scenario by 2050.

"The cumulative total expenditure for adapting to climate-change in India is estimated to be ₹85.6 lakh crore (at 2011-12 prices) by 2030", according to projections by the Ministry of Environment, Forest and Climate Change.

12.0 India's Current Green Financing

"India got its first 'Green Budget' in 2019 when the Union Budget was termed as Green on account of having provisions for pollution control and green infrastructure." (Jain S. , 2022). With its slogan "One Earth, One Family, One Future," India's 2023 G20 presidency signifies a definite drive towards sustainability, even though the country's green finance sector is still in its inchoate stages. This is in alignment with the country's pledge to attain net zero emissions by 2070 made at the United Nations Climate Change Conference in Glasgow (COP26). However, in order to accomplish these goals, a momentous inflow of cash and a robust legal framework is needed.

India made an enormous leap ahead in 2021 when it pledged to the Panchamrit goals. India must raise more green funds to accomplish this higher objective. According to estimates, India will need to spend **INR 716 lakh crores (USD 10.1 trillion) to attain net-zero emissions by 2070 and INR 162.5 lakh crores (USD 2.5 trillion) until 2030** for NDCs. The nation requires investments of over \$170 billion annually. However, anticipated climate finance flows have fallen short, at \$44 billion annually on average.

The Indian government stated on February 1st, 2022, that it would be issuing SGBs in order to raise funds for environmentally friendly infrastructure. The money raised will be used for public sector initiatives that lower the economy's carbon footprint. India released the first tranche of its first sovereign green bond, valued at INR 16,000 CRORE on January 25, 2023. The Indian government announced on February 9, 2023, that it would be issuing another batch of sovereign green bonds for INR 20,000 CRORE².



India's sovereign green bonds reflect its commitment to reducing its carbon footprint and expanding renewable energy by investing in renewable energy and electrifying transportation infrastructure. These sectors contributed over 41% of the country's GHG emissions in 2019 and are expected to account for two-thirds by 2050. Green bond proceeds will fund both emerging technologies like tidal energy and established sources like solar, wind, and small hydro to support India's energy transition, as coal currently fulfills 55% of its energy needs.

India has introduced a range of green financial instruments, such as green indices, bonds, loans, venture capital, banking, insurance, guarantees, and risk-sharing tools. However, only 8 out of 18 green financial instruments available globally are accessible in India. Indian investors have yet to experience products commonly available elsewhere, like green mutual funds, ETFs, hedge funds, investment banks, sukuk, revenue bonds, and convertible bonds. (Roy, 2021)

13.0 Industrial Analysis

Industrial sector is considered as hard-to-abate sector and its contribution to GHG emissions is more what this sector contributes to gross value and employment. (Jean Chateau, 2023) India's industrial sector contribute around 22 percent of total GHG emissions. Within the sector, around 98 percent of emissions are from CO₂. As a developing economy, India needs industrial growth to complement its service sector, but this will lead to higher CO₂ emissions, which are already increasing. Without policy changes to reduce the carbon intensity of the industrial sector, emissions will rise significantly. Government intervention through appropriate policies is crucial to curb future GHG and CO₂ emissions.

Strategical Step by India to Reduce Emission

Introduction of several policies and programs like, PAT (Perform, Achieve, Trade), National Motor Replacement Program (NMRP), ECBC- commercial (*Sets minimum energy standards for commercial buildings*) helped to tackle the emission problems. In India, start-ups or MSME witnessed a remarkable growth as it contributed (Jain N. T., 2024) 33% in India's GDP. Interestingly, (Jean Chateau, 2023) MSMEs constitute about 90 percent of India's industrial sector, and it is estimated that 10-30 percent of energy consumption and GHG emissions could be reduced if MSMEs adopted energy efficient technologies.

² Department of Economic Affairs, Ministry of Finance: <https://pib.gov.in/PressReleasePage.aspx?PRID=1990745>

From the Bureau of Energy Efficiency (BEE), GOI, it is evident that application of the Energy Conservation Building Code (ECBC) lead to a 50 percent reduction in energy use by 2030, which is estimated to lead to a reduction in CO₂ of 250 million tons. The cost of installing the renewable energy has remarkably decreased which voluntarily shifted to renewable energy as their primary source of energy. A heightened policy emphasis on green hydrogen is paving the way for cleaner energy options for industries in India. (Jean Chateau, 2023)

Barriers to Decarbonize

Transitioning to alternative fuel sources may necessitate a complete overhaul of production processes and technologies, practically, which may not be financially viable for many firms.

13.1 Hard-To-Abate Industries

13.1.1 Steel

The Indian steel industry is a major contributor to the country's carbon emissions, accounting for about 12% of India's total CO₂ emissions. The emissions intensity of the Indian steel industry is significantly higher than the global average, due to the use of outdated technologies and lack of emission control measures. Major Indian steel companies have announced plans to invest over Rs 22,000 crore in the next five years to adopt advanced technologies and reduce their carbon emissions. (Vibhuti Garg, 2023), (Krishnamurthy, 2022) and other government report³ have mentioned many researches that reveals the position on steel industry.

13.1.2 Cement

The Indian cement industry, which accounts for around 6% of India's overall emissions, is taking steps to reduce its environmental impact, including adding waste heat recovery units, renewable power sources, and targeting higher thermal substitution rates, with significant investments in green capex planned over the next 3-5 years.

Based on CSE (Centre for Science and Environment) report, top 5 cement companies in terms of production– Ultratech Cement, ACC, Ambuja Cement, Shree Cement and Dalmia Cement – contributed almost 51 per cent of the CO₂ emissions from the sector in India as of 2019-20. India can do much better in reducing the CO₂ emission from its cement production, but due to unavailability of sedimentary rocks for storage and high capex requirements it becomes a challenge to meet the NET ZERO.

13.1.3 Refining

As per the research by CRISIL, “The refining sector in India is responsible for ~10% of the overall annual industrial emissions, as compared with a global average of only 5-7%”. India, as a growing economy, is developing key sectors like power, transport, cement, steel, and agriculture. Fuel remains the primary energy source, and as development progresses, fuel demand will rise, leading to an expansion in refinery capacity. This makes India a major contributor to increased global GHG emissions from the refining industry. (Krishnamurthy, 2022) “Recent technology adoption for lowering emissions has involved flare gas recovery, which consists of treating and storage of CO₂, as well as steam trap management, which focuses on reusability of heat to reduce the need for steam generation.”

Key industry players are actively working to reduce CO₂ emissions. IOCL approved an investment of ₹1,660.15 crore for renewable energy power plants, representing a 50% stake in a joint venture. Reliance Industries Ltd (RIL) pledged ₹7,500 crore toward achieving Net Zero status, focusing on green hydrogen production for its oil-to-chemicals business. To achieve Net Zero, grey hydrogen should be substituted with blue or green hydrogen, also (Krishnamurthy, 2022) prioritizing the capture of emitted carbon dioxide, considering the inherent characteristics of the refining process.

13.1.4 Chemical

The chemical sector is the largest industrial energy consumer and the third-largest source of direct CO₂ emissions. Increasing demand for chemical products and primary chemicals is driving emissions growth. To address this, the industry is focusing on decarbonization efforts, including process optimization, renewable energy, carbon capture, green hydrogen, and responsible investments. In 2022, the sector emitted 186 million MT CO₂e globally, a 6% increase since 2013. In India, the chemical industry contributes about 5% of industrial emissions, compared to the global average of 15%.

Key strategies for reducing emissions include optimizing processes and energy use, increasing renewable energy adoption, and improving carbon capture and storage (CCUS). The industry also emphasizes using low-carbon feedstocks and robust monitoring systems. Major companies like Reliance Industries and Tata Chemicals are investing in green technologies, aiming for net-zero emissions by 2030. RIL's five giga-factories and Tata Chemicals' low-carbon growth strategy are notable initiatives. The shift toward responsible investment and ESG-focused funds shows progress, but challenges like policy alignment, securing capital, and managing costs must be addressed for a successful transition.

³ <https://steel.gov.in/sites/default/files/Monthly%20summary%20for%20March%202023.pdf>

14.0 Findings and Conclusion

As a developing economy, India faces growth across various sectors but is highly vulnerable to climate risks, requiring well-formulated mitigation strategies. This paper integrates multiple studies and data, offering a comprehensive view of climate risks, India's CO₂ emissions, and its initiatives to manage these risks. The study indicates that even if countries adhere to sustainable policies and pledges, there is only a 14% chance of limiting global warming to 1.5°C.

Managing climate transition risks through green finance instruments is vital for sustainable growth and reducing climate change impacts. The study underscores the role of green finance in key sectors like power, industry, cement, refining, and agriculture, detailing their emission profiles and India's strategic efforts to reduce emissions. It highlights the challenges in decarbonizing these sectors and emphasizes the importance of technologies like renewable energy, carbon capture, and green hydrogen. The study also showcases actions by major players to achieve net-zero emissions and stresses the need for green financing to support these initiatives.

15.0 Suggestions

To manage transition risks, key strategies include diversifying the economy, enacting climate policies, strengthening financial sector resilience, enhancing risk transparency, and mobilizing climate finance. Since banks are a major funding source for industries, a robust system is needed to support India's economic transition. The study suggests that green funding largely comes from domestic sources, so government initiatives should attract international green financing. Additionally, offering low-interest green loans could boost investment in green projects. A taxonomy-based approach, with tax incentives for companies reducing their carbon footprint, can help offset the costs of adopting green finance practices.

Tax reform will help India to better manage the transition risks, in limiting as well as in encouraging the sustainable activities. (Erik Feyen, 2020) "Environmental tax reforms (ETR) which combine environmental taxes, expenditure policies and supplementary policies are an effective tool to pursue climate objectives." Diversifying finance flow from green instruments across various significant sectors and increasing private sector involvement is essential to meet India's Panchamrit targets related to green finance. As a result, the government ought to aggressively support green investment frameworks and green investments.

16.0 Limitation and Scope

Data available, on green finance is limited only to green bonds, so further study can be done to find out trends and patterns in other green finance instruments issued by banks and other NBFCs with the help of primary data. The reports and data used for the analysis are based on the year 2021-2022 as most current data was unavailable, so in the future, research based on recent data will be more rewarding in suggesting the policy framework to mitigate climate transition risk and help India to achieve its sustainable goals and Net Zero goals by 2070.

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