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*Research Article*

# Environmental Sustainability and Economic Transformation: Evidence from India's Green Economy Initiatives

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## Abstract

India, one of the fastest-growing economies in the world, is at a critical juncture where sustainable development and environmental stewardship have become central to its growth trajectory. The transition towards a green economy represents both an urgent necessity and a promising opportunity for the country. This paper explores India's transformation towards a low-carbon, resource-efficient, and socially inclusive growth model, highlighting the key challenges and opportunities involved. Challenges include the heavy reliance on fossil fuels, the complexity of balancing rapid urbanization with ecological conservation, technological gaps, and the financial burden of green investments. At the same time, opportunities arise from India's abundant renewable energy potential, government initiatives such as the National Green Hydrogen Mission and solar energy expansion, private sector participation, and global collaborations supporting green finance and innovation. The study emphasises that while policy frameworks and technological interventions are essential, success ultimately depends on inclusive governance, behavioral change, and strong institutional mechanisms. The findings suggest that India's green transition, if strategically implemented, can not only reduce carbon emissions but also generate employment, improve energy security, and ensure long-term economic resilience.

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## 1. INTRODUCTION

The We all are familiar with the concept of sustainable development. Sustainable development can be interpreted in different ways. It is an approach to balance development which often competing, needs against an awareness of the environmental, social and economic limitations. In many ways sustainable development promotes transition of an economy towards a green economy. Green economy has recently emerged as an important concept on the global agenda of sustainable development. The green economy promotes macro-economic approach to sustainable economic development. In fact, green economy is a vehicle to achieve sustainable development.

### What is a Green Economy?

The green economy helps to improve human well-being and social equity and significantly reduce environmental risks and ecological scarcities. Green economy is a model of economic development based on sustainable development and knowledge of ecological economics. A Green Economy is a linkage between economy, society, and environment which transform various economic activities like consumption and production with contributing to a reduction per unit in waste. It also considers best possible use of resources, materials, energy and pollution emission will revitalize and diversify economy, create decent employment opportunities, promote sustainable trade, reduce poverty, and improve equity and income distribution. (UNEP, 2022). According to UNEP, A green economy is defined as low carbon, resource efficient and socially inclusive.

### World as a Green Economy

In the 2021 Glasgow Climate Pact targeted to reduce global carbon dioxide (CO2) emissions to net zero by 2050 is consistent with efforts to limit the long-term increase in average global temperatures to 1.5˚C. This calls for nothing less than a complete transformation of how we produce, transport and consume energy. In line to achieve this target ambitious climate policies are framed. Few countries like, Denmark and UK are currently slated to reach GHG neutrality by 2050. Other countries like China, India and Russia are headed in the wrong direction and rapidly rising GHG emissions. As fastest fifth growing economy in the world, India is Asia's second largest economy in terms of nominal GDP. India's Gross Domestic Product for 2022 was $3.535 trillion with an annual growth rate of more than 7%. But India is far away from the target of net-zero GHG emission. The Environmental Performance Index (EPI) predicts that only four countries – China, India, the United States and Russia – will account for more than 50% of the world's remaining GHG emissions in 2050. A total of 24 countries will account for nearly 80% of emissions by 2050, unless policymakers strengthen climate policies and change emissions pathways. Pandemic was a good opportunity to change policies. After a record decline in global GHG emissions in 2020, emissions returned to pre-pandemic levels in 2021. The global figures mask some of the most striking and important country-level trends. China and India's 2021 emissions were 5.5% and 4.4% higher than their 2019 levels, respectively, while the US and EU's emissions fell below their 2019 levels in 2021. These downward trends in emissions suggest that stimulus packages were given by many developed and developing countries during pandemic era may be successful in promoting climate change. US and EU's both were declared many packages during the pandemic and reduced GHG emissions at some extent. But both are not on track to meet the goal of net zero emissions by 2050. Globally, economic growth seemed to have picked up in the last one year and it is expected to further improve in future. Key development indicators for top 10 high GDP countries are listed in Table 1.

**Table No.** 1 Key Indicators of Top Countries (in GDP)

| Rank | Country | GDP in USD Bn (2022) | GDP per capita (USD) | CO2 emissions (MT) (2022) | 2CO2 emissions MT per capita) (2022) | Net trade in goods and services in USD Bn (2021) | Energy Use (Kilograms of oil equivalent Per Capita) |
|---|---|---|---|---|---|---|---|
| **1** | United States | 25,346.81 | 63,416 | 4,535.30 | 13.68 | -861.4 | 6804 |
| **2** | China | 19,911.59 | 17,192 | 11,680.42 | 8.2 | 462.81 | 2224 |
| **3** | Japan | 4,912.15 | 42,248 | 1,061.77 | 8.39 | -22.51 | 3429 |
| **4** | Germany | 4256.54 | 54,076 | 636.88 | 7.72 | 228.91 | 3818 |
| **5** | India | 3,534.74 | 6,461 | 2,411.73 | 1.74 | -74.7 | 637 |
| **6** | United Kingdom | 3376 | 44,117 | 313.73 | 4.66 | -39.9 | 2765 |
| **7** | France | 2936.7 | 46,062 | 279.99 | 4.26 | -35.93 | 3692 |
| **8** | Canada | 2221.22 | 48,720 | 542.79 | 14.43 | 1.89 | 7631 |
| **9** | Italy | 2058.33 | 40,861 | 297.35 | 5.03 | 51.07 | 2482 |
| **10** | Brazil | 1,833.27 | 14,916 | 451.80 | 2.11 | 19.26 | 1496 |

**Source:** World Bank Database.

### Environmental Performance Index (EPI)

The EPI 2022 is a data-driven summary of the state of sustainability around the world. EPI ranks 180 countries on climate change performance, environmental health and ecosystem vitality using 40 performance indicators in 11 thematic categories. At the country level, these indicators show how far each country is from its environmental targets. The EPI Indicator provides a way to identify problems, set goals, track trends, understand results, and identify policy best practices to achieve the United Nations Sustainable Development Goals and move society towards a sustainable future. (Wolf, 2022) High-scoring countries have a long-term commitment to action to

protect environmental health, protect biodiversity and habitats, conserve natural resources, and decoupling GHG emissions from economic growth. It represents a sustainable investment. Denmark tops in 2022 ranking of EPI. This feat builds on a strong performance on nearly every issue tracked by EPI and outstanding leadership in efforts to advance a clean energy future and sustainable agriculture. The UK and Finland are ranked second and third, both achieving high scores in reducing GHG emissions in recent years. China stood at 160$^{th}$ rank and India is on the last rank, i.e. 180, with an 18.9 EPI score. (See table no. 2)

**Table No. 2:** Environmental Performance Index of selected countries. 2022

| Rank | Country | EPI Score |
|---|---|---|
| **2** | United Kingdom | 77.7 |
| **12** | France | 62.5 |
| **13** | Germany | 62.4 |
| **23** | Italy | 57.7 |
| **25** | Japan | 57.20 |
| **43** | United States | 51.10 |
| **49** | Canada | 50 |
| **81** | Brazil | 43.60 |
| **160** | China | 28.40 |
| **180** | India | 18.90 |

**Source-** (Wolf, 2022)

## Green Growth Challenges

Being a fastest growing economy, India is lagging in many indicators i.e., lack of capital formation, limited availability of resources, unemployment, un-utilisation of working populations, dependency on other countries for latest technology. Similarly transition towards green economy has also many challenges. Some of them are discussed here.

## Insufficient Climate Action and Net zero target

India, the world's third largest emitter of GHG, faces many challenges including heavy dependence on coal and lack of funding. With a strong and effective policy framework, India has set a target to achieve net zero by 2070. But it is more challenging because we do not set sectoral targets to achieve this milestone. Still India is depending on fossil fuels and transition towards renewable energy is not clear. There is huge gap in demand and supply of the renewable energy sources. To achieve net zero target upto 2070, India needs an investment of $10.1 trillion in the beginning. If the deadline is advanced to 2050, the amount rises to $13.5 trillion. (Sharma, 2022). Green Investment is also important challenge to Indian Economy.

## Air Quality

Poor air quality is a serious global public health issues in most of the countries. It results many deaths every year. Vehicle emissions, fuel oils and natural gas to heat homes, by-products of manufacturing and power generation, coal-fuelled power plants, and fumes from chemical production are the main human made sources to degrade the air quality. Continuously we are using many efforts, but due to slow progress the India has not gained much ground toward improving the air quality. Similarly, exposure to other noxious pollutants like sulphur dioxide (SO2), nitrogen oxides (NOX), carbon monoxide (CO), and volatile organic compounds have marginally improved in recent years. Many of the countries including India with low scores in the overall EPI also place near the bottom of the Air Quality issue category.

## Waste Management

Inadequate waste management can put great strain on ecosystems and undermine public health. Waste management show such a marked difference in performance between developed and developing countries. India produced 72,368 million litters per day (MLD) sewage, while the installed capacity of sewage treatment plants was 31,841 MLD (43.9%). Out of installed capacity, 26,869 MLD (84%) was operated and only 20,235 MLD (75%) was actually in use. Five States and Union Territories – Maharashtra, Gujrat, Uttar Pradesh Delhi and Karnataka account for 60 % of the country's total installed capacity. Reuse of treated wastewater is an issue that has received little attention in policymaking by many state governments.

The Central Public Health and Environmental Engineering Organization reports that treated wastewater is reused for horticulture, irrigation, washing operations (roads, vehicles, and trains), firefighting, industrial refrigeration, toilet flushing, and gardening. Reusing treated wastewater can reduce the demand for water from sources such as rivers, ponds, lakes and groundwater sources. According to the CPCB report, reducing raw water consumption contributes to the conservation of natural water resources. (Down to Earth, 2021)

## Forest Cover

According to the Indian Forest Survey, India's total forest and tree cover in 2021 was 80.9 million hectares, representing 24.62% of the country's geographical area. Compared to the 2019 assessment, the country's total forest and tree area increased by 2,261 km². Of these, an increase in forest cover of 1,540 km² and tree cover of 721 km² was observed. 17 states/UT have more than 33% of their geographic area covered by forest. Increased forest cover was observed in sparse forests, followed by very dense forests. The three states with the largest forest cover are Andhra Pradesh (647 km²), followed by Telangana (632 km²) and Orissa (537 km²). (GOI, 2022)

## Biodiversity & Habitat

Loss of biodiversity and habitat is one the important challenge of climate change. India is a highly diverse country covering just 2.4% of the world's land area and hosts a significant proportion of recorded species. Four of the world's 34 biodiversity hotspots i.e. The Himalayas, Western Ghats, Northeast, Andaman and Nicobar Islands are in India. To date, over 147,500 species have been assessed on the IUCN Red List. According to the International Union for Conservation of Nature's Red List, India has a total of 199 endangered species in 2021. The 20 number of species is added to the IUCN's Indian Red List of Threatened Species in

2021, 14 of which are animals and 6 which are plants. (RED LIST, 2022).

**Water**

India is heading towards a permanent water shortage. In India, water has become as precious as gold. India's population is 18% of the world, but water resources are only 4%, which makes India one of the driest countries. Many Indians face extreme water stress. This challenge is compounded because it relies more and more on unstable monsoons for its water needs. Climate change is likely to increase these pressures on water resources, even as domestic floods and droughts increase in frequency and severity. (World Bank, 2022) Water is one of the most important renewable natural resources for sustaining life. On an average, India receives about 4000 $km^3$ of annual rainfall (including snowfall). However, there are significant spatial and temporal differences in the distribution of precipitation and, therefore, significant differences in the temporal and spatial availability of water across the country. Of the 4000 $km^3$ of water, 1869 $km^3$ is estimated to be the average annual potential flow of rivers available as a water resource. Of this available water resource, only 1123 $km^3$ is available (690 $km^3$ from surface water resources and 433 $km^3$ from groundwater resources). Water demand was 634 $km^3$ in 2000 and is expected to grow to 1093 $km^3$ by 2025. Due to rapid population growth and the country's economic growth, the demand for water will continue to grow and will become scarce in the coming decades. (India WRIS, 2022)

**Climate Change**

Climate, Ecosystems, Biodiversity, and human society are interconnected and the effects of climate change are beginning to affect India. Rising heat is breaking records, with temperatures in the capital surpassing 49 degrees Celsius. Heatwaves are becoming more likely, afflicting in India. The latest Sixth Assessment Report of IPCC Working Group II warns that without immediate action to mitigate or adapt to climate change, the consequences could be dire, especially in India.

The increase in emissions is an all-time high, evidenced by recorded global temperature rise, 1.1 degrees Celsius higher than at the end of the 19th century. The last decade between 2011-2020 was the warmest one on record. the report outlines several impacts of the above projections such as reduction in food and water security, implications on social and economic human systems, limited functioning of critical infrastructure due to heatwaves, air pollution, etc. In addition, it also predicts adverse effects on climate-sensitive sectors such as forestry, fisheries, agriculture, energy and tourism as well as humanitarian crises such as climate-induced migration, etc. (PIB-GOI, 2022)

**Energy**

India's energy supply is heavily dependent on fossil fuels, coal and petroleum products, together accounting for about 88% of total primary energy supply. Most of the domestically consumed oil is imported, posing serious challenges to long-term energy security. In recent years a severe heat wave has pushed the electricity demand forecast to 7% from the previous 6% for 2022. The heat wave spurred the use of air conditioning, causing a large surge in electricity demand with a shortage of supply. Considering the increasing demand for electricity in the country, conventional thermal power projects with a total capacity of 27,550 megawatts (MW) and conventional hydropower projects with a capacity of 14,103.50 MW are currently under construction in the country. In addition, an 8,700 MW nuclear power project is under construction. India is unlikely to meet its target of adding 175 GW of renewable energy generation capacity by December 2022. India, built 116 GW of renewable capacity by mid-2022, still only 66% of the 2022 target. Much of the deficit exists only in four states i.e. Maharashtra, Uttar Pradesh, Andhra Pradesh and Madhya Pradesh. (Noble Varghese, 2022)

**Agriculture**

India holds the record for the second-largest agricultural area in the world, with approximately 60% of India's rural households making their living from agriculture. The agricultural sector employs half of the country's population and is highly dependent on farms for their livelihoods. The food and livelihood security of millions of people in India is highly precarious. Indian agriculture is sensitive to climate change and variability. The impact of climate change on agricultural systems varies by region, and the impact of changes in temperature and precipitation on major crops is well known. Despite the success of manufacturing in ensuring the country's food security, food inflation and its volatility remain challenges, requiring supply-side interventions such as increased public investment, storage infrastructure and food processing support. (Manjula, 2022). India needs a second green revolution and next-generation reforms to make agriculture more climate-resilient and environmentally sustainable. It has also been observed that Indian agriculture has shown remarkable resilience during the COVID-19 period.

**Urbanisation**

The important challenge to green economy is about the ongoing urbanization process in India. The population of Indian cities is estimated to have nearly quadrupled from 197 million to 460 million between 1970 and 2018. Already India has a second largest urban community in the world and the country is expected to see an additional 416 million people moving into cities making its 50% of the population in cities by 2050. Indian cities occupy only 3 % of the country's area but contribute a whopping 60% to the GDP. Urbanization and industrialization continue to emit dangerous levels of air pollutants with challenge to sustainability. At the same time, Indian cities face major challenges related to the quality and availability of infrastructure such as power, telecommunications, roads, water and mass transit, which if left unchecked could seriously hinder economic growth. (NITI Aayog, 2022)

**Opportunities to India as a Green Economy**

In transition to a green economy, Economic policies for the recovery should aim to support sustainable growth by facilitating the reallocation of resources to green sectors and business models. It is also important to recognize that COVID-19 is a crisis within a larger crisis arising from the escalating impacts of climate change on lives and economies. Preserving the ability of governments to invest in the transition to a green economy will be critical to counteract the inequitable impacts of climate change. Pandemic may be an opportunity to take political harsh and economically good decision specially in India.

**The Green Path of Indian Economy**

After a huge shock of Covid-19 pandemic Indian economy is stabilising. Economist, researchers and policy makers agree that a capital approach is essential for a smooth and fast recovery of economy and for empowering sustainable development. Being a biodiverse country, natural capital plays an important role in the sustainable development. Many core sectors like, agriculture, mining, energy, MSMEs and tourism heavily rely on natural resources and natural capital. These sectors have significant role in employment generation, income generation, rural development, poverty alleviation, decrease in inequality and development of MSMEs. To overcome these economic, social and natural challenges, transition to green economy is one of the best options.

**Major steps towards Green Economy**

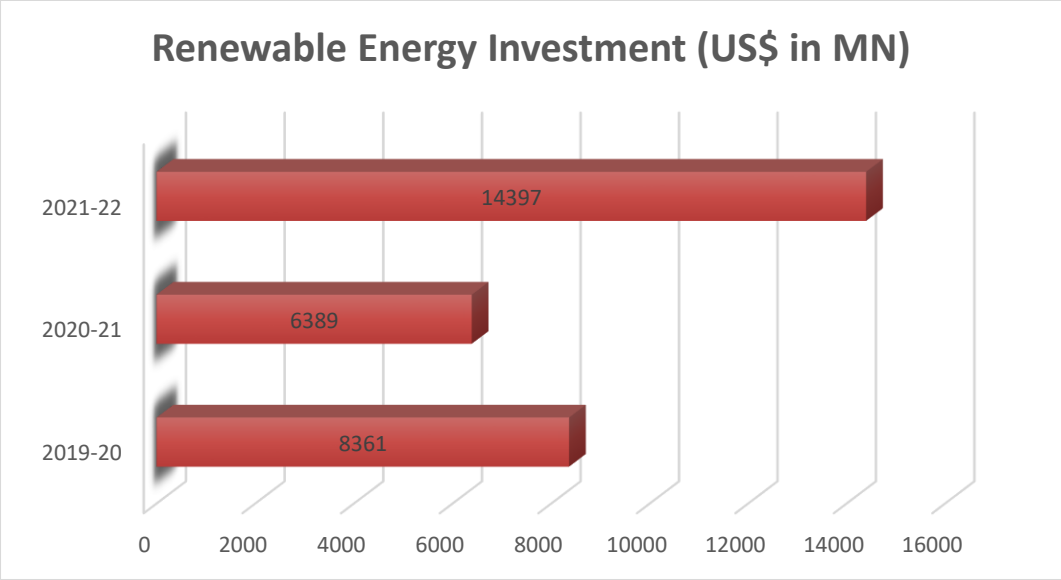
India has already started journey towards green economy. To cope up with covid pandemic and crisis of the healthcare system policy makers have made budgetary allocation to maintain economic stability and human wellbeing. Faster economic recovery prioritizes to maintain sustainability and strengthen natural capital, ecosystem services and biodiversity for a green economic recovery. This implies taking action for nature-positive impact as well as minimizing the negative impact of certain policies and programmes. (Datta, 2021).

As part of a global study commissioned by the Green Economy Coalition and funded by the Mava Foundation, a country study on India is identified and assessed the integration of natural capital in the post-COVID policy. The study came up with assessment of the direction (positive, negative or neutral) and degree of natural capital impacts of the post-COVID public policies of five sectors: agricultural and allied, MSME (Micro, Small and Medium Enterprises), power, mining and the social sector. Last two consecutive budgets announced by the national government, certain policies were promoted with a significant linkage to natural capital. Promotion of the agriculture sector investment in micro irrigation will promote organic farming. This will have positive impact on the small traditional farmers and allied industries. Development of traditional industries will reduce environmental impact of MSMEs and promotes use of renewable energy to maintained balanced between natural resource and rural development.

**Investment in renewable energy**

According to latest report of the Institute for Energy Economics and Financial Analysis investment in renewable energy hit record levels in India in the FY 2021-22. A total of $14.5 billion was invested in renewable energy, up by 125% compared with FY 2020-21 and 72% higher than in the pre-pandemic period of the 2019-20 financial year.

**Figure 1:** Investment in Renewable Energy in India



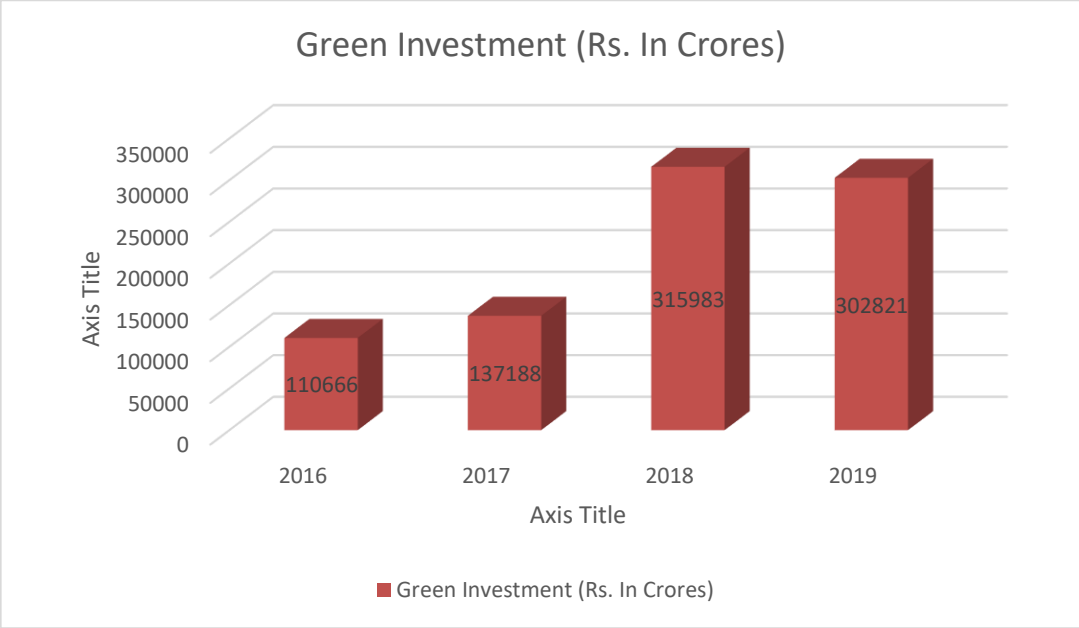

**Source:** (Khanna, 2022)

**Green Finance Inflow in India**

The Landscape of Green Finance in India evaluates finance flows to key real sectors i.e. clean energy, clean transport and Energy efficiency. This study tracks both public and private sources of capital-- domestic as well as international— and builds a framework to track the flow of finance right from the source to the end beneficiaries through different instruments.

India's National Contributions (NDCs) under the Paris Agreement require the country to make approximately Rs. 162.5 billion (USD 2.5 trillion) from 2015 to 2030, or approximately Rs. 11 billion (USD 170 billion) annual increase. In 2021, India has increased its climate change ambition and announced the 'Panchamrit targets'. This includes expanding non-fossil fuel-based power capacity by 500 GW to meet 50% of energy demand from non-renewable sources. This increased ambition requires faster mobilization of green finance.

**Figure: 2** Green Investment in India




**Source:** (Khanna, 2022)

Domestic sources continue to make up the majority of green finance, with 87% and 83% in FY 2019 and 2020 respectively. The share of international sources increased from 13% to 17% for the same period. The clean energy sector is evenly split between public and private sources of funding, with cash flows from PSUs accounting for 35%, followed closely by commercial FIs at 27%. Domestic inflows (82%) were much higher than foreign inflows (18%).

Within the clean energy sector, solar power projects received the largest share of accounting for 41% of the total financial flows to the clean energy sector. Clean transport received the largest amount of public funds (96%) in FY2019-20. Domestic inflows of 72% far exceeded international inflows of 27% (of which 99% were from international public sources). The flow of funds into the energy efficiency sector was mainly from the private sector (91%). Domestic inflows are 96%, well above international inflows of 4%. Cash flow to energy efficiency sector increased by 26% from 2019 to 2020, while cash flow to process efficiency and green buildings decreased by 83% and 81% respectively in 2020. (Khanna, 2022)

## CONCLUSION

India is one of the fastest growing economies and second highest populated country in the world. In may indicators India stood among first 10 countries. Similarly, India is also lagging in many indicators in the world. There is a need to focused need-based practical approachable policies to achieve sustainable development. Green economy is one of the important aspects of it. Natural economy may achieve many SDGs. But this is not possible without the help from the developed countries. This transition requires huge capital investment. But we people of India, considered to achieve this target by curtailing the time and help to reach our destination. This will help us to overcome many problems of our economy.

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