WWW.IJRPR.COM

**International Journal of Research Publication and Reviews**

Journal homepage: www.ijrpr.com ISSN 2582-7421

# A Study on Carbon Emissions in India

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**ABSTRACT**

India ranks among the most important nations in the world. India's emissions of greenhouse gases are rising due to its sizable and expanding population. Additionally, India could be severely impacted by the following climatic changes: sea level rise, monsoon shifts, an increase in severe storms and flooding, more drought, and extreme water stress. Recent floods and cyclones caused by climate change have had a negative impact on people's health and well-being as well as destroyed crops, property, and infrastructure. The overall socioeconomic progress is halted by all of these effects. Inclusionary growth objectives in the fields of economic development, human development, and environmental protection are part of India's diverse range of well-articulated national policies. India has frequently been a major player in international climate negotiations. India led the creation of a consensus declaration that served as the foundation for the Berlin Mandate, breaking the deadlock at the first Conference of the Parties. India is one of the most vulnerable nations in the world to predicted climate change and one of the main emitters of greenhouse gases. The country is already undergoing climate change, its effects, such as water stress, heat waves, drought, severe storms, flooding, and related detrimental effects on health and livelihoods. India, with a population of 1.2 billion people and a reliance on agriculture, is certain to see significant effects from ongoing climate change.

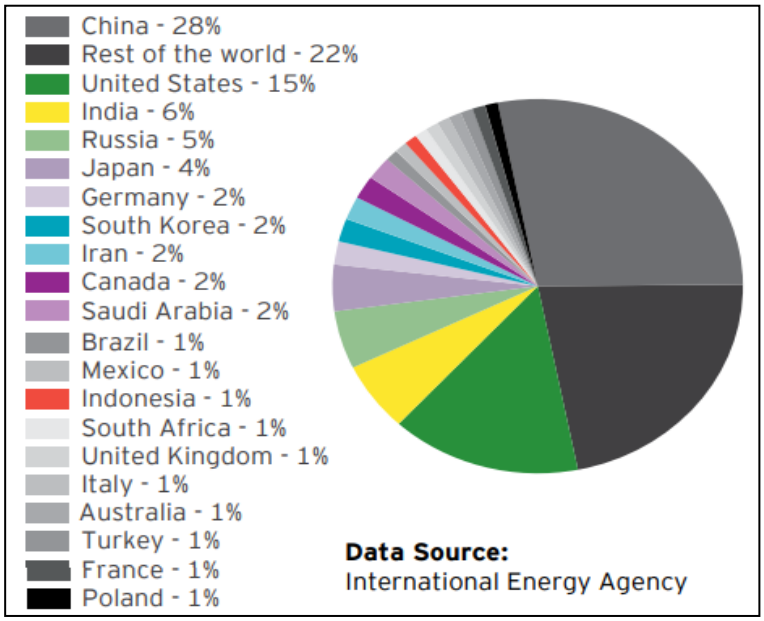
**Keywords:** Carbon emissions, GHG, CDM, India, Kyoto protocol

## Introduction

The emergence of climate change as a global issue necessitates an integrated global response to promote sustainable measures consistent with national circumstances and priorities. The United Nations Framework Convention on Climate Change (UNFCCC) includes India as a party. Additionally, it is one of the 175 countries that have ratified the Paris Agreement. India stated that it will adhere to its national laws and development agenda, including the elimination of poverty and the provision of basic requirements for all of its population, when signing the pledge. It pledged to following the low carbon route to progress, on the assumption of unrestricted availability of cleaner sources of energy, technologies and financial resources from around the world. The Paris Agreement's long-term objectives include limiting temperature increases to well below 2°C and to 1.5°C above preindustrial levels. The accord also aims for a carbon neutral world starting in 2050 and for greenhouse gas (GHG) emissions to peak as soon as possible. According to the World Bank's most recent World Economic Outlook, India's economy will grow by 7.5% in 2018, making it one of the fastest-growing in the world.

India is the third-largest emitter of carbon dioxide ($CO_2$) from fuel combustion after China and the United States and is home to around 17.5% of the world's population. As a result, it understands that in order to establish a balance between sustainable development and holistic development, its expansion must be led by environmental sensibility. In reality, India is one of the world's top economies and has been instrumental in advancing affirmative action in this area. Clean Development Mechanism (CDM), Joint Implementation (JI), and International Emission Trading (IET) were the market-based tools added by the Kyoto Protocol. The two offset mechanisms—CDM and JI—are among the three mechanisms. In non-Annex I nations without Kyoto Protocol emission reduction targets, CDM assisted in financing emission reduction initiatives. The CDM projects produced Certified Emission Reductions (CERs), a different name for carbon credits, which were purchased by the Annex B countries (mostly developed countries) and applied to their emission-reduction goals. Emission Reduction Units (ERUs), a different name for carbon credits, were created as a result of JI initiatives, which were developed in Annex B nations. JI projects come in two different varieties: Track 1 and Track 2. Track 2 projects are, whereas Track 1 projects are not, subject to international control. The unused Assigned Allowance Units (AAUs), or the entire assigned amount of GHG that each Annex B nation was permitted to release during the first commitment period of the Kyoto Protocol (2008–12), may also be traded by Annex B countries under IET.

**Figure 1: Contribution of emissions country wise Share of Global Carbon Dioxide Emissions from Fuel Combustion (2015)**




## Risk in India through Carbon emissions

While the actions of nations around the world have an impact on climate change, such impacts might vary from one nation to another. Tropical nations like India are seen to be more at risk from the threat posed by climate change. The following potential threats to the Indian economy were identified by a study conducted on behalf of the World Bank:

- India's summer monsoon can become extremely unpredictable with a 2°C increase in global average temperatures. In broad portions of India, increased flooding as well as more frequent droughts could result from an abrupt change in the monsoon, setting off a serious crisis.
- The stability and dependability of northern India's largely glacier-fed rivers, particularly the Indus and the Brahmaputra, are predicted to be threatened by a rise in global temperatures of 2.5°C, melting glaciers, and the loss of snow cover over the Himalayas. Due to the Ganges receiving a lot of rain every year during the monsoon season, it is possible that it may depend less on melt water. The amount of food that can be produced in the basins of the Indus, Ganges, and Brahmaputra rivers as well as the livelihoods of millions of people (209 million in the Indus basin, 478 million in the Ganges basin, and 62 million in the Brahmaputra basin in 2005) could all be significantly impacted by changes in river flows.
- A 4°C increase in warming would result in:

    a) By the end of the century, it is predicted that a highly rainy monsoon, which currently has a possibility of happening just once every 100 years, will happen every ten years.

    b) It is anticipated that the west coast and southern India will transition to new, high-temperature climate regimes, which would have a considerable impact on agriculture.

    c) In some regions, especially in north-western India's Jharkhand, Orissa, and Chhattisgarh, droughts are anticipated to occur more frequently.

    d) By the 2040s, excessive heat could have a severe negative impact on crop productivity.

## India's response for Carbon emissions

India has launched a number of steps to address the problems caused by climate change. Eight national missions are enshrined in its National Action Plan on Climate Change (NAPCC), which serve as the foundation for comprehensive, long-term, and integrated solutions. The missions encompass the following topics: solar energy, improved energy efficiency, sustainable habitat, water, green India, sustainable agriculture, and strategic knowledge for climate change. To address the expense of cleaner technology in specific targeted sectors, two dedicated funds have been established: the National Clean Energy Fund (later renamed as National Clean Energy and Environment Fund (NCEEF)) and the National Adaptation Fund on Climate Change (NAFCC).

Nationally Determined Contributions (NDC) have been prepared to reduce carbon emissions. By 2030, it is planned to increase forest cover and establish a carbon sink that will absorb 2.5 to 3 billion tonnes of CO2. In comparison to 2005 levels, India wants to cut emissions intensity (carbon emissions as a percentage of GDP) by 33–35% by 2030. By 2022, India hopes to boost installed renewable energy generation capacity from 35 GW (March 2015) to 175 GW, a more than five-fold increase. This is a crucial step taken by the Indian government to lessen the intensity of emissions. Additionally, the government has implemented the Perform, Achieve and Trade (PAT) programme to lower industrial energy use and thereby lower emissions. A number of additional measures, like the nation's major initiatives on smart cities, river cleaning, and the Swachh Bharat Mission, are in line with India's efforts to combat climate change. The NITI Aayog's National Energy Policy reaffirms the significance of achieving decarbonization through the complementary strategies of energy efficiency and renewable energy. While these actions have been helpful in reducing carbon emissions, one question worth discussing is whether they fully address all the sources of emissions in India or fall short of the objective.

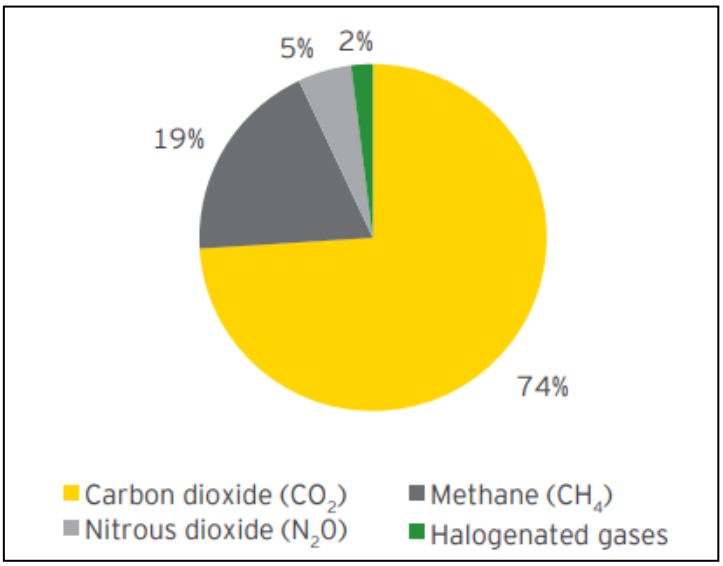
Additionally, India has implemented economic policies to lower carbon emissions. Coal is subject to a cess of INR 400 per tonne. Additionally, the market-determined diesel and petrol prices, the elimination of subsidies (the LPG subsidy was eliminated for consumers with taxable income of more than INR 10 lakh), and the gradual rationalization of the Public Distribution System (PDS) Kerosene quota over time are all in line with the objective of reducing carbon emissions. Particularly exposed to high levels of taxation in the form of excise levies and value added taxes are petrol and diesel. In some Indian states, indirect taxes might make up the whole cost of goods sold. Although they are not "carbon taxes" in the traditional sense, they are similar to implicit carbon taxes. India has been progressively raising its levies on fossil fuels while simultaneously encouraging the use of renewable energy sources through subsidies. Although fiscal measures have been effective in reducing the usage of fuels that release carbon dioxide, it is still unclear if India's pricing and taxing policies are in line with its carbon footprint. There are cases where fuels having a bigger carbon footprint are subject to lower tax rates, subsidized pricing, or prices that are not determined by the market.

## Greenhouse Gas emissions

The most important element contributing to climate change is thought to be greenhouse gas (GHG) emissions from anthropogenic factors and economic activities. GHGs essentially include of six gases i.e., water vapour ($H_2O$), carbon dioxide ($CO_2$), nitrous dioxide ($N_2O$), Methane ($CH_4$), Sulphur hexafluoride ($SF_6$) and Halocarbons (PFCs & HCFCs).

- Fossil fuels and biomass combustion are the main sources of $CO_2$ emissions. Direct human-induced effects on forestry and other land uses, such as deforestation, clearing land for agriculture, and soil degradation, are other sources of $CO_2$ emissions. Domesticated animals (such as dairy cows and pigs) and activities connected to rice farming, gas flaring, and mining are the main sources of methane. The management of agricultural land, the handling of animal waste, the burning of fossil fuels, the manufacture of fertilizers, and the creation of nitric acid are the main sources of $N_2O$.
- More than 70% of the world's GHG emissions come from $CO_2$ emissions, which has prompted concerns about lowering carbon emissions and developing strategies for limiting carbon emissions and promoting cleaner forms of energy.

**Figure 2: India's GHG Emissions by Gas**




**Source:** India's Biennial Update Report to UNFCCC, 2015

## Approaches for Measurement of Emissions

In general, two techniques, namely the direct measurement approach and the indirect measurement approach, are employed to quantify emissions. The method of indirect measurement is often known as a calculation-based method. The direct measurement strategy involves utilizing a measuring instrument that records emissions for auditing purposes to record emissions in real time on the emitter's premises. On the other hand, the calculation-based approach calculates emissions by applying an emissions factor to the amount of fuel used in an activity. Calculating direct emissions for an entire economy is exceedingly challenging. There are no data available to use this method of estimation of $CO_2$ emissions.

Under the indirect measuring method, emissions can be calculated in one of three ways broadly: When precise data on the breakdown of fuel's heat or carbon content by volume is not available, the scope/tier I formula is used. This is the simplest computation, and because Tier I emissions are calculated using data, it is independent of technology and represents averaged emissions values.

**Tier I Emissions = Fuel (tonnes) * EF (tonnes $CO_2$/tonne of fuel)**

Where,

- Emissions = Mass of $CO_2$, $CH_4$, or $N_2O$ emitted
- Fuel = Mass or volume of fuel combusted
- EF = $CO_2$, $CH_4$, or $N_2O$ emissions factor per unit mass or volume
- Emissions = Activity Data * Emissions factor (Fuel) (Volume of fuel) (Carbon Emitted per unit of fuel by Combustion)

**Sources of carbon dioxide emissions**

All of the major fuels have been included in order to analyse the level of CO2 emissions in India. The total number of fossil fuels, biofuels, and biomass considered was fifteen. Table 1 lists the fuels and their respective usage by the home, transportation, energy, industrial, and agricultural sectors. They have not taken into account the emissions from forestry, land use change, and domesticated animals like cows, buffaloes, and camels. Despite making a sizable contribution to India's overall emissions, domestic animals and LULUCF are not taken into account in national inventories because of a lack of accurate information. The breakdown and description of the sectors taken into account for estimating emissions in India, based on consumption data for a few selected fuels in the year 2015, are provided below:

**Table 1: Sector-wise consumption of fuels**

| Fuels (In '000 Tonnes) | Domestic Distriution | Transport | Energy | Industrial | Agriculture | Misc. | Total Fuel | Emissions factors |
|---|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| LPG | 17,182 | 172.0 | 2.70 | 1,666 | 7.0 | 594 | 19,623 | 2,940 |
| Naphtha | 0 | 0.0 | 50.0 | 13,221 | 0.0 | 0.0 | 13,271 | 3,143 |
| SKO (Kerosene) | 6,649 | 0.0 | 0.0 | 64.00 | 0.0 | 113 | 6,826 | 3,165 |
| High Speed Diesel Oil | 0.0 | 71,514 | 224.0 | 2,279 | 630 | 0.0 | 74,647 | 3,210 |
| Light Diesel Oil | 0.0 | 3.70 | 154.0 | 63.00 | 1.30 | 185 | 407 | 3,210 |
| Furnace Oil | 0.0 | 380.00 | 430.0 | 5,616.00 | 57.00 | 0.0 | 6,482 | 3,227 |
| Low Sulphur Heavy Stock/ Hot Heavy Stock | 0.0 | 0.0 | 51.0 | 71.0 | 0.0 | 29 | 150 | 3,470 |
| Motor Spirit (Petrol) | 0.0 | 21,847 | 0.0 | 0.0 | 0.0 | 0.0 | 21,847 | 3,105 |
| Aviation Turbine Fuel | 0.0 | 6,262 | 0.0 | 0.0 | 0.0 | 0.0 | 6,262 | 3,181 |
| Bitumen | 0.0 | 0.0 | 0.0 | 5,938.00 | 0.0 | 0.0 | 5,938 | 3,16,541 |
| Lubes and Grease | 0.0 | 0.0 | 0.0 | 3,571.00 | 0.0 | 0.0 | 3,571 | 3,165.41 |
| Natural gas | 0.0 | 0.0 | 27,340 | 18,200.00 | 0.0 | 0.0 | 45,540 | 2,808.57 |
| Coking Coal | 0.0 | 0.0 | 0.0 | 2,03,949 | 0.0 | 0.0 | 20,39,49,000 | 1,782 |
| Thermal Coal | 0.0 | 0.0 | 5,55,324 | 37,902 | 0.0 | 81,763 | 67,49,89,000 | 1,782 |
| Biofuels | 0.0 | 0.0 | 505 | 0.0 | 0.0 | 0.0 | 505 | 0.0 |
| Biomass | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3,600 | 0.0 |

Source: Ministry of Petroleum and Natural Gas, Ministry of Coal and Ministry of Natural and Renewable sources for the year for 2015-16; BP Statistical Review, 2016

**Table 2: Emissions produced by different sectors/ fuel wise; contribution to total national emissions**

| Fuels (In '000 Tonnes) | Domestic Distriution | Transport | Energy | Industrial | Agriculture | Misc. | Total emissions (fuel wise) Million tonnes CO2 equivalent | Total $CO_2$ emissions (%) |
|---|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| LPG | 50.51 | 0.51 | 2.7 | 1,666 | 7 | 594 | 19,623 | 2,940 |
| Naphtha | 0.0 | 0.0 | 50 | 13,221 | 0.0 | 0.0 | 13,271 | 3,143 |
| SKO (Kerosene) | 21.05 | 0.0 | 0.0 | 64 | 0.0 | 113 | 6,826 | 3,165 |
| HSD(Diesel) | 0.0 | 229.56 | 224 | 2,279 | 630 | 0.0 | 74,647 | 3,210 |
| LDO | 0.0 | 0.01 | 154 | 63 | 1.3 | 185 | 407 | 3,210 |
| Furnace Oil | 0.0 | 1.22 | 430 | 5,616 | 57 | 0.0 | 6,482 | 3,227 |
| LSHS | 0.0 | 0.0 | 51 | 71 | 0.0 | 29 | 150 | 3,470 |
| Motor Spirit | 0.0 | 67.83 | 0.0 | 0.0 | 0.0 | 0.0 | 21,847 | 3,105 |
| ATF | 0.0 | 19.92 | 0.0 | 0.0 | 0.0 | 0.0 | 6,262 | 3,181 |
| Bitumen | 0.0 | 0.0 | 0.0 | 5,938 | 0.0 | 0.0 | 5,938 | 3,16,541 |
| Lubes | 0.0 | 0.0 | 0.0 | 3,571 | 0.0 | 0.0 | 3,571 | 3,165.41 |
| Natural gas | 0.0 | 0.0 | 27,340 | 18,200 | 0.0 | 0.0 | 45,540 | 2,808.57 |
| Coking Coal | 0.0 | 0.0 | 0.0 | 2,03,949 | 0.0 | 0.0 | 20,39,49,000 | 1,782 |
| Thermal Coal | 0.0 | 0.0 | 5,55,324 | 37,902 | 0.0 | 81763 | 67,49,89,000 | 1,782 |
| Biomass | 0.0 | 0.0 | 505 | 0.0 | 0.0 | 0.0 | 505 | 0.0 |
| Biofuels | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3,600 | 0.0 |
| Total Emissions (sector wise) million tonnes $CO_2$ | 71.56 | 319.06 | 1,069.32 | 584.73 | 2.23 | 148.50 | 2,195.40 | 100% |
| | **3.26%** | **14.53%** | **48.71%** | **26.63%** | **0.10%** | **6.76%** | **100%** | |

**Source:** BP Statistical Review, 2016

Due to two reasons, no emission estimates for biomass and biofuels have been made:

- Since no breakdown is known for the use of fuels like cow dung, wood, crop leftovers, and other farm residues that are burned as biomass, estimating emissions based on such nebulous information is challenging. Although there is data on biofuels, accounting exclusively for biofuels and excluding biomass would result in double counting of emissions.
- Double counting: A single process involves the emission and absorption of $CO_2$ at different phases.

The quantity of $CO_2$ emissions for India has been estimated by a number of various international and national organizations. The outcomes of the estimates made by various agencies are summarized in the table below. As may be noted, the estimations in table 2, 2195.40 Mt $CO_2$, are largely within the reference range of estimates as determined by international agencies as presented in table 3.

**Table 3: Estimates of India's Emissions**

| Agency | Emissions estimates ($MtCO_2$) | | | Formula Employed |
|---|---|---|---|---|
| IEA (International Energy Agency) | 1990 | 2005 | 2014 | (5) |
| | 530 | 1080 | 2020 | Tier I $CO_2$ Emissions= Fuel Consumption* Emission Factor |
| BP Statistical Review 2016 | 2014 | 2015 | 2016 | 13221 |
| | 2085.9 | 2157.4 | 2271.1 | Tier I $CO_2$ Emissions= Fuel Consumption* Emission Factor |
| Global Carbon Atlas (BNP Paribas Foundation)[12] | 2016 | | | |
| | | | 2431 | Individual National calculation# |
| Global Carbon Budget, 2016[13] | 2015 | | | |
| | | | 2270 | |
| European Commission[14] | 2014 | | | |
| | | | 2340 | Tier I $CO_2$ Emissions= Fuel Consumption* Emission Factor |
| National Greenhouse Inventory (India's Reporting to UNFCCC) | 2010 | | | |
| | 1884 | | | Tier I $CO_2$ Emissions= Fuel Consumption* Emission Factor |
| **EY Estimate of Total emissions = 2195.40 million tonnes $CO_2$** | | | | |

Note: # Global carbon atlas is reporting numbers as reported to UNFCCC by different countries. Hence, the methodology for reaching those numbers is different as employed by different countries.

## Conclusion and Policy implications

Research that has already been published has stressed the need of reducing carbon emissions in light of the threat posed by climate change. The development of a carbon trading mechanism to reduce carbon emissions by emphasizing the corporate viability under the worldwide regulation depending on the market. The carbon trading mechanism in India and its variability under various business features are examined in depth in this research utilizing data from India power plant locations in 2015-16 data. According to prior studies, we find consistent evidence that the carbon trading system encourages a reduction in carbon emissions. Additionally, by demonstrating that the co-benefits of carbon trading mechanisms, such as decreased carbon emissions and air pollution, go hand in hand with the lowering impacts of these mechanisms, this work contributes to the body of knowledge in these fields. When we evaluate the primary characteristics of power plants, the results are resilient to the corporate heterogeneity.

The following are further policy consequences of our findings. First and foremost, in order to speed the modernization of both the energy structure and the industrial structure in response to the global climate problem, policymakers should place more emphasis on the coordination of governmental policies and market processes. Second, they might also think about keeping track of the policy's effects on carbon emissions from a micro viewpoint, particularly at the plant level, which would give them more specific information on the real environmental outcomes. Last but not least, create and enhance the carbon trading mechanism by incorporating pertinent knowledge from other emerging nations in order to draw in more investors and specialists and broaden the sorts of trading instruments available to boost the carbon market's effectiveness.

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