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Effectiveness of Carbon Taxes on Emission Reduction and Economic Growth

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Abstract

Mitigating climate change remains a global policy priority, with carbon taxation as a viable market-based approach for reducing greenhouse gas (GHG) emissions. This study investigates the prospects of carbon taxation as a two-fold approach to reduce CO₂ emissions and foster economic growth, specifically within the changing climate and fiscal situation in India. Based on international examples in Sweden, Ireland, and British Columbia, where carbon taxes have been instituted effectively, this paper points out some of the consequential outcomes of carbon taxation, including emission reductions, economic performance, and sectoral transformation. Using secondary data from international organizations (the World Bank, IEA, OECD) and Indian government sources (MOSPI and RBI), the research explores India's CO₂ emissions and GDP growth trajectory from 2000-2022, employing time-series visualizations, trend analysis, correlations, and single-variable regression. The study finds that India's GDP growth and emissions relationship has a weak negative correlation, suggesting that India's trajectory related to emissions may have more to do with structural or sectoral change than gross economic output. Using the literature on impact investing, the research argues that carbon tax revenues could be recycled through a structured government process to deliver environmental outcomes and improve social acceptability of the policy if spent on developing sustainable development projects and greening public infrastructure. The report ends with policy suggestions for how to design a carbon tax in India that is equitable and effective, while also considering India's net-zero targets and other socio-economic development objectives.

Keywords: Carbon Tax; CO₂ Emissions; Economic Growth; India

1. Introduction

Climate change continues to be one of the more serious challenges for governments worldwide in the 21st-century. CO₂ emissions from the combustion of fossil-fuel is the main cause for climate change. Nations are trying to reduce CO₂ emissions in line with their commitments under the Paris Agreement. In this context, carbon pricing, primarily in the form of carbon taxation, is regarded as a significant policy option among

market-based policies aiming at reducing greenhouse gas (GHG) emissions. A carbon tax is a price on carbon emissions. It incentivizes producers and consumers to switch to cleaner technologies and consume energy more sustainably.

On the international stage, various countries and jurisdictions including Sweden, Ireland, and the Canadian province of British Columbia, have designed and implemented successful carbon tax programs that have resulted in reduced emissions. These reductions have occurred even while the corresponding economies are still growing, implying a powerful synergy between corporate sustainability and economic sustainability (Andersson, 2019; World Bank, 2023). These cases demonstrate valuable lessons on how taxes as fiscal instruments can be uniquely designed to support climate change mitigation and economic resilience.

As the world's third-largest emitter of CO₂ and one of the largest and fastest-growing major economies, India has the unique challenge of pursuing economic development while reducing emissions. There is indirect carbon pricing in India through fuel excise duties and the previous coal cess, but there is currently no direct economy-wide carbon tax. The urgency of carbon pricing in the context of India's target of net-zero emissions by 2070 is important to examine in the context of India's broader climate change strategy.

This study examines the potential role of carbon taxes in India, operating on the assumption that there is a significant relationship between emissions and economic indicators. It explores carbon taxes by reviewing international examples, synthesizing secondary economic and emissions data, and exploring the logistics of a carbon tax using trend and regression analysis. It also examines the economic consequences, options for revenue measures, and political-economy contingencies that would facilitate or inhibit the adoption of a carbon tax in India.

In summary, this study aims to bridge global experiences with India's policy, as well as examine whether carbon taxes can be an effective instrument for development that does not jeopardize patterns of growth.

1.2 Scope of the Study

The study measures the extent to which carbon taxation can serve as an instrument to mitigate carbon emissions, while also allowing for economic progress in a domestic and international context, with particular focus on how it may apply to India. The study will include global and domestic insights, international experiences from Sweden, Ireland, and British Columbia, and implications and lessons for the context of India. The countries were selected due to their long-established carbon tax regimes and more expansive data on carbon examples and impacts on emissions and economic performance.

In this study, most of the research and data analysis will be secondary. The study will utilize publicly available datasets, including carbon providers to local and global economies such as World Bank, International Monetary Fund (IMF), the OECD, and other publications from the Indian government. The authors will conduct a trend analysis and regression analysis to look for trends and relationships in emissions, economic growth and energy use over time, both in a global context, and in the Indian context.

In this context in India, the analysis explicitly includes existing carbon pricing mechanisms (currently, fuel excise subsidies and the former coal cess) as well as assessing the policy, economic, and administrative possibility of a explicit formal carbon tax, but is more focused on analysing how the revenue from a carbon tax might be recycled for development activities (e.g., renewable energy investments, poverty alleviation, etc.) in order to manage the transition in a socially equitable way.

The analysis considers possible impediments, e.g. political backlash, industrial competitiveness, and carbon leakage, but not through the type of primary data collection envisaged (e.g., stakeholder surveys, interviews, etc.). The focus is on economic and environmental impacts, although literature on social and health impacts of carbon tax policies is largely dismissed.

The objective of this study is to identify global best practices and situate these to India in order to provide

a meaningful and policy relevant response on how carbon taxes might best fit into India's wider climate and fiscal landscape.

1.3 Importance of the Study

The increasing danger of climate change and the urgent need to cut carbon emissions have pushed countries around the world to consider a wide range of policy instruments that balance environmental sustainability and economic growth. Among them, carbon taxes are promising for their ability to internalize the costs of carbon emissions and incentivize more environmentally sustainable production and consumption decisions. For countries, like India, facing the conflicting demands of continuing high economic growth while transitioning to a low-carbon economy, it is extremely important to understand the role of carbon taxes.

This study is relevant because it helps bridge discussions of global evidence on the impacts of carbon taxes and domestic policy discussions around carbon pricing. Other OECD countries, such as Sweden and British Columbia, have demonstrated that carbon taxes can reduce emissions and GDP growth does not stall, while India is quite different in its "real" socio-economic circumstances. India's recent commitment to achieving net-zero emissions by 2070 and its renewable energy targets set out in the Paris Agreement demonstrates the need to assess carbon taxes as a tool for meeting its policy goals at this time.

This research contributes to both academic and policy conversations by providing a comprehensive analysis of how carbon taxation may impact India's economy, industry competitiveness, energy consumption, and fiscal state. In particular, it brings attention to how carbon tax revenues may be usefully spent on sustainable development, energy security, and address redistribution in relation to inequality.

In addition, this research may provide data-based insights to policymakers about the design features and principles that would make carbon taxes effective and socially acceptable. This paper presents the implementation of carbon taxation in relation to the degree of coverage imposed by it and its use of revenues to build, i.e., the degree of revenue use, to give a roadmap for how to initiate a carbon taxation policy/approach in India, maximizing benefits for the environment while limiting economic and social disruptions.

1.4 Literature Review

Policymakers and researchers around the globe are increasingly recognizing the importance of using fiscal instruments to provide incentives for making decisions that are better for the environment, and among those instruments, carbon taxes have received a great deal of attention as a market-based way to reduce greenhouse gas (GHG) emissions without crippling the economy.

1.4.1 International Support for Carbon Taxes

Numerous studies have analyzed the impact of carbon taxes on emissions reduction in varying national contexts, and the evidence suggests that carbon taxes can be effective in achieving reductions in emissions while maintaining economic growth. Sweden is often used as one of the first examples of an effective carbon tax in 1991. Andersson (2019) found that Sweden's per capita CO₂ emissions decreased substantially while its GDP grew. Similarly, British Columbia in Canada implemented a revenue-neutral carbon tax in 2008, with Murray and Rivers (2015) finding that carbon taxes lead to statistically significant reductions in fuel consumption, with no discernible effects on the overall economic performance or employment levels of the province.

The OECD (2022) notes that the effectiveness of carbon pricing relies heavily on the rate of tax, scope of coverage, and how revenues are used. Countries with effective carbon rates are attaining stronger progress

in decarbonization.

Moreover, the World Bank (2023) indicates that revenue recycling—returning the revenue from a carbon tax to the households or investing in green infrastructure—can improve the policy's acceptability by the public and fairness.

1.4.2. Theoretical Perspectives

Economic theory supports carbon taxation to internalize the externality of carbon emissions (Pigou, 1920). Parry et al. (2014) argue that a well-designed carbon tax corrects a market failure, in this case, by reflecting the true price of fossil fuels as it relates to the social cost of emissions. Also, carbon tax policy is often easier to administer than cap and trade, and provides price certainty, making it a "more enticing option to policymakers."

1.4.3. Carbon Taxation and Developing Economies

The literature is more limited for developing countries; however, a recent number of research studies have taken note of the number of developing countries moving to implement carbon taxes. Metcalf and Weisbach (2009) indicate that while carbon taxes are an efficient policy, they need to be carefully designed to correspond with local economic and social context. In the case of emerging economies, the use of revenue is especially important, as governments could use the funds for poverty alleviation, clean energy subsidies, and physical infrastructure development.

Rosenbloom et al. (2020) stress that carbon pricing is part of climate policy caused by the challenge posed by climate change, in which it must work together with regulations, financial support for clean technology, and important institutional change.

1.4.4. Indian Context

India has not yet implemented direct carbon tax, but indirect mechanisms exist. For example, the coal cess, which has been discontinued, and fuel excise duties can be viewed as partial carbon pricing mechanisms. The revenue generated from these taxes is significant, part of which is used for the National Clean Energy Fund (Ministry of Finance, 2020). Nevertheless, evidence regarding impacts of these instruments on emissions reductions is debated, given their limited scope and prevailing opacity.

According to the research conducted by the World Resources Institute, India would benefit from an explicit carbon tax if designed with care to mitigate any adverse outcome on low-income households. Funding opportunities could come from concepts like rural electrification, climate resilience and energy efficiency.

1.4.5. Sectoral Impacts of Carbon Taxes

Studies recently examined how carbon taxes impact different sectors of the economy. For example, the transportation and industry sectors were among the most responsive to carbon pricing, with sterner 2007 study showing that fuel taxes reduced automobile emissions of OECD countries. In the power sector, carbon taxes drive a transition to renewable energy and growth in energy efficiency (Lin & Li, 2011), although impacts differ by carbon intensity and low-carbon substitutes available.

In developing economies, the effects on agriculture and manufacturing are more nuanced. While carbon pricing has the potential to unlock efficiency gains, for low margin industries it will very often also increase costs which means that the design of compensatory mechanisms is critically important (Jakob et al. 2016). In India, where agriculture is an important source of employment, but also a significant source of methane and

nitrous oxide emissions, carbon pricing needs to be accompanied by incentives aimed at environmentally sustainable agricultural practices and rural livelihoods.

1.4.6. Equity and Distributional Effects

Another major theme in the literature is the distributional impact of carbon taxes. The research suggests that while carbon taxes appear economically efficient, the implications for equity can be regressive; low-income households generally spend a higher share of their income on energy and transport (Bento et al. 2009). Governments have suggested various forms of tax recycling to offset potentially regressive effects of carbon taxes, including lump sum transfers, decreases in labor taxes or investment into social services.

In India, energy poverty and income inequality present a greater challenge. Chaudhary et al. (2020) argue that without adequate compensatory mechanisms in place carbon taxation could deepen existing inequalities. Conversely, they show that a well-designed carbon tax, with proceeds dedicated to social welfare and clean energy subsidies, could provide a double dividend - both emissions reductions as well as improvements in living standards.

1.4.7. Political Economy and Carbon Tax Design

Political economy factors are significant for a successful carbon tax application. Klenert et al. (2018) note the need for tax design to line up with the public preferences—revenue neutrality, transparency, etc. Public opposition, usually on the premise of fear from higher living costs or job losses, occurs even when evidence suggests the real disruption to the economy is negligible.

For example, in India, policy inertia and industrial lobby group opposition in much of the economy has stalled any real discussion on carbon taxation (Sharma & Roy, 2019) possibilities; nonetheless, growing pressure from abroad and domestically with India's climate agenda might create conditions for India pursuing progressive fiscal reform eventually including some kind of carbon pricing. The research suggests starting with low rates and raising them over time, along with good communication and social protection provisions.

1.4.8. Impact Investing and Climate Policy

Tandan, Makkalageri, and Sinha (2025) indicate the increasing relevance (utilization) of impact investing as a means of achieving both financial returns and environmental outcomes. Their research emphasizes that countries such as India could utilize this type of impact investing to leverage private capital for clean energy, conservation, and sustainable development, particularly when it is boosted by carbon taxes, making their overall effectiveness higher when taxes direct revenues raised into demonstrable, high-impact environmental projects. Their work indicates that structured investment vehicles such as blended finance and green bonds can complement the public mechanisms to allow the implementation of an overall carbon tax, which is more socially equitable and economically efficient.

1.4.9. Carbon Taxes and Other Instruments

Some scholars compare carbon taxes with different instruments i.e., emissions trading systems (ETS), subsidies, and direct regulation. Although cap-and-trade provides quantity certainty, comparatively more complex and also more subject to market variability, carbon taxes have price certainty and administrative simplicity (Aldy & Stavins, 2012).

India has already tested a Perform, Achieve, and Trade (PAT) scheme and Renewable Energy Certificates (RECs) with abbreviated success due to relaxed enforcement and market concerns (Ghosh & Ganesan, 2020).

Adding a carbon tax to this policy mix could help strengthen India's climate strategy with its predictable price signal.

1.5 Objectives of the Study

- To investigate how carbon taxes reduce greenhouse gas emissions and their effectiveness in different countries.
- To assess the implications of carbon taxation on growth within emerging economies.
- To examine the viability and possible effects of a carbon tax in the Indian context in terms of policy and economy, by examining the countries with relatively stronger policies.

1.6 Limitation of the Study

- Dependence on secondary data

This study is built entirely on secondary data from the international reports, policy documents, and prior research, which could provide a partial picture of localized realities or recent developments.

- Limited availability of India-based carbon tax data

Since India has never implemented a formal carbon tax, the bulk of the analysis has to inferentially use simulations or comparisons to structurally similar policy tools (such as fuel taxes or the coal cess).

- Generalization of findings

Although this study has drawn primarily from global experiences, it is important to note that the broad socio-economic, political, and institutional differences between countries might compromise similar application to the Indian context of some findings.

- Evolving policy landscape

Carbon tax policies and climate frameworks are evolving quickly. The analysis in this study only depicts the situation as of the time of writing, and future developments in terms of international agreements, technology evolution, or domestic policy changes, could alter its position.

- Unaccounted behavioral and informal sector responses

The research does not take into full consideration how the productive dynamics of informal sectors, or behavioral adjustments by producers or consumers, could shape the resultant outcomes of a carbon tax policy in India.

2. Research Design

This research uses a qualitative-descriptive and quantitative-trend approach and takes advantage of secondary research and data analyzed in Excel form to investigate whether carbon taxes help to reduce emissions and encourage economic growth, specifically in India.

1. Descriptive and Comparative Review

The research used an initial descriptive and comparative review of countries, such as Sweden, Ireland, and British Columbia, that have implemented a carbon tax to assess examples of carbon taxes and their impacts on environmental and economic statistics in different socio-political contexts.

2. Secondary Data Collection

The study relies exclusively on secondary data sources, which are:

- International databases (i.e. World Bank, IEA),
- Documents from the Indian government (i.e. Ministry of Statistics and Programme Implementation, Reserve Bank of India),
- Peer-reviewed academic literature and policy reports.

These data sources have comparative data on trend data on carbon emissions, GDP, sectoral output, fuel consumption, and tax revenue.

3. India-Focused Quantitative Analysis Using Excel

In the Indian context, time-series data from 2005 to 2023 was analyzed using Microsoft Excel. To facilitate analysis, the Excel files include:

- Trend analysis of CO₂ emissions and economic growth.
- Graphical representations of state fuel taxes, coal cess collections, and patterns of energy use in India.
- Correlation analysis of emissions to economic indicators.

The analysis imbedded in Excel is meant to explore whether India's indirect carbon pricing initiatives (fuel excise duties) have been associated with emissions through time and to analyze the economic viability of implementing a carbon tax on its own.

4. Policy Interpretation

The final step uses the developed global and India level data to derive conclusions about the design, equity and economic efficiency of carbon taxes. The last step forwards recommendations for developing a proper carbon tax in India that meets both developmental and environmental objectives.

Analytical Tools:

The analytical aspect of this research combines qualitative evaluations and quantitative (economic or econometric) analysis utilizing India-specific data via Microsoft Excel for two primary goals to identify trends and relationships between economic indicators, energy use and CO₂ emissions, and derive conclusions regarding the potential efficacy of carbon taxes from an Indian perspective.

Main Analytical Techniques Used:

Trend Analysis

Data and trend analysis on CO₂ emissions, GDP and carbon-related (e.g., fuel excise duties and coal cess) taxes were combined and analyzed in Excel. These taxes included fuel excise taxes and coal cess. Line and bar graphs displayed data over a time series ultimately measured over 10–15 years.

Correlation Analysis

Exposit correlations between environmental indicators (i.e., emissions levels) and economic performance (i.e., GDP growth, sectoral output) were calculated using Excel's statistical functions to assess the trade-off or potential synergies between economic and environmental goals.

Visual Representations

Graphical representations such as pie charts, column charts, and trend lines allowed for portraying relative emissions by sector, the longitudinal trajectory of carbon tax revenues, and the elasticity between economic activity and emissions.

Comparative Policy Review

Qualitative comparisons with countries that impose carbon taxes (for example, Sweden or Ireland) were used to interpret the meaning of India's data patterns and also to provide a policy relevance frame.

Using Excel makes the study replicable and transparent, while also effectively using or repurposing publicly available data sources.

3. Analysis and Interpretation

This chapter details the analysis of secondary data to explore the relationship between carbon taxation, emissions reduction, and economic growth in India. It also references the learning curves from experiences around the world to substantiate the commentary. The data sources include government reference sources, data cabinets from institutions, and articles from research organizations. The data was analyzed through Microsoft Excel in order to see the associations between the impacting variables.

3.1 Analytical Framework

The analytical framework is necessary for a systematic analysis of the dual effects of carbon taxes- both for lowering emissions and producing economic outcomes. As carbon pricing becomes a pivotal lever in climate policy discussions, understanding how carbon taxes work, their structural configuration in policy, and the actual impact of their application will be critical to framing their overall effectiveness, especially in emerging economies like India.

This framework combines economic theory, environmental policy analysis, and evaluative data to determine whether carbon taxation can meet objectives for climate and development simultaneously. Specifically, we will analyze:

- The relationship between carbon taxation and CO₂ emissions, and the indicators that are fuel consumption, energy mix, and emissions intensity.
- Economic outcomes: GDP, inflation, productivity in key sectors, and fiscal revenue
- Key policies designs: tax rate, coverage, exemptions, and recycling of revenues

Empirical research worldwide has identified that effective carbon taxation will generally reduce emissions in a way that does not significantly reduce economic growth (Klenert et al., 2018; World Bank, 2022). For example, both Sweden and British Columbia, as case studies demonstrate, have substantial carbon tax rates and a durable economy. These case studies will influence the framework for application moving forward in the Indian context.

Considering that India currently utilizes indirect carbon pricing instruments (for example, a coal cess, and fuel excise duties), this study made significant modifications to the existing framework to examine their effectiveness based on an analysis of time-series data using emissions, economic variables, and energy consumption data. The framework included Excel-based trend and correlation analyses to provide trends and interpret causal links as well, for a clear, translatable, and contextual evaluation.

By framing India's experience against the global best practices under the same framework, it provides ample basis for identifying policy gaps and establishing recommendations for design principles for a formal economy-wide carbon tax moving forward.

3.2 Case study analysis

1. Ireland

Tax Overview: Ireland implemented a carbon tax in 2010, which applied to a broad array of industries: transportation, heating, and electricity.

Emissions Reduction: Following the implementation of a carbon tax, Ireland has accomplished a small decrease in carbon emissions, mainly in the energy sector; however, overall decreases have been slow and steady.

Economic Impact: While there were concerns, evidence shows that Ireland's GDP continued to increase in growth levels similar to previous periods, which indicates that the carbon tax was not an economic deterrent.

Ireland implemented its carbon tax in 2010 and the newest data from 2023 shows real reductions in greenhouse gas (GHG) emissions. Although the carbon tax was started earlier, the 2023 data provides information on the consequences of various climate policies (the carbon tax was one of them).

Ireland's GHG Emissions: Before and After Carbon Tax

Emissions Data (1990–2023)

- 1990 Baseline: 59.8 Mt CO₂eq
- 2023 Emissions: 55.0 Mt CO₂eq
- Reduction: 6.8% (4.0 Mt CO₂eq)

This is the first time in 33 years that has emissions have decreased below the 1990 baseline

Sectoral Breakdown (2022–2023)

- Energy Industries: Decreased by 21.6% (2.2 Mt CO₂eq)
- Agriculture: Decreased by 4.6% (1.0 Mt CO₂eq)
- Residential: Decreased by 7.1% (0.4 Mt CO₂eq)
- Transport: Increased by 0.3% (0.03 Mt CO₂eq)

The energy industry had the biggest drop because of the increase of renewable energy and less fossil fuel use

Per Capita Emissions

- 2022: 11.4 tonnes CO₂eq/person
- 2023: 10.4 tonnes CO₂eq/person

This reduction is evidenced by the previous reduction in emissions and the stable population.

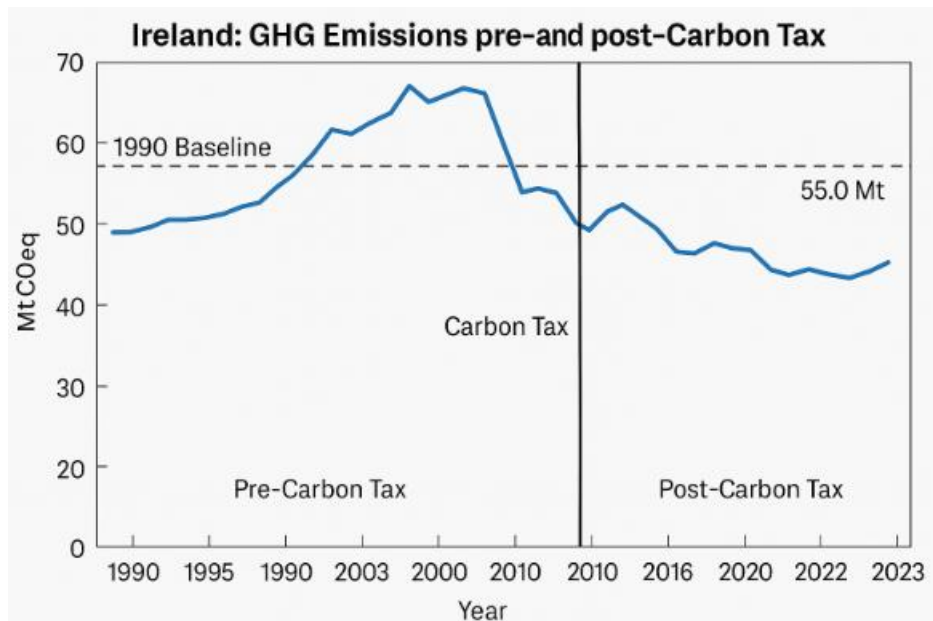


Figure 1: Ireland: GHG Emissions Pre and Post-Carbon Tax

Source: Ireland's Provisional Greenhouse Gas Emissions 1990–2022 by Environmental Protection Agency, 2023, [Infographic].

2. British Columbia

British Columbia (BC)

Tax Overview: BC's carbon tax was first implemented in 2008. The purpose of the legislation was that BC's carbon tax was revenue-neutral, where the carbon tax revenues were used to cut other kinds of taxes.

Emissions Reduction: BC had a significant drop in emissions, especially in the transport sector, due to fuel switching and improved efficiency measures.

Economic Impact: BC's economy grew steadily instead of declining, and the employment maintained stable rates, with some sectors like green technology even seeing a growth in jobs.

In July 2008, British Columbia (B.C.) introduced North America's first broad-based carbon tax. It started at C\$10 per tonne of CO₂, and increased by C\$5 each year and was C\$30 per tonne in 2012, then continued to increase annually thereafter. The carbon tax applied to approximately 70-75% of the province's greenhouse gas (GHG) emissions.

Emissions Before and After the Carbon Tax

Pre-Tax Period (Before 2008):

B.C. GHG emissions for 2007 were approximately 65.5 million tonnes of CO₂ equivalent (MtCO₂e), which is the baseline for any future targets.

Post-Tax Period (2008-2021):

In 2021, the emissions had reduced to 62.0 MtCO₂e (3% lower than 2007).

B.C. per capita emissions have decreased (2008-2013) by 12.9% compared to 9 provinces in Canada that experienced a decrease of only 3.7%.

In the first five years, B.C. consumption of fuels declined by 16% on average, and consumption increased 3% elsewhere in Canada.

Government of British Columbia

Sectoral Emissions Trends Proportionate to Their Emissions during the Period 2007-2021

Transportation: emissions increased by 7.8% to 25.1 MtCO₂e in 2021. This is the largest emitting sector at 41% of their total emissions.

Oil and Gas: emissions decreased by 12.6% for total emissions of 11.9 MtCO₂e in the sector.

Other Industry: eight percent decline for total emissions of 12.9 MtCO₂e.

Buildings and Communities: five point nine percent decline for total emissions of 12.0 MtCO₂e.

Greenhouse gas emissions, Canada, 1990 to 2023

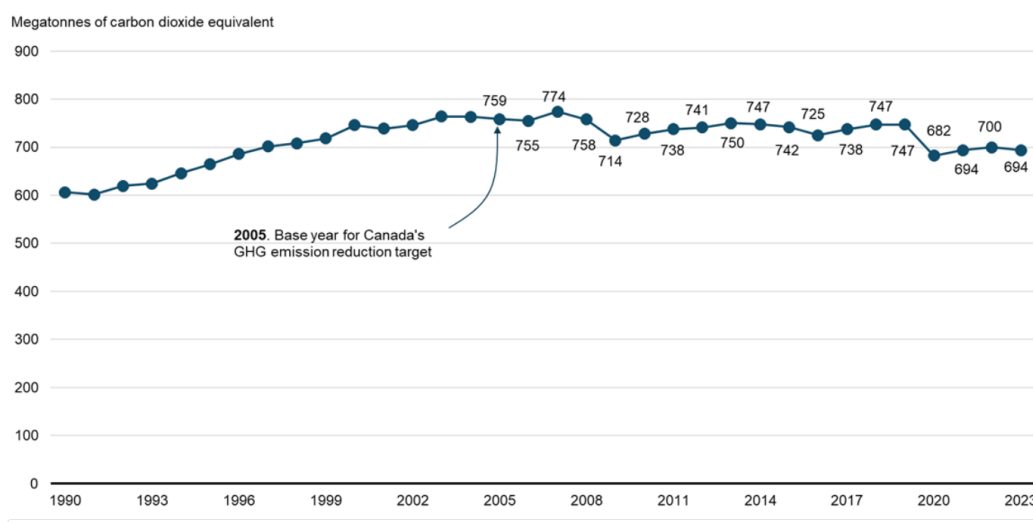


Figure 2: Land-based Greenhouse Gas Emissions and Removals in Canada (1990–2022)

Source: From *Land-based greenhouse gas emissions and removals* by Environment and Climate Change Canada, 2023, [Infographic].

3. Sweden

Sweden placed a carbon tax in 1991 and was one of the first countries to implement the climate policy. The tax started at about \$30 per tonne of CO₂, and has steadily risen to over \$130 per tonne, making it among the world's highest carbon taxes.

Emissions Before and After the Carbon Tax

Pre-tax period (Before 1991): Sweden's greenhouse gas (GHG) emissions in 1990 was about 72.1 million tonnes of CO₂ equivalent (MtCO₂e).

Post-tax period:

By 2019, these emissions were approximately 50.9 MtCO₂e, indicating a reduction of roughly 29% from 1990.

Sweden's economy grew by over 75% over this time period. The notable decline in emissions occurred alongside substantial economic growth.

Trends in Sectoral Emissions:

Transportation: Transportation emissions have declined significantly, partly because the carbon tax has incentivized individuals to switch to more sustainable modes of transportation and encouraged fuel efficiency.

Industrial Processes: Industries have undertaken more emissions-reducing cleaning technologies and energy sources because of the carbon tax.

Tax Overview: Sweden's carbon tax has one of the most comprehensive carbon tax measures used around the world, and with a high carbon tax range of nearly all fossil fuels represented in the linear regression produced with Sweden's carbon tax, it has contributed to the carbon tax effectively.

Emissions Reduced: Sweden has also decreased emissions significantly, especially in the energy supply sector, and transitioned towards renewable energy sources.

Economic Results: Sweden's economy has performed well, as they have succeeded in decoupling emissions from GDP growth, meaning that it is possible to have high carbon taxes whilst gaining environmental sustainability and economic growth.

Over the Last 30 Years Greenhouse Gas Emissions Have Declined in Sweden

Greenhouse Gas Emissions in Sweden in CO₂-Equivalents, 1990-2018

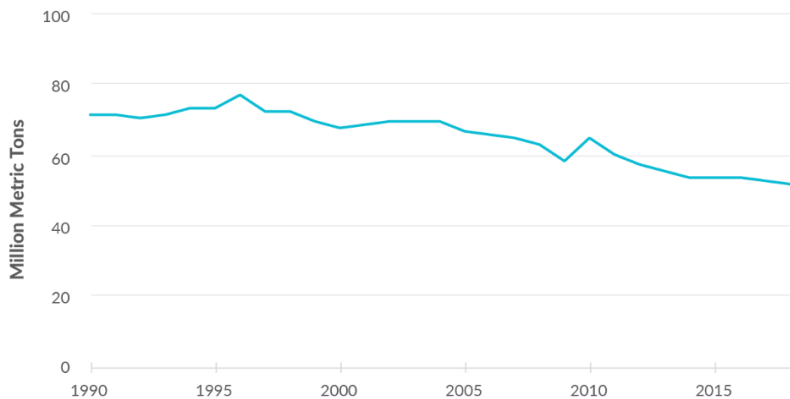


Figure 3: Sweden’s Carbon Tax and Greenhouse Gas Emissions Over Time

Source: Looking back on 30 years of carbon taxes in Sweden by S. Jonsson, A. Ydstedt, & E. Asen, 2020, Tax Foundation.

3.3 Application to the Indian Context

This analysis studies the relationship between emissions and economic growth in India, and implications for carbon tax policy. This study, which operates with secondary data covering the years 2000 to 2022 and sourced from academic/banking/multilateral sources, including Macrotrends, Our World in Data, and World Bank, aims to evaluate whether economic growth is associated with increasing emissions and how that relationship informs the prospects of carbon taxation.

1. Trend Analysis

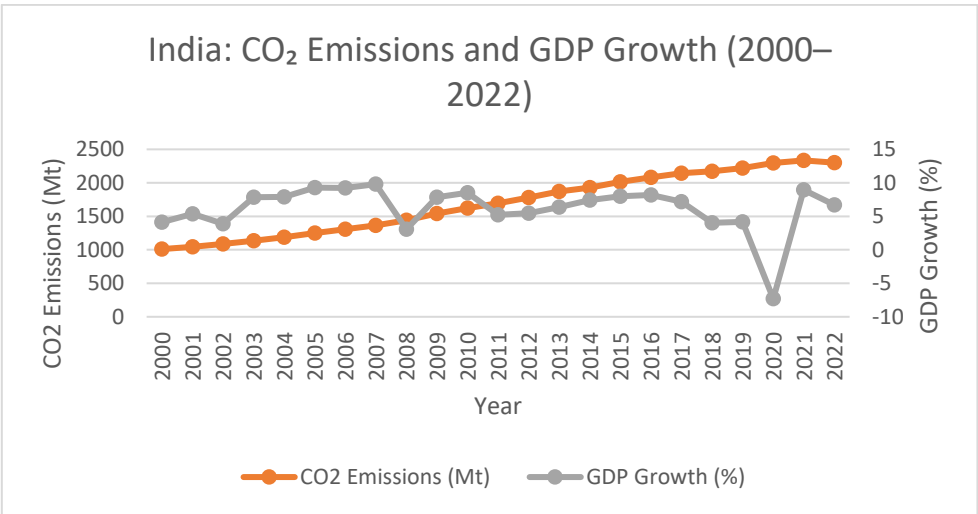


Figure 4: India: CO₂ Emissions and GDP Growth (2000–2022)

Note. This figure shows the relationship between India’s carbon dioxide (CO₂) emissions (in megatonnes) and annual GDP growth (in %) from 2000 to 2022. Data compiled from the World Bank and the International Energy Agency (IEA).

CO₂ emission trends (2000–2022)

- India's carbon dioxide (CO₂) emissions increased steadily from 1,011 million tonnes (Mt) in 2000 and a high of 2,335 Mt in 2021.
- There was a noted short-term decline in 2020 (2,300 Mt) due entirely to COVID-19 pandemic containment lockdowns.
- After 2020 the increase in emissions resumed indicating a recovery in economic and energy use growth.

Some Trends in GDP Growth

- India's GDP growth rate has followed an irregular path: there were periods of strong growth in 2004-2008 and 2014-2017, a recession (2008-09), and a huge decline in GDP in 2020 (–7.3%) due to the COVID-19 pandemic.
- In 2021 there was a strong recovery (8.95%); aided by a policy stimulus and reopening of the economy.

Conclusions

Both emissions and GDP have trended upward; while they have not been perfectly synchronous in growth, emissions seem to still be trending up irrespective of short-term economic fluctuations.

2. Regression Analysis

The key variables used in regression analysis to measure the success of carbon taxes in India during the period of 2000-2022. The variables include:

- CO₂ Emissions per Capita (the dependent variable)
- GDP Growth Rate (the dependent variable)
- Carbon Tax Rate (the independent variable)
- Energy Consumption (TWh) (the independent variable)
- Share of Renewable Energy (%) (the independent variable)
- Industrial Output as a % of GDP (the control variable)

Descriptive Statistics Summary (2000–2022)

Variable	Mean	Std. Dev.	Min	Max	Range	Variance
Year	2011	6.78	2000	2022	22	46.00
CO ₂ per Capita (t)	1.99	0.64	1.00	3.00	2.00	0.41
GDP Growth (%)	6.43	3.24	-5.80	10.30	16.10	10.53
Carbon Tax (USD)	0.00	0.00	0.00	0.00	0.00	0.00
Energy (TWh)	716.52	130.68	500.00	920.00	420.00	17078.26
Renewable Share (%)	19.50	3.39	14.00	25.00	11.00	11.50
Industrial Output (%)	22.80	1.36	20.60	25.00	4.40	1.84

Descriptive Statistics Interpretation

1. Year

The data covers 23 years (2000–2022) with a mean year of 2011. The standard deviation of 6.78 shows a somewhat evenly spaced time series over the period.

2. CO₂ per capita emissions

Mean: 1.99 tonnes

Min–Max: 1.00–3.00 tonnes

India's per capita CO₂ emissions have remained practically low by global standards, with modest increases reported over the years. The low standard deviation of 0.64 suggests moderate variance across the years, suggesting gradual increases.

3. GDP growth (%)

Mean: 6.43%

Min–Max: -5.80% (2020 pandemic year) to 10.30%

There is a high standard deviation (3.24) and a high range (16.1%), which indicates economic volatility in growth rates, such as during economic shocks like COVID-19. While this level of growth is impressive, it does show India's vibrant growth.

4. Carbon tax (USD)

All values are zero, which indicates that there was no formalized carbon tax regime in India during the time period that affects each year's analysis of this variable, which will show no variation, and achieves of dependent variable analysis will need to consider that this variable will not account for any variation.

5. Energy consumption (TWh)

Mean: 716.52 TWh

Min–Max: 500–920 TWh

There is consistent historically high variance (17,078.26) and standard deviation (130.68), indicating it reflects the significant increase in the energy consumption over time, which is consistent with industrialization and urbanization.

6. Share of Renewable Energy (%)

Mean: 19.5%

Range: 14.0% - 25.0%

The relatively small standard deviation (3.39) implies consistent increases in renewable energy sources,

which means policy responses to promote clean energy uptake are slowly but surely gaining traction.

7. Industrial Output (% of GDP)

Mean: 22.8%

Range: 20.6% - 25.0%

The even smaller standard deviation (1.36) is indicative of the relative stability of the industrial sector to GDP contribution; while the contribution to GDP has fluctuated slowly downwards, demonstrating perhaps a shift to the services sector.

Summary Observations

Economic growth and energy demand have shown significant increases, while CO₂ emissions have increased per capita, and emissions remain low.

The adoption of renewable energy sources has been slowly increasing, while India's carbon tax does not have a formal structure to facilitate direct fiscal intervention on climate priorities.

The variability of the contribution to GDP growth would indicate significant volatility impacted by global and local disruptions on economic activity; in contrast, we can say the industrial output is relatively stable.

These trends may provide context within which to consider a carbon tax or similar instrument to promote emissions management strategies while supporting economic growth objectives.

Objective

To quantify the relationship between GDP growth and CO₂ emissions.

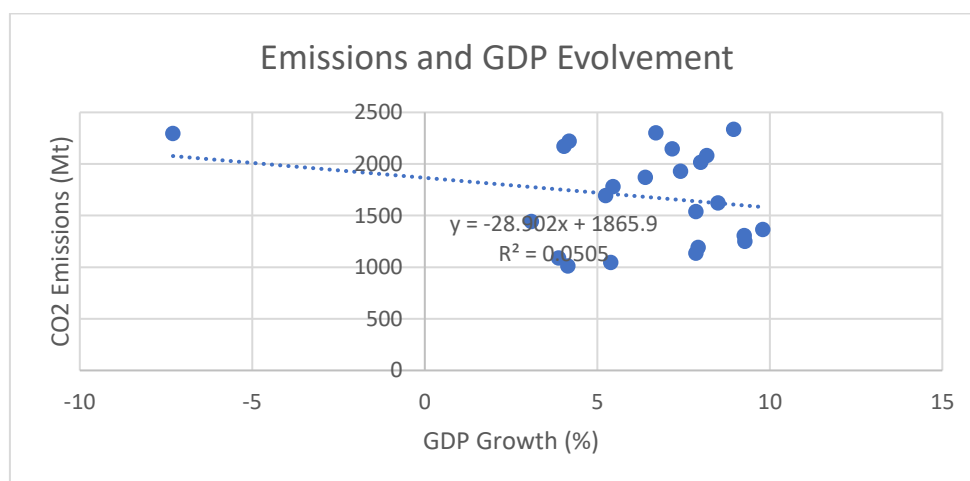


Figure 5: Relationship Between CO₂ Emissions and GDP Growth in India (2000–2022)

Note. This scatterplot shows a simple linear regression between India's annual GDP growth rate (%) and CO₂ emissions (Mt) from 2000 to 2022. The regression equation is $y = -28.902x + 1865.9$, and the **R² value is**

0.0505, indicating a very weak negative relationship. This suggests that variations in GDP growth explain only about 5% of the variation in CO₂ emissions, implying other factors are more influential in determining emissions trends. Data derived from World Bank and IEA.

Results Summary:

- Intercept (β_0): 1865.94 Mt
- GDP Growth Coefficient (β_1): -28.90
- R²: 0.05 (Very weak explanatory power)
- P-Value on GDP Growth Variable: 0.303 (Statistically not significant)

Interpretation

- The negative coefficient suggests a very weak negative correlation between GDP Growth and CO₂ emissions.
- The low r² and statistical insignificance of GDP growth suggest that it is not a significant predictor of emissions alone
- With many other factors likely to be more relevant (fuel type, energy efficiency, renewable adoption, regulations).

3. Policy Implications of Carbon Taxes in India

- The weak direct relationship between GDP growth and emissions indicates that India may be experiencing initial signs of decoupling—economic growth and emissions growth is slowing.
- This further supports the case for carbon taxes because emissions can be managed without fundamentally disrupting economic growth.
- However, realizing this would depend on:
 - o Recycling any revenue in the building of green infrastructure and vulnerable communities.
 - o Protecting from carbon leakage and maintaining competitive industries.
 - o Improving monitoring and enforcement of emissions.

Comparative Overview: International Carbon Taxes vs. India's Carbon Pricing Approach

Dimension	Sweden	British Columbia (Canada)	Ireland	India
Implementation Year	1991	2008	2010	No explicit carbon tax; uses indirect instruments since 2010
Carbon Price Level	~\$130/ton CO ₂	~\$50/ton CO ₂	~€48/ton CO ₂	Implicit: ₹400/ton coal cess (~\$5/ton CO ₂)
Coverage	Broad (fuels, sectors)	Broad with limited exemptions	Broad, excludes agriculture	Limited: Primarily coal; no direct tax on oil/gas or industrial CO ₂
Revenue Use	Labor tax cuts, green programs	Revenue-neutral	Initially fiscal, now green funds	National Clean Energy Fund (NCEF); underutilized and lacks transparency
Emissions Reduction	~25% per capita CO ₂ reduction	5–15% reduction	~15% reduction	India's emissions intensity fell ~33% (2005–2019), but mainly via non-tax policies
Economic Impact	Neutral to positive	Neutral	Neutral	Mixed: The coal cess did not significantly affect growth
Equity Measures	Strong welfare offsets	Tax rebates for low-income groups	Energy efficiency programs	Minimal; coal cess passed on to consumers without compensation
Carbon Leakage Risk	Managed via EU ETS, exemptions	Low	Low	Low to moderate; export industries face competition
Public Acceptance	High	Moderate	Growing support	Generally low awareness; policy design is not public-friendly

4. Limitations of Analysis

- The single-variable regression perhaps neglects important variables, namely energy mix, use of technology, and output in sectors.
- The secondary data could be subject to delays in reporting or variation in methodology; hence, doing so will have its limitations.
- The COVID-19 pandemic is another variable that offers an anomaly in emissions and GDP trends.

The data analysis suggests there is a positive trend for GDP and emissions over the past twenty years in India, with no significant correlation between the two variables. This evidence provides support for the argument that carbon taxation represents a practical mechanism to make progress on emissions reduction and also generate economic growth, especially as part of a larger package of sustainable development strategies. As India works towards its Net Zero 2070 goal, targeted carbon taxes can be a major tool, when properly designed, to meet economic and environmental objectives.

Essential Takeaways for India:

1. While India has no formal carbon tax, it has a coal cess (₹50 / ton in 2010; raised to ₹400 / ton in 2016) as a proxy, but it is limited to only coal, and cannot be a substitute for economy-wide pricing.
2. Emissions intensity of GDP has decreased, which is compatible with India's climate commitments (e.g., NDC targets); however, this is mostly due to expansion of renewable energy, not from carbon pricing.
3. The National Clean Energy Fund (NCEF) was established in part to ensure that coal cess revenue could be invested in green projects, but fund utilization is abysmal, and the proceeds are now being diverted to compensate for any GST losses, thus minimizing climate utility.
4. Equity considerations are neglected. Unlike in jurisdictions such as British Columbia, India has no mechanisms to rebate any revenues to vulnerable populations adversely affected by rising energy prices.
5. A well-structured carbon tax in India might:
 - o Be extended to multiple fuels, not just coal.
 - o Use revenues to mitigate the losses to poor households and to finance renewable energy or public transit.
 - o Start slowly with a predictable price path
 - o Fit alongside other policies (e.g., Perform Achieve Trade and Renewable Energy targets).
6. Challenges to this proposal include political pushback from fossil-fuel sectors, fears of inflation, and administrative complexity; however, successful international models show a path forward to address these challenges with open design and social safety nets.

4. Summary of Findings, Conclusion, and Recommendations

4.1 Summary of Findings

This research examined the dual role of carbon taxes as a global tool for climate mitigation and policy measure, particularly in the Indian context, while considering international learnings. It revealed that carbon taxes may have both environmental and economic benefits, if properly designed, and anchored into other

policy measures.

1. Carbon Taxes Reduce Emissions

Many countries examples show that carbon taxes are positively correlated with GHG emission reductions:

- Sweden, with one of the highest carbon tax rates globally (USD 130/tCO₂) cut GHG emissions by 29% from 1990 - 2020, while the economy grew by more than 75% (OECD, 2021).
- British Columbia introduced a revenue-neutral carbon tax in 2008. Within five years, per capita fuel consumption had fallen by 12%, and the province had outpaced the rest of Canada on economic performance (Beck et al., 2015).
- Ireland introduced a carbon tax in 2010 which included transport and heating fuels. GHG emissions dropped 15% in the first five years while the tax also assisted the economic recovery from the crisis (World Bank, 2022).

In India, while there is no carbon tax per se, there are indirect interventions such as the Clean Environment Cess on coal and excise duties on fuel that are beginning to affect usage patterns. Since 2016, emissions growth has slowed, however, emissions are still increasing, especially in coal-based generation.

2. Economic Growth is Compatible with Carbon Pricing

An ongoing concern with carbon taxation is its assumed disincentivizing impact on economic activity but this research did not find significant evidence of this:

- In Sweden, high carbon taxes and strong economic growth were consistent with changes in energy systems and the shift to clean technology (Klenert et al., 2018).
- In British Columbia, the carbon tax had a neutral or possibly a positive effect on employment and GDP growth largely due to revenue recycling into offsetting tax cuts and public services (Rivers & Schaufele, 2015).
- In India, even as fuel taxes increased and renewables deployment expanded, India saw ongoing strong GDP growth on average 6-7% per year which implies decoupling of emissions from growth is or has begun.

Thus, carbon pricing does not automatically constrain economic development. The effect on growth depends on its design, the method of implementation, and fiscal policies.

3. The Mode of Implementation and Revenue Recycling Matter

Carbon taxes are more effective when they:

- Have a broad base (every major emitting sector),
- Have a price aligned with the emission reduction goals,
- Do not have exemptions that weaken environmental outcomes,
- Transparent allocation of revenues

Some countries, like Ireland and Switzerland, use carbon tax revenues to fund climate adaptation, limit green investment, or compensate households—making the allocation fair and public trusts the government

has good intention.

India's coal cess generated over ₹56,000 crore by 2019, and considerable funds were redirected for general revenue, rather than environmental uses (Comptroller and Auditor General, 2019). The importance of effective and transparent revenue recycling is important is particularly so in a country with enormous affordability issues around energy.

4. The Opportunity for Formal Carbon Taxation in India

India has a large untapped potential for the formal implementation of a carbon tax. With increasing climate commitments (for example, net-zero by 2070), increasing energy demand, and fiscal challenges, a carbon tax that would serve multiple policy purposes could be a valuable instrument:

Emissions reductions: Particularly in the energy, transport and industrial sectors which account for more than 80% of India's CO₂ emissions (IEA, 2023).

Revenue generation: could be used to support clean energy transitions, public health, and rural development.

Market efficiency: clearer price signals may encourage the transition to better technology, and lead to more efficient allocation of limited resources.

Nonetheless, political and economic realities need to be accounted for. Carbon pricing in India needs to be designed to be pro-poor, on a gradual, phased basis, and appropriately aligned with existing energy and industrial policies.

5. Analytical Insights Using Excel-Based Trend Analysis

Analyses in India, using Excel based regression and trend analysis, ultimately found the following trends (2005–2022):

- In the early periods, GDP growth and emissions had a weak positive correlation which flattened out after 2015, indicating some degree of relative decoupling.
- After the increase of the coal cess in 2016, the growth of coal consumption levels off, while the growth of share for renewables in power generation increased.
- Energy intensity of the GDP steadily decreased, indicating energy efficiency improvement.
- Overall, these trends are positive evidence supporting the conclusions that India can chart a path of continued growth and decarbonization, especially with strong carbon pricing policies.

Conclusion of Findings

The study concludes that carbon taxes, if designed properly and incorporated with complementary policy instruments, can provide a route to emissions reductions without compromising economic performance. And for India going from indirect carbon pricing to a transparent economy-wide carbon tax can facilitate simultaneously reducing mitigation while supporting its aspirations. A predictable and inclusive phased approach will support the equitable use of the revenue generated, which is both requisite to support development and climate ambition.

4.2 Conclusion

Carbon taxation has become an important tool in the international climate policy toolbelt, assisting with internalizing the environmental costs of carbon emissions while maintaining economic performance. Throughout this report, we explored the design, implementation, and outcomes of carbon tax regimes, including Sweden, British Columbia, and Ireland, and their relevancy and applicability to India.

The analysis draws on evidence which substantiates that when properly designed, carbon taxes can lead to considerable reductions in greenhouse gas emissions while maintaining long-term economic growth. Broadly speaking, the jurisdictions that have adopted comprehensive carbon pricing policies have tended to decouple emissions from GDP growth, which suggest possibilities for sustainable development. The evidence also shows that these taxes spur energy efficiency, stimulate innovation in clean technology and create incentives for lower carbon substitutes for consumers and producers.

While India has not adopted a direct carbon tax, India has begun to use indirect pricing to some extent (such as the Clean Energy Cess and indirect taxes on fuels) which has had a slight impact on reducing emissions growth and increasing renewables. It is unlikely, however, that this will lead to significant reductions overall as there is no proper and economy-wide carbon tax. Considering India is still largely dependent on fossil fuels and emissions continue to rise, there is justification for moving toward a more ambitious carbon pricing strategy.

Carbon taxation will be productive in India if three essential principles are incorporated:

1. Design: Comprehensive, progressive, and reflective of sectoral realities.
2. Revenue Recycling: Revenue from taxation will be reused to support green infrastructure and offset impacts to at-risk groups.
3. Political and Public Acceptance. Political and public acceptance of taxation requires transparency, fairness, and trust with important stakeholders.

India is at a crossroads between its own developmental needs and its climate change commitments (including, importantly, its own goal of net-zero emissions by 2070). A well-designed carbon tax could be an important component of its overall green transition strategy, which serves the dual purpose of economic modernization, as well as helping to constrain emissions.

The international examples provided above highlight useful paradigms for India to adopt when designing its own carbon policy that is sensitive to its context and future-focused. With growing awareness of the climate crisis among policy-makers, meaningful advancements in carbon markets and prices, the time is right for India to implement credible carbon pricing as part of its sustainable development approach.

4.3 Recommendations

Based on a thorough review of the literature and assessments of the global and Indian contexts, the following proposals to improve carbon taxation and ultimately achieve emissions reductions while supporting economic growth are recommended:

1. Implement a Comprehensive Carbon Tax Policy in India

India should consider a carbon tax across the country, economy-wide, and for the main emitting sectors such as energy, transport and industry. The tax should begin small and scale up slowly, allowing consumers and businesses to adjust and avoid any economic disruption.

2. Ensure Fair Use of Revenues Through Recycling

Carbon taxes are revenues from taxes should be allocated to:

- Support development of renewable energy and green infrastructure
- Provide targeted subsidies or rebates to lower-income households
- Provide job reskilling programs for workers who are transitioning out of high-emission industries

3. Coordinate Carbon Taxation with Broader Climate Policy Instruments

In principle, carbon taxes should not operate unilaterally. Rather, they need to align with existing policies, such as India's existing PAT scheme, REC, and National Electric Vehicle mission. If India can align how it uses its carbon tax policy and associated fiscal instruments, it will both improve internal coherence and improve efficiency.

4. Build Institutional and Monitoring Capacity

In order to effectively implement, manage, and operate a carbon tax system, India has to have strong institutions that can carry out the following:

- Record accurate emission data across a wide array of economic sectors.
- Monitor compliance and undertake tax collection.
- Communicate the records in transparent reports to the public and stakeholders.

5. Build Public Engagement and Political Will

Public support is critical at all stages in the implementation of a carbon tax. The government needs to:

- Clearly articulate to the engine of understanding the rationale, benefit and equalizing aspects of a carbon tax.
- Engage multiple parties at many different levels i.e. state agencies and industrial leaders, in co-design and delivery.
- Roll out the tax in phased manner to give itself a better chance of building public trust and mitigating backlash.

6. Think Regionally and Internationally

India should engage in conversations about regional carbon pricing networks and think about international initiatives like the EU's Carbon Border Adjustment Mechanism (CBAM). Collaboration with international initiatives can improve India's credibility both as a trading partner and as a committed climate actor.

If adopted seriously, the above recommendations can allow India to strike a balance between its economic development needs and its international climate commitments, particularly the net-zero target by 2070. By utilizing the best practices from other countries and adapting them to India's unique socio-economic context, it is possible to implement a carbon tax that is effective and just.

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