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India's Carbon Border Adjustment Mechanism (CBAM) Challenge

Strategic Response and Policy Options

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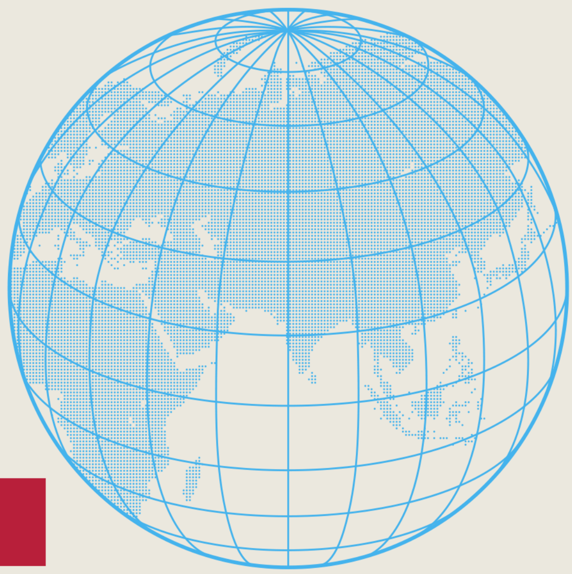

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India's Carbon Border Adjustment Mechanism (CBAM) Challenge

Strategic Response and Policy Options

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Table of Contents

List of Figures

List of Tables

List of Boxes

List of Abbreviations

AEA	Accredited Energy Auditor
B2B	Business-to-Business
B2G	Business-to-Government
BEE	Bureau of Energy Efficiency
BF	Blast Furnace
CaT	Cap-and-Trade
CBAM	Carbon Border Adjustment Mechanism
CBDR	Common but Differentiated Responsibilities
CCTS	Carbon Credit Trading Scheme
CCCs	Carbon Credit Certificates
CCUS	Carbon Capture, Utilisation, and Storage
CERC	Central Electricity Regulatory Commission
CISA	China Iron and Steel Association
CO_2	Carbon Dioxide
COP	Conference of the Parties
CPP	Captive Power Plants
CSR	Corporate Social Responsibility
DC	Designated Consumer
DISCOM	Distribution Company
DRI	Direct Reduced Iron
DJSI	Dow Jones Sustainability Indices
EAF	Electric Arc Furnace
EC	European Commission
EKC	Environmental Kuznets Curve
ESCerts	Energy Saving Certificates
ESG	Environmental, Social, and Governance
ETS	Emissions Trading System
EU	European Union
EV	Electric Vehicle
FMCG	Fast-Moving Consumer Goods
FTA	Free Trade Agreement
G2G	Government-to-Government
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GoI	Government of India
GST	Goods and Services Tax
HMRC	His Majesty's Revenue and Customs
HMT	His Majesty's Treasury
HS	Harmonised System
I&S	Iron and Steel
IAI	International Aluminium Institute
ICM	Indian Carbon Market

ICP	Internal Carbon Pricing
IEA	International Energy Agency
IH2A	India H2 Alliance
IOP	IOC Phinergy Private Limited
IRA	Inflation Reduction Act
JISCO	Jindal Iron and Steel Company
JVSL	Jindal Vijaynagar Steel Ltd
LDC	Least Developed Countries
LCI	Life Cycle Inventory
MoU	Memorandum of Understanding
MRV	Monitoring, Reporting, and Verifying
MSME	Micro, Small and Medium Enterprises
MTPA	Million Tonnes per Annum
NALCO	National Aluminium Company Limited
NDAIAPA	National Designated Authority for the Implementation of Article 6 of the Paris Agreement
NDC	Nationally Determined Contributions
NSCICM	National Steering Committee for the Indian Carbon Market
NTB	Non-Tariff Barrier
OECD	Organisation for Economic Co-operation and Development
PAT	Perform, Achieve, and Trade
PHDCCI	PHD Chamber of Commerce and Industry
R&D	Research and Development
RE	Renewable Energy
RECs	Renewable Energy Certificates
RGGI	Regional Greenhouse Gas Initiative
RoDTEP	Remission of Duties and Taxes on Exported Products
RPOs	Renewable Purchase Obligations
SAIL	Steel Authority of India Limited
SDG	Sustainable Development Goals
SDS	Sustainable Development Scenario
SLB	Sustainability-Linked Bond
tCO_2	Tonnes of CO_2
tCO_2/tcs	Tonnes of CO_2 per Tonne of Crude Steel
TERI	The Energy and Resources Institute
UAE	United Arab Emirates
UK	United Kingdom
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
VAT	Value-Added Tax
WTO	World Trade Organization

Abstract

This study investigates how India can navigate the challenges posed by the European Union's Carbon Border Adjustment Mechanism (EU's CBAM) for steel and aluminium exports. It explores policy options for a smooth transition, including the feasibility of establishing an Emissions Trading System (ETS) in India or implementing a domestic carbon tax regime. The findings highlight the need for a carbon pricing mechanism in India to meet sustainability goals and international commitments. Given uncertainties, repurposing existing energy and environmental taxes on exported goods (excluding those subsumed within GST)—especially taxes used to prepare data for the Remission of Duties and Taxes on Exported Products (RoDTEP) scheme—emerges as a potentially reliable interim approach. Revenue generated from this tax could be strategically used as seed funding to support green initiatives and technological advancements. The critical question of how a domestic carbon tax could be integrated with the Carbon Credit Trading Scheme (CCTS) remains unanswered, creating confusion for policymakers and industry. The CCTS's lack of appeal to industry players primarily stems from the lack of clarity about its specifics, potential effectiveness, and the possibility of any cost increase. This seems more complex mainly owing to the absence of domestic expertise and technological advancements in carbon trading. Furthermore, structural variations exist within the steel and aluminium industries, with aluminium currently excluded from the CCTS. The study recommends a multi-faceted approach: implementing a data-driven carbon tax system aligned with CBAM, followed by progress on the CCTS; promoting scrap availability and recycling; extensively increasing the use of renewable energy; exploring alternative fuels; and fostering research and development (R&D) for clean technologies. Additionally, supporting Micro, Small, and Medium Enterprises (MSMEs) and encouraging technology-sharing agreements are critical for a successful transition. The study also examines the opportunities for India to adopt more decarbonisation initiatives across its value chains. It particularly conceptualises the computation of obligations under the EU's CBAM and its short-term and long-term impacts on the Indian steel and aluminium industries. It proposes a comprehensive strategy for India to address CBAM challenges and position itself for a sustainable future in the global export market.

Executive Summary

This study explores the complexities of the European Union's Carbon Border Adjustment Mechanism (CBAM) and its implications for India, particularly its steel and aluminium export sectors. It explores various policy options, including a domestic emissions trading system (ETS) or a carbon tax, to facilitate a smoother transition for Indian industries under the new CBAM regime. The findings highlight the need for a carbon pricing mechanism in India to meet sustainability goals and international commitments. Given uncertainties, repurposing existing energy and environmental taxes on exported goods (excluding those subsumed within GST)—especially taxes used to prepare data for the Remission of Duties and Taxes on Exported Products (RoDTEP) scheme—emerges as a potentially reliable interim approach. The study recommends a multi-faceted approach: implementing a data-driven carbon tax system aligned with CBAM, followed by progress on the CCTS; promoting scrap availability and recycling; extensively increasing the use of renewable energy; exploring alternative fuels; and fostering research and development (R&D) for clean technologies.

Research Background

The backdrop of the research is the growing international discourse surrounding climate change mitigation and the responsibilities of various nations in curbing greenhouse gas (GHG) emissions, particularly carbon dioxide (CO_2). The study highlights the contrasting views on emission responsibility—developed nations often point to current emission levels, while developing countries emphasise the historical contributions of industrialised nations to the existing atmospheric GHG concentrations.

This tension is central to the CBAM debate. The EU's CBAM, part of its "Fit for 55" strategy, aims to reduce carbon leakage—where companies shift production to countries with less stringent environmental regulations to avoid carbon costs—and encourage global decarbonisation. However, CBAM has met with mixed reactions. While proponents see it as a crucial step towards global climate action, critics, particularly in developing countries like India, raise concerns about its potential to act as a trade barrier, harming their competitiveness and potentially hindering economic growth.

Research Questions

The study sets out to address several key questions:

1. How can India navigate the challenges posed by CBAM, and what policy options are available to the government and the affected industries?
2. What are the specific challenges and opportunities for Indian firms, including the impact on domestic production, trade, carbon emissions, and pricing?
3. Can India implement its own ETS, similar to the EU's, or should it consider alternative policy measures like a domestic carbon tax?
4. What strategic initiatives are Indian companies undertaking to adapt to CBAM, and how can the government support them?

Methodology

The study adopts a mixed-methods approach, incorporating both qualitative and quantitative research methods. It draws upon secondary data on trade and carbon emissions from government databases and international datasets, as well as a review of existing research on CBAM, international trade, and CBAM Exposure Indices. It carries two case studies, one each for steel and aluminium producing and exporting firms. The study conducts surveys with various stakeholders in India, including policymakers, industry associations representing steel and aluminium producers, trade lawyers, specialists in green energy and green hydrogen, green start-ups, auditors, consultants, and representatives from Micro, Small and Medium Enterprises (MSMEs). This primary research offers valuable insights into the practical challenges and opportunities related to CBAM implementation.

Furthermore, in-depth case studies of two major Indian firms—JSW Steel (representing the steel sector) and Hindalco (representing aluminium)—provide a more granular understanding of how individual companies are responding to CBAM and adapting their sustainability strategies. Data for the case studies were drawn from company annual reports, sustainability commitments, and future-oriented plans, enriched by insights gathered through policy discussions.

Key Findings

1. **Significant Export Exposure and Vulnerability:** India's steel and aluminium industries face significant exposure to CBAM due to their reliance on carbon-intensive production processes and their considerable exports to the EU. While larger firms like JSW Steel and Hindalco have initiated sustainability measures, MSMEs face significant challenges in adapting to the new regulations due to limited resources and awareness.

2. **Carbon Pricing as a Necessary Step:** The study argues that a carbon pricing mechanism—either an ETS or a carbon tax—is essential for India to meet its sustainability goals, address climate change, and fulfil its international commitments. Given the uncertainties surrounding the recommended Carbon Credit Trading Scheme (CCTS), the study suggests repurposing existing energy and environmental taxes on exported goods (excluding those subsumed within GST)—especially taxes used to prepare data for the RoDTEP scheme—emerge as a potentially reliable interim approach.

3. **Strategic Responses of Indian Firms:** Both JSW Steel and Hindalco have proactively embraced sustainability initiatives, including investments in renewable energy, improving energy efficiency, and exploring alternative fuels. However, challenges remain in fully transitioning to cleaner production processes due to technological and economic constraints.

4. **Need for Policy Support:** The study emphasises the need for policy support from the government to help Indian industries adapt to CBAM. This includes:

   - Facilitating the development and adoption of renewable energy (RE) sources by strengthening regulations for mandatory RE obligations.
   - Increasing the availability of scrap; a dedicated scrap recycling facility can be considered for a few countries, such as the EU, UK, Australia, the US, etc.
   - Exploring and scaling alternative fuels like green hydrogen and biochar by developing an ecosystem with the help of technical institutions such as IITs.
   - Providing financial and technical support to MSMEs.
   - Promoting technology-sharing agreements to accelerate the development and adoption of clean technologies.

Conclusions and Policy Recommendations

The study concludes that CBAM presents both challenges and opportunities for India. While the short-term impacts may be adverse for some sectors, CBAM can act as a catalyst for India to accelerate its transition to a greener economy and enhance its competitiveness in the global market. The report emphasises a multi-faceted approach for India, including aligning a data-driven carbon tax system with CBAM, followed by focussed progress on the CCTS. Other crucial recommendations include increased scrap availability, aggressive recycling initiatives, extensive use of renewable energy, exploration of alternative fuels like green hydrogen and biochar, and fostering research and development (R&D) for clean technologies. Critically, the study emphasises supporting MSMEs and fostering international technology-sharing agreements. Rather than replicating the historical patterns of developed nations, it advocates a different approach that leverages technology to minimise the environmental impact of industrialisation from the outset.

Significance and Implications

The study is significant for several reasons:

1. **Timely and Relevant:** It addresses a critical and timely issue facing Indian industries, providing valuable insights for policymakers, businesses, and other stakeholders.
2. **Comprehensive Approach:** It adopts a comprehensive mixed-methods approach, combining secondary data analysis with primary research and case studies.
3. **Policy Relevance:** The study offers concrete policy recommendations for the government to consider in developing its response to CBAM.
4. **Global Implications:** The findings of the study have implications beyond India, contributing to the broader international discussion on climate change mitigation and trade policy.

The study concludes with a positive outlook and encourages a proactive approach. It highlights that technology is the key to tackling climate change in developing countries and emphasises the potential for developing domestic clean technologies, followed by trading them. This approach can promote sustainable growth, help India achieve its climate goals, and strengthen its position in the global economy.

1. Introduction and Context

A complex international debate around balancing sustainability and climate goals is underway. It is typically contentious concerning who should own and bear responsibility for greenhouse gas (GHG) emissions—primarily carbon dioxide (CO_2), which constitutes about 75% of emissions (Ritchie et al., 2024)—that are acting like a blanket, trapping heat and causing global temperatures to rise at an alarming rate. The process of rapid industrialisation and the consequent increasing production of steel, aluminium, and cement, among others, requires the burning of fossil fuels, mainly coal, which contributes to rising carbon emissions. As these gases stay in the atmosphere for hundreds—if not thousands—of years, they act as major drivers of climate change.[1] This phenomenon transcends borders and thus demands a collective global response. Realising the climate urgency, the 2023 United Nations Climate Change Conference (COP28) marked the conclusion of the first "global stocktake" under the Paris Agreement[2] and signalled the beginning of the end of the fossil-fuel era (UNFCCC, n.d.).

The GHG Protocol defines three emission scopes—Scope 1, 2, and 3—which help measure environmental impacts (see Bhatia et al., 2004). Scope 1 deals with direct emissions from sources owned or controlled by a company, such as furnaces and vehicles. The other two deal with indirect emissions, which may be more challenging to control. Scope 2 covers emissions from purchased electricity (which can be tackled by moving to renewable energy). Scope 3 examines indirect emissions from companies' activities that are outside their control (e.g., supply chains, product use, and purchased materials).

The EU's Carbon Border Adjustment Mechanism (CBAM), a cornerstone of its "Fit for 55" climate strategy, applies to the reporting obligations for all three scopes of emissions (Scope 1 deals with those products covered within the CBAM Regulation, and Scopes 2 and 3 are related to the raw materials when those raw materials are also covered by the CBAM Regulation). The tax, however, is to be levied from January 2026 only on direct emissions (Scope 1) and embedded emissions of those raw materials also covered by the CBAM Regulation (partially Scope 3). CBAM is hailed as a bold step to track emissions in value chains and control them. The EU's CBAM is aimed at reducing global carbon emissions and especially tackling carbon leakage. Carbon leakage refers to a situation where companies, in an effort to avoid the costs of carbon regulations or taxes in one location, shift production to countries with lower or no restrictions. The 1997 Kyoto Protocol brought this element into the limelight, which has been a matter of concern since then for many industrialised economies, especially the EU. It eventually paved the way for introducing carbon pricing.

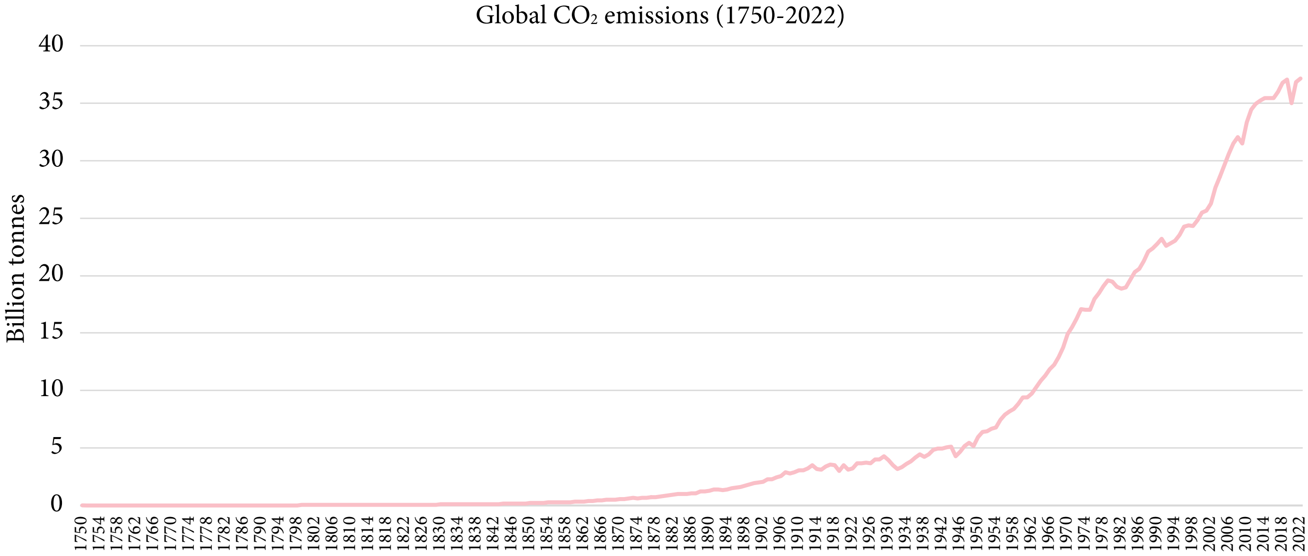
As the world grapples with an escalating climate crisis, CBAM has emerged as a contentious but potentially game-changing policy. It aims to reduce net GHG emissions by at least 55% by 2030 and make the EU climate-neutral by 2050. Proponents focused on mitigating GHG emissions see CBAM as a potential catalyst for global environmental action. This mechanism would impose a levy on imported goods based on their carbon footprint, incentivising cleaner production practices in countries with lax environmental regulations. However, CBAM has ignited a complex international debate, and such concerns continue to simmer. Although proponents hail it as a crucial tool for global decarbonisation, critics warn of trade wars and economic hardship. Figure 1 highlights the tremendous rise in CO_2 emissions at a global level and, consequently, the attendant challenge.

Many countries, including industrialised ones (particularly those with established steel manufacturing), fear CBAM could function as a disguised trade barrier, eroding their competitive edge and jeopardising jobs. Developing nations, caught between environmental concerns and economic realities, fear becoming collateral damage. They face the possibility of economic sluggishness in export markets, especially if they are unable to meet the CBAM requirements.

[1] The half-life of CO_2 is about 120 years (see, Takle, n.d.); Also, Inman (2008) explains the reasons why carbon emissions stay much longer than expected for thousands or hundreds of years.

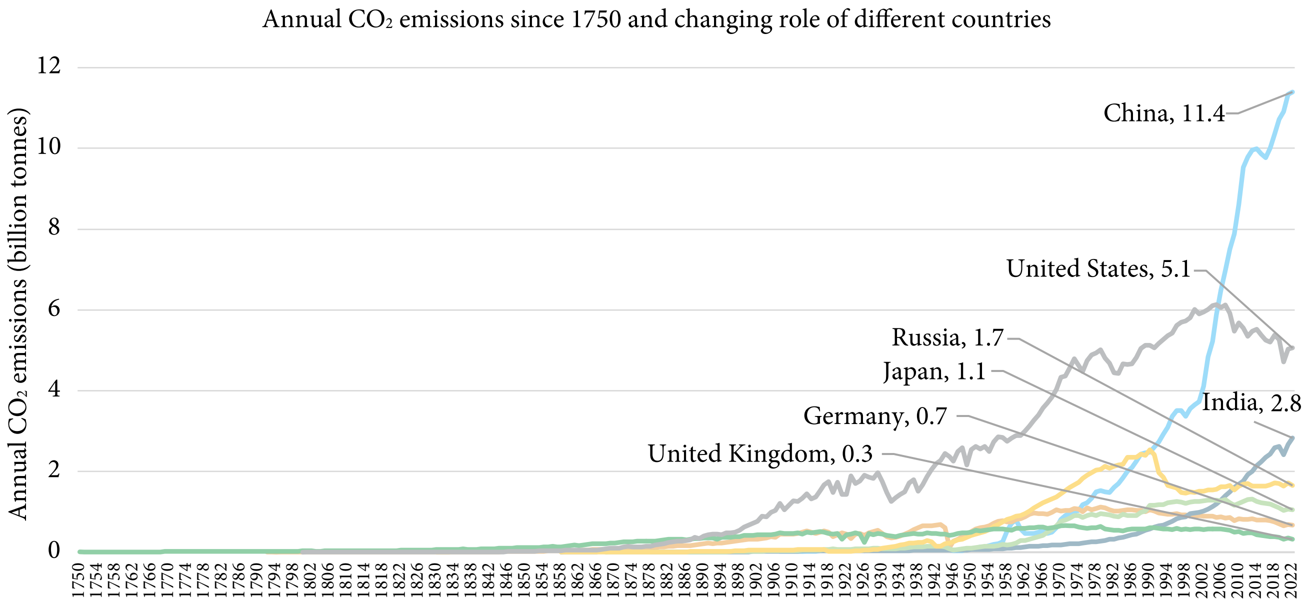
[2] This international treaty on climate change was adopted by the parties to the United Nations Framework Convention on Climate Change (UNFCCC) in 2015, with the aim of limiting the rise in average global temperature to below two degrees Celsius, possibly 1.5 degrees.

Figure 1: Carbon Emissions are Rapidly Rising Since the Second Industrial Revolution



Source: Our World in Data.

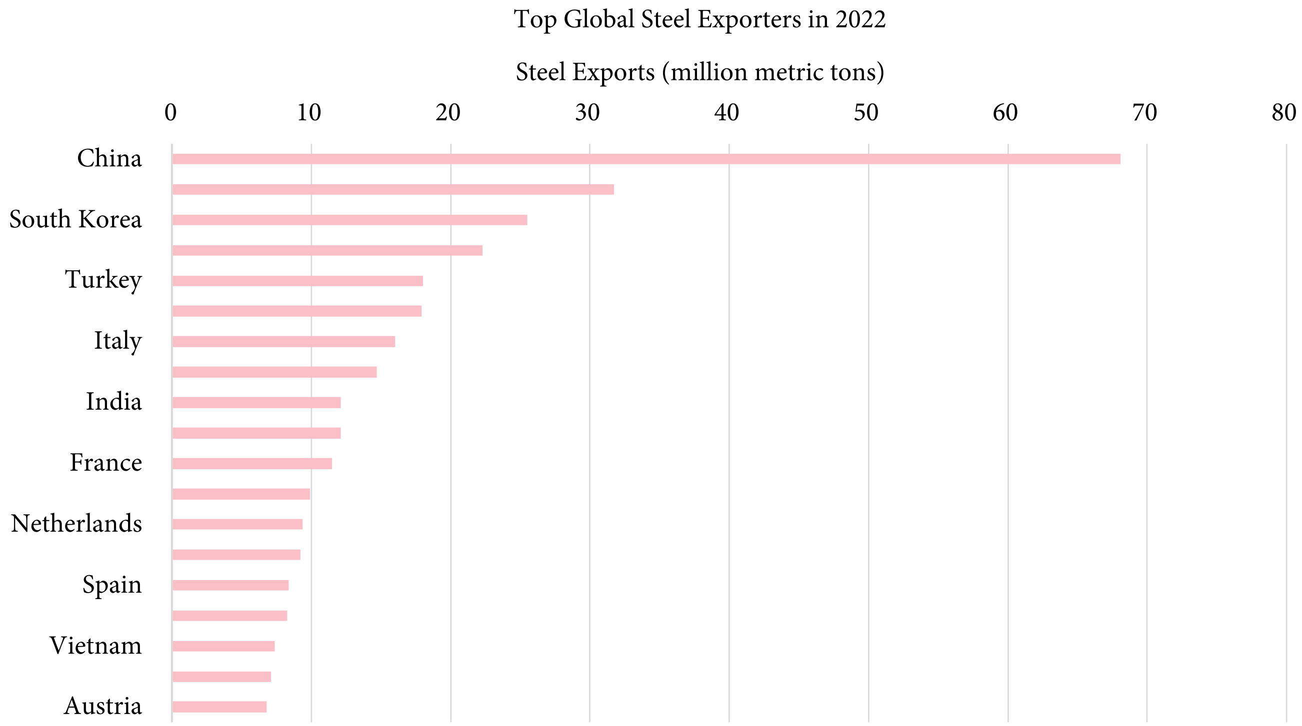
Figure 2: China's and India's Carbon Emissions are Rising Continuously



Source: Our World in Data.

There has understandably been a mixed response among stakeholders to the potential impacts of CBAM. Many advanced nations, including the US, Canada, and Australia, plan to follow suit and may eventually implement their own carbon regime like the EU. The UK has announced launching its own CBAM by 2027. It published the *Consultation on the Introduction of a UK Carbon Border Adjustment Mechanism* on March 21, 2024 (HMRC & HMT, 2024). On the other hand, developing nations like India, China, South Africa, and Brazil have been opposing the carbon tax. The reason is straightforward—rapid growth has resulted in rising industrial production since 1991, especially in China and India (see Figure 2 for top carbon-emitting countries). These countries are the top steel producers in the world, with China as the leading exporter, while India was among the top 10 exporters in 2022 (see Figure 3). Steel is the industry most affected worldwide, as steel demand is rising globally, and so is its production, resulting in carbon emissions due to the increased use of coal.

Figure 3: India's Steel Industry is Among the Top 10 Exporters in the World



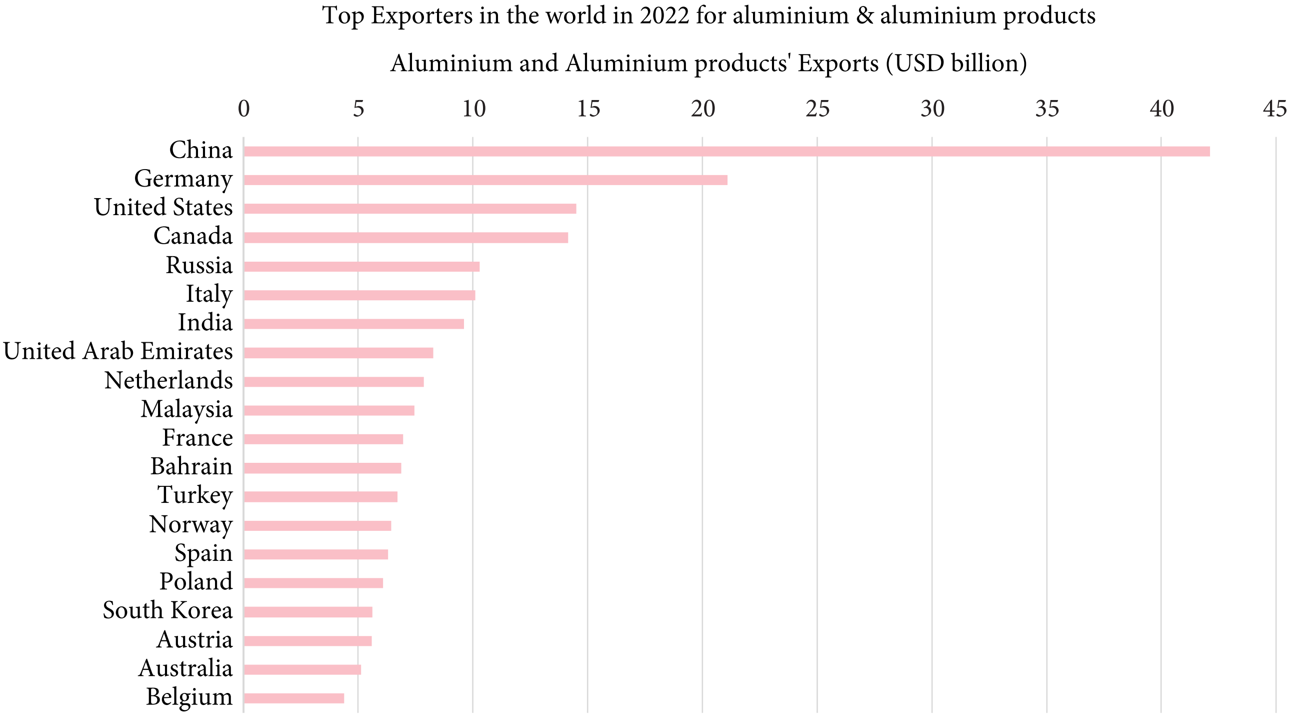
Source: Statista.

India's rejuvenated focus on manufacturing since 2014–2015 to meet its economic goals, such as productive job creation, is upsetting calculations, particularly in light of its commitments at the COP26 Summit in Glasgow to achieve net-zero emissions by 2070. India is also committed to reducing the emissions intensity of GDP by 45% by 2030 (Press Information Bureau, 2022).

The CBAM debate is thus a microcosm of a complex global challenge: balancing growth and sustainability. Least Developed Countries (LDCs) are facing prohibitive compliance costs to the extent they export to the EU, potentially hindering their development. As the international community grapples with this complex issue, the question that begs an answer is: can CBAM be implemented in a way that fosters international cooperation and drives a sustainable future? Or will it exacerbate existing divisions, hindering progress? Will technological progress render the Environmental Kuznets Curve (EKC) hypothesis irrelevant? Empirical evidence suggests that the EKC hypothesis overlooks imported carbon, and it may be difficult to repair damage caused in the initial phases of growth (Leal & Marques, 2022).

The primary argument in favour of CBAM is that its implementation will reduce global trade in CBAM-affected products, primarily iron and steel (I&S), aluminium, and cement. The EU's imports of CBAM products are estimated to decline by 14% by 2030, affecting exporters in Russia, India, and China (Simona, 2021). In general, the lack of access to finance and technology to address carbon emissions for some firms in these countries could, however, lead to diversion. In the same spirit, impacts are likely to be adverse for smaller countries, particularly those in Africa (Luke, 2023; Pleek & Mitchell, 2023; Scoppio et al., 2023), which generally have very limited access to cleaner technology and mostly rely on exports to the EU. It is further estimated that steel and aluminium exports from India to the EU will decline by almost US$2 billion (UNCTAD, 2021). This is particularly concerning because, like steel, India is also among the top exporters of aluminium (Figure 4).

Figure 4: India is the 7th Largest Exporter of Aluminium in the World in 2022



Source: Statista.

Nevertheless, the concerns go beyond immediate economic losses. Critics of CBAM argue that it unfairly penalises emerging economies like India, which face steeper challenges in adopting clean technologies and transitioning to low-carbon manufacturing due to limited access to finance and technology. The benchmark carbon price set by CBAM, based on European standards, is seen as discriminatory against countries with lower per capita emissions, such as India.

Conversely, some studies have shown that carbon taxation would increase research and development and innovation, prevent carbon leakage, and help achieve the Paris Agreement's goal of keeping the global temperature within two degrees Celsius. For example, implementing a carbon tax of US$44 per tonne is estimated to reduce carbon leakage from 13% to 5%, with the impact on emerging markets' exports being just 1.4% (UNCTAD, 2021). How robust are these forecasts? Against the backdrop of this tentative calculation looms the imminent imposition of CBAM and the enormous amount of impassioned debate around it. The outcome document of the July 2023 G20 Environment and Climate Ministers' Meeting underlined the global disquiet. Some members went so far as to brand CBAM as a tariff and/or a non-tariff barrier (NTB) camouflaged as climate action, while others disagreed with this characterisation.

The implementation of CBAM's first reporting phase began in October 2023 and immediately sparked uncertainties among large exporters of energy-intensive goods to the EU, including India. The EU is India's second-largest trading partner; Indo–EU goods trade increased by about 30% in the last decade (Grover et al., 2023). In 2022, India's exports of CBAM products to the EU amounted to US$9 billion, with the largest share of 70% coming from the I&S industry, followed by 29% for aluminium (Goldar et al., forthcoming). Naturally, CBAM will impact these trade flows. For example, India is among the top ten exporters of steel to the EU, which by any calculation will be affected. CBAM could also impact India's exports of steel and aluminium in their primary form to third countries (other than the EU) when such countries use the primary metal to produce goods covered by CBAM, where these goods are ultimately exported to the EU. However, precise estimates of such trade volumes and the impact of CBAM are unavailable at this juncture.

Since India's target of net-zero emissions is set for 2070, it allows time for adjustment even as significant development challenges confront the nation. The EU's CBAM simultaneously presents an opportunity for India to accelerate its transition towards a greener economy. The potential economic pain from CBAM could serve as a catalyst for new carbon pricing initiatives, encouraging firms to invest in cleaner technologies and improve energy efficiency. Moreover, the ambitious steel production target of 300 million tonnes by 2030[3] (from the current level of around 125 million tonnes) demands a serious focus on cleaner steelmaking technology, and CBAM could serve as that impetus.

What then are the policy options available to the government and Indian steel and aluminium exporters, among others, for the smooth implementation of CBAM? What are the specific issues and challenges therein? What is India's stance on carbon pricing? Can India implement its own Emissions Trading System (ETS), or can it put a carbon tax in place of CBAM, and if so, what could a prototype of this regime be? What measures have the large steel and aluminium manufacturers in India adopted in anticipation of CBAM, including management of their Micro, Small and Medium Enterprises (MSME) supply chains? What can the government do to support them?

The study's objective is to address these questions and, in the process, understand the challenges and opportunities faced by India. We will also identify policy measures that could enable India to develop an effective domestic carbon tax while sustaining its exports of energy-intensive goods, mainly steel and aluminium. This study examines the following:

(i) The government's response to CBAM implementation;

(ii) Understand the strategic initiatives of companies, the challenges, and their options, including the impact on domestic production, trade, carbon emissions, and pricing; and

(iii) Evaluate different policy alternatives, such as phase-ins, as a way forward to meet the target of net-zero emissions and help devise India's own carbon tax.

The overarching issues are many and include (a) appropriate tax rates; (b) emissions reporting and certification; and (c) other necessary certifications acceptable to the European Union (EU). These matters will be relevant whether a carbon ETS is fully implemented in India, or an export tax regime is implemented. Theoretically, exports to Europe can be taxed within India since the overall objective is to tax the negative externality, whether in the EU or India, and the aim is to reduce emissions globally. At the firm level, any response will involve (a) higher costs, including those related to necessary certifications; (b) diversion of exports; and/or (c) locating production facilities in the EU. The study also explores these options. The Appendix presents the research framework.

In our analysis, we employ both qualitative and quantitative research methods. Data on trade and carbon emissions were obtained from several sources, including Government of India (GoI) databases and international datasets. We also examined numerous secondary sources concerning country-specific policy measures and strategic responses to the CBAM, including published research. Importantly, we supplemented this information with primary surveys conducted in India. We engaged various stakeholders, including policymakers and industry associations representing alloy steel producers and aluminium firms, as well as trade lawyers, specialists in green energy/green hydrogen, green start-ups, and auditors and consultants in the field to understand the minutiae in policy that are often ignored in such analysis (see Appendix A for the survey framework and questionnaire). Industry associations represent a vast share of the industry (including both large and medium-sized firms) and are therefore important to this research. To understand the challenges and opportunities for MSMEs, we also engaged with the Federation of Indian Small and Medium Enterprises (FISME), which represents thousands of small businesses. Their insights are critical to this analysis. Customised workshops conducted by FISME and PHD Chamber of Commerce and Industry (PHDCCI) enabled broader consultations with other key players, including from government, academia, think tanks, and international organisations. These consultations yielded useful insights on the CBAM (such as using digitisation for reporting solutions). Discussions with these stakeholders offered a wide range of views and helped synthesise a holistic view of the options available to India—a perspective that could not have been developed otherwise. Moreover, in-depth case

[3] In the recent edition of 'ISA Steel Conclave 2023', the GoI declared steel production as a significant factor to hasten growth. A target of 300 million tonnes of steel annually has been set for 2030.

studies of two large Indian firms in the energy-intensive and trade-exposed industries, namely JSW for steel and Hindalco for aluminium, were chosen to complement the insights gained from the stakeholder consultations. Data for the case studies were taken from their annual reports, sustainability commitments, and future-oriented plans, as well as from insights gained during policy discussions.

This paper is timely and important for strategy and policy development. Companies are updating their processes to ensure compliance, obtain necessary certifications, and prepare for the future. India is also developing its own response to CBAM. A range of voices must be heard at this juncture, and even if repetitive, it serves the purpose of reinforcement that is so important in policy debates. At the same time, this study's comprehensiveness is its foremost distinction, besides presenting two ground-breaking case studies in the industries most affected by the imposition of CBAM. It also conceptualises and computes the obligations under CBAM to assess the impact on the industries. The paper underscores the necessity of a carbon pricing mechanism to fulfil sustainability commitments and proposes strategies for both firms and policymakers to help drive sustainable and inclusive growth. The paper recommends a multifaceted approach, including implementing a data-driven carbon tax system aligned with CBAM, monitoring the progress of the Carbon Credit Trading Scheme (CCTS), and exploring alternative fuels. Rather than replicating the historical patterns of developed nations, it advocates a different approach that leverages technology to minimise the environmental impact of industrialisation from the outset.

The remainder of the study is organised as follows. The next section presents nation-specific and global carbon emission data and provides a brief history of CBAM. Section 3 reviews the growing literature on CBAM, international trade, and CBAM Exposure Indices, focusing on the impact on emerging countries. Section 4 maps out the notion of ETS and carbon taxes globally and in India. Section 5 presents the results of surveys conducted in India and two case studies of the steel and aluminium industries. Section 6 concludes with short-, medium-, and long-term policy recommendations.

2. Global Carbon Emission Trends and the EU-CBAM's Evolution

The need for addressing climate change, carbon leakage, achieving net zero emissions, and devising carbon pricing mechanisms or taxes depends on available data on CO_2 emissions. In this section, we present descriptive statistics of CO_2 emissions by country and region (excluding land-use change). Asia has become the largest emitter because China and India are among the fastest-growing populous markets, followed by North America (led by the US). Asia's emissions have increased over the last three decades since 1991, while those of Europe have declined (see Table 1 and Figures 7 and 8).

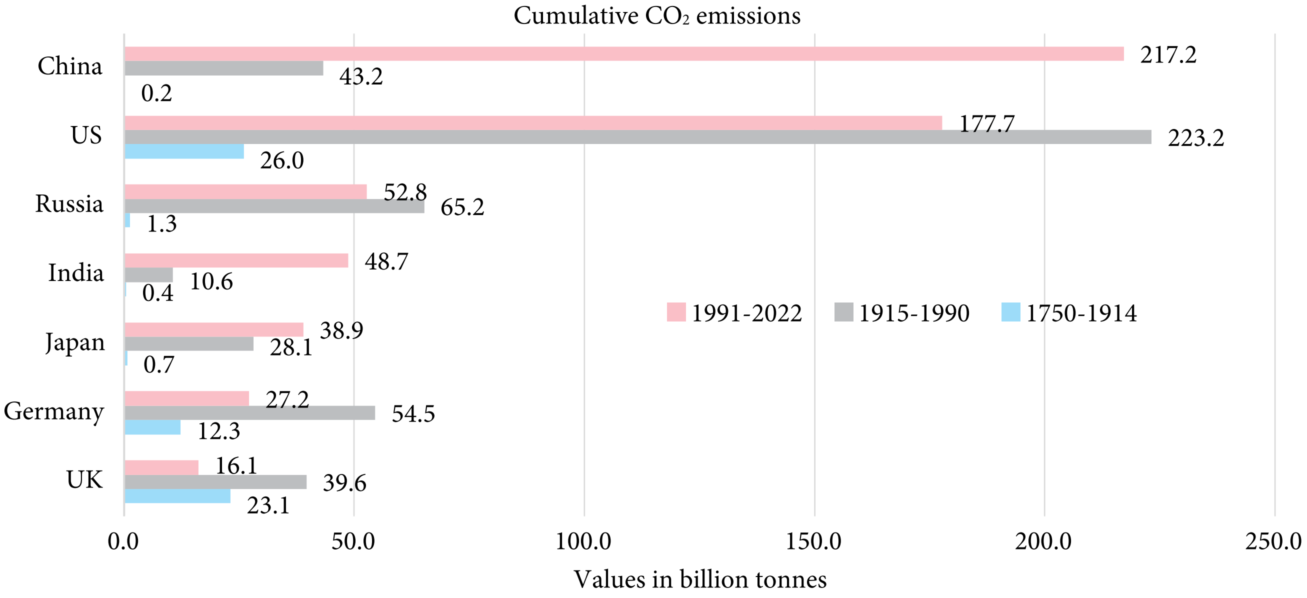
Although India is not a historical high emitter, it is now among the top in aggregate emissions. China, with minimal emissions prior to 1914, has experienced a significant increase in emissions since 1991, surpassing India. However, their per capita emissions remain below the US and the EU. For India, per capita emissions are around 2 tonnes of carbon per annum (Figures 5 and 6).

Table 1: Carbon Emissions of Different Regions, With Their Top Emitting Countries

Region/ Country	CO_2 Emission (2022) Billion tons	CO_2 emission in 1750 or of the year when reporting started (Million tons)	CO_2 in 1914 (Million tons)	Change in annual CO_2 emissions (%) 1991-2022	Cumulative CO_2 Emission (2022) (B tons)	Cumulative CO_2 (1750-1990) (B tons)	Cumulative (1991-2022) (B tons)
Asia	21.8	0.002 (1830)	142.9	194.0	578.4	130.2	448.2
China	*11.4*	*19.8 (1907)*	*26.7*	*337.3*	*260.6*	*43.4*	*217.2*
Asia (excl. China & India)	*7.5*	*0.002 (1830)*	*84.4*	*80.3*	*258.1*	*75.8*	*182.3*
India	*2.8*	*0.394 (1858)*	*31.7*	*359.8*	*59.7*	*11.0*	*48.7*
North America	6.3	0.004 (1785)	1396.8	5.8	490.2	276.6	213.6
United States (US)	*5.1*	*0.253 (1800)*	*1318.0*	*-0.1*	*426.9*	*249.2*	*177.7*
North America (excl. US)	*1.2*	*0.004 (1785)*	*78.8*	*40.1*	*63.3*	*27.4*	*35.9*
Europe	5.1	9.3 (1750)	1574.0	-34.0	542.5	346.6	195.9
EU-27	*2.8*	*0.469 (1792)*	*981.0*	*-40.4*	*296.0*	*186.8*	*109.2*
Europe (excl. EU-27)	*2.3*	*9.306 (1750)*	*593.0*	*-27.4*	*246.5*	*159.8*	*86.7*
Africa	1.4	0.022 (1884)	19.6	106.0	51.0	15.9	35.1
South America	1.1	0.004 (1884)	17.2	78.9	45.1	15.4	29.6
International shipping	0.6	–	–	106.6	28.3	11.6	16.7
Oceania	0.4	0.001 (1806)	30.0	41.5	21.7	8.5	13.2
International aviation	0.4	–	–	106.6	15.6	3.0	12.7

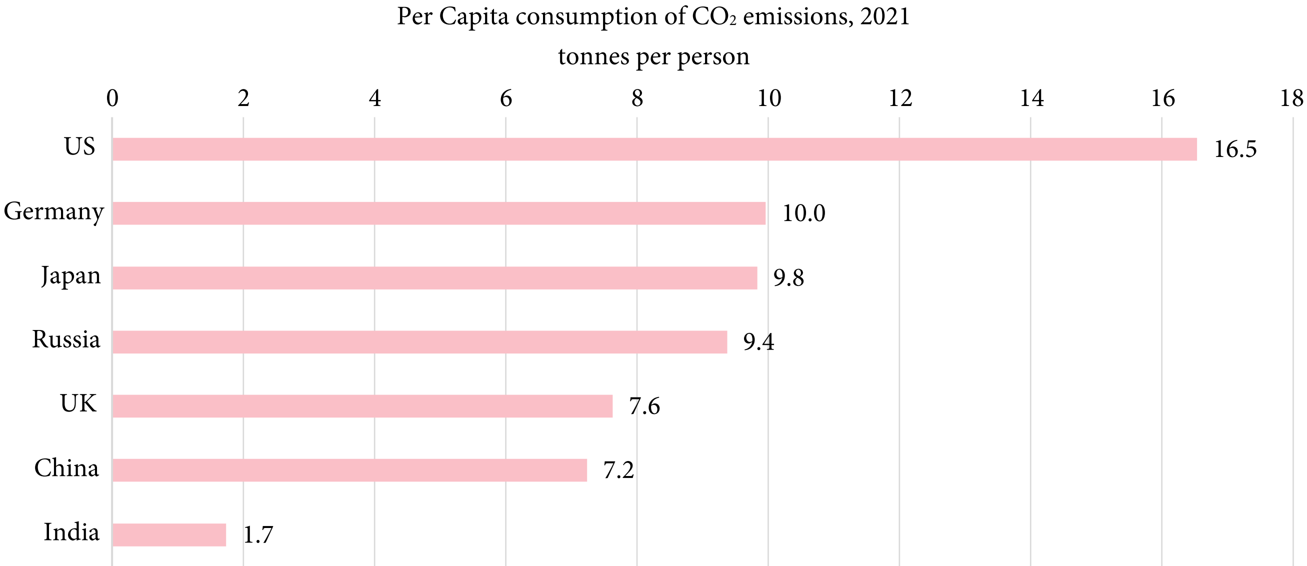
Source: Our World in Data.

Figure 5: India is Not Historical Emitter



Source: Our World in Data (cumulative CO_2 emissions).

Figure 6: India's Per Capita Emissions are Much Lower



Source: Our World in Data.

The EKC hypothesis attempts to rationalise the trajectory of carbon emissions in countries by income. Once the tipping point or peak is attained, environmental degradation tends to decline. For example, the UK attained its turning point around 1985 when decoupling began to occur between per capita GDP and CO_2 emissions (Syed, 2019). Note that the UK's emissions increased between 1915 and 1990 and thereafter decreased, mainly from 1991 onwards. However, because CO_2 stays in the environment for hundreds of years, the decline in emissions does not change the reality of historically high emitters. China and India have yet to reach their respective tipping points. Tipping points naturally vary by country, influenced by—among other things—technological breakthroughs. The UK took over two centuries to reverse emissions following the Industrial Revolution in the 1750s. The UK has reduced its dependence on fossil fuels (mainly coal) from 29 million metric tonnes of oil equivalent in 2000 to 1.4 million tonnes in 2022, while the share of gas was 22 million tonnes in 2022. Bioenergy, wind, solar, and hydroelectric power have seen an increase from their relatively low levels (see Table 2). India will not take two centuries, as the UK did, and therefore should be granted respite, especially given the enormous international pressure to do so.

Table 2: UK's Changing Fuel Mix to Generate Electricity (Million Metric Tonnes of Oil Equivalent)

Year	Gas	Bioenergy	Nuclear	Wind	Other fuels	Coal	Solar	Oil	Hydro
2000	27.9	1.6	19.6	0.1	1.4	28.7	–	1.6	0.4
2015	18.3	8.1	15.5	3.6	2.0	18.3	0.7	0.6	0.5
2019	23.2	12.6	12.1	5.6	2.5	1.9	1.1	0.4	0.5
2022	22.0	12.8	10.3	6.9	4.1	1.4	1.2	0.5	0.5

Source: Statista.

Data on carbon emissions since 1750 capture a well-known picture and oft-told narrative. The Global North, led by developed and industrialised nations of the EU and North America, has been historically responsible for pollution since the 18th century. The share of the Global South, mainly comprising emerging economies of China and India, began to rise only in the last three decades or so. The burden of adjustment to meet global climate goals, therefore, ought to reflect this reality. The principle of Common but Differentiated Responsibilities (CBDR) is an attempt towards achieving climate justice. The launch of the EU's CBAM has brought this issue to the forefront. Its origin can be traced back to the 1992 Rio Declaration.

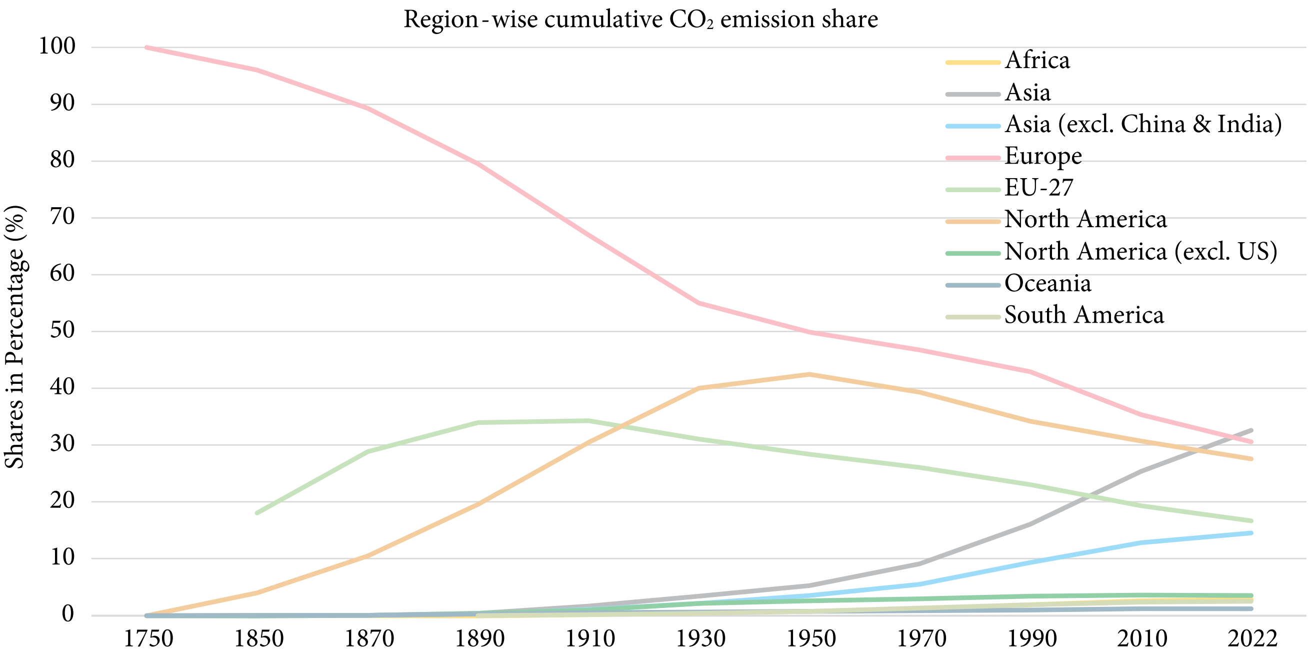
CBAM reflects the incubation of an idea from laboratory to market reality. Like a start-up, it confronted challenges and overcame predictions of collapse. Early discussions of CBAM can be traced back to the 1990s. The EU has long sought to incorporate environmental considerations into its trade policy. CBAM grappled with trade law minutiae and carbon leakage. In 1991, the EU proposed an international carbon tax and committed to stabilising CO_2 emissions at 1990 levels by 2030.

The proposed tax had two components: one on fossil fuels based on the intensity of carbon emissions, and the other was an energy tax on all types of fuels based on energy content. It required member countries to impose their own carbon tax based on a standard rate prescribed by the EU, although revenues could be retained for domestic purposes. A number of political and economic challenges confronted it, such as the US refusal to commit to mandatory carbon abatement targets. In 1994, the European Commission (EC) decided to impose higher excise duties on energy (Herber & Raga, 1995), and over time adopted the Framework Convention on Climate Change, which was first framed during the Rio Summit. Meanwhile, Finland and Sweden introduced their own carbon taxes in 1991 before joining the EU in 1995. The major turning point was the 1997 Kyoto Protocol, which established legally binding international emissions reduction targets for 38 developed nations like those in the EU and Japan.

The EU has often grappled with the spectre of 'carbon leakage'—the fear that stricter climate regulations at home could incentivise companies to relocate production to countries with softer rules. This concern simmered during the Kyoto Protocol negotiations, where the Clean Development Mechanism (CDM) emerged as a potential solution (Kainou, 2022). CDM allowed developed nations to offset emissions by investing in energy conservation and new energy projects in developing countries. This earned them certified emission reduction credits. While CDM offered opportunities for emissions reductions in developing countries, it also raised concerns about potentially undermining domestic action and becoming merely an offsetting mechanism. This spurred the EU to explore mechanisms that could level the playing field for its industries, which faced stricter climate standards.

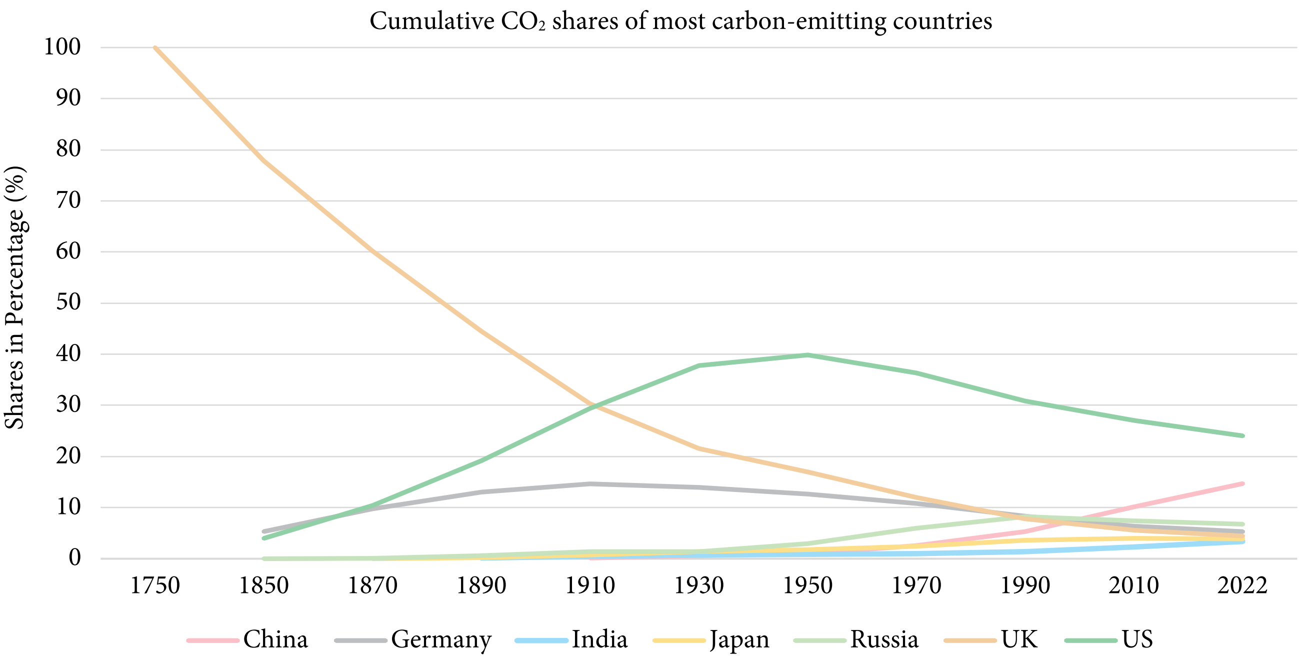
In the late 1990s and early 2000s, the EU explored tax adjustment options to address the growing concerns of climate change and carbon leakage. Voluntary measures had proven ineffective. This period also saw the EU actively exploring various border carbon adjustment mechanisms. These proposals aimed to level the playing field for EU industries facing stricter climate regulations by imposing a carbon price on imports from countries with weaker regulations. However, these initiatives faced stiff opposition from developing countries within the World Trade Organization (WTO) framework. Concerns about protectionism and the consequent violation of free trade principles loomed large as the debates focused on trade barriers and an unfair burden on developing economies. Nevertheless, the first official step towards CBAM took the form of the EU ETS as the world's first large-scale carbon market. The EU ETS was shaped through several stakeholder discussions following a green paper by the EC on GHG emissions trading within the EU in March 2000.

Figure 7: Asia's Share has Increased, but Mainly Attributed to China and Even India; Share of Europe Declined Drastically



Source: Our World in Data.

Figure 8: UK's Share in CO_2 Emissions Declined to Below 5% in 2022; These Increased for China and India



Source: Our World in Data.

The EU ETS Directive was adopted in 2003 and launched in 2005. It has gone through different phases (European Commission, n.d.; Vlachou, 2014):

- **Phase 1 (2005–07):** This served as a three-year pilot, covering CO_2 emissions from power and energy-intensive industries. Allowances were largely given for free (at least 95%), with penalties for non-compliance set at €40 per tonne of CO_2 equivalent (tCO_2e). This period saw an over-allocation of allowances, and thus aggregate allowable emissions surpassed actual (verified) emissions in the EU-27 by 360 million tonnes of CO_2, leading to a drop in the carbon price to zero.

- **Phase 2 (2008–12, coinciding with the Kyoto Protocol commitments):** This phase saw a lower cap on allowances and the inclusion of new countries (Iceland, Liechtenstein, and Norway) and sectors. The proportion of free allocation decreased to around 90%. Auctions were introduced in a few countries, and the penalties for non-compliance increased to €100 per tonne. Businesses were also permitted to buy international credits. However, the 2008 economic crisis caused greater emissions reductions than anticipated, with lower demand for allowances. Once again, carbon prices dropped significantly.
- **Phase 3 (2013–20):** This brought substantial reforms, including a single EU-wide cap on emissions (which had to decrease each year linearly by a factor of 1.74% as per the total cap of Phase 2), the default method of auctioning allowances, harmonised allocation rules for free allowances, and the establishment of the New Entrants Reserve to fund innovative energy technologies. Concerns about carbon leakage soon surfaced, questioning the effectiveness of the ETS.

Globally, the urgency for effective climate action is palpable. The Stern Review on the Economics of Climate Change (Stern, 2007) highlighted carbon pricing mechanisms for achieving global goals (see Box 1 on the concept of carbon pricing). It also emphasised the need for implementing innovative low-carbon technologies and achieving energy efficiency. In 2015, the Paris Agreement was adopted under the UNFCCC framework.

EU's Decadal-Long Efforts Started to Take Centre Stage (2019–21): Europe's Green Deal, announced in 2019, sought to make the EU climate-neutral by 2050 and included CBAM as part of the EU's climate ambition. This proposal was debated, and in December 2021, the EC unveiled a formal CBAM proposal, initially targeting five carbon-intensive industries—aluminium, cement, electricity, fertilisers, and I&S—aimed at addressing carbon leakage and ensuring a level playing field for EU industries facing stricter regulations at home by imposing a carbon price on imports.

Intense Negotiations and Compromise (2022): The issues were thorny and intensely debated by the EC, member states, and the European Parliament. These were:

a. Should the scope of CBAM be expanded beyond the initial five industries? How could concerns from specific industries be addressed?
b. Should EU industries receive free allowances to compensate for CBAM's impact? This raised concerns about distorting competition.
c. How can it be ensured that CBAM complies with international trade rules and avoids conflict with WTO rules? This emerged because navigating the delicate balance between environmental goals and international trade rules was crucial to ensuring CBAM's legality.
d. Can CBAM be implemented fairly and avoid a disproportionate burden on developing countries?

Concerns about CBAM's potential impact on developing countries and its compatibility with WTO rules persist. Despite these concerns, a phase of ***Provisional Agreement and Beyond (December 2022–September 2023)*** emerged, marking a turning point in CBAM's journey. The key features included: (i) expanding the scope to include hydrogen as the sixth sector, reflecting its growing importance; (ii) a gradual phase-out of free allowances to address carbon leakage while ensuring a smooth transition; and (iii) phasing in, which provided countries the benefit of a two-step approach, allowing for gradual compliance: a transitional phase (starting October 2023) with reporting obligations but no financial adjustments, followed by a full implementation phase with financial adjustments starting in 2026. The main CBAM Regulation (EU) 2023/956 (*Official Journal of the European Union*, 2023), establishing CBAM, was launched by the European Parliament and the Council on May 10, 2023.

The Curtains Rise on the Transitional Phase: From Proposal to Pilot (October 2023–Present): October 1, 2023, marked a historic milestone as CBAM entered its transitional phase. It is historic because it could well mark the beginning of the development of a global carbon market. The transition stage focuses on data collection and reporting, requiring importers to report the volume and embedded emissions of their imports without facing financial adjustments. The first reporting period ended on January 31, 2024, paving the way for the next stage.

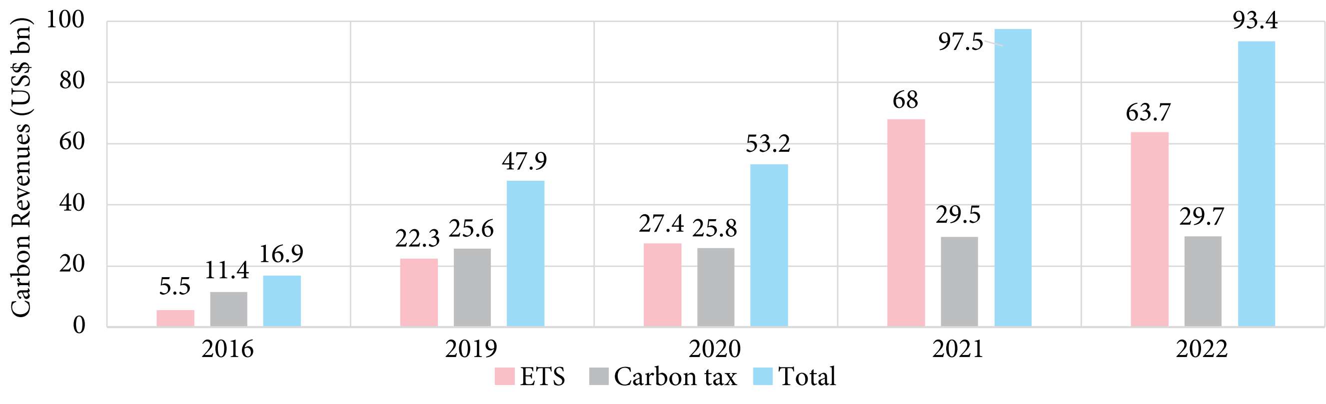
BOX 1: Carbon Pricing: An Introduction and Latest Developments

Carbon pricing is a tool that assigns a financial cost or price to GHG or carbon emissions. This cost reflects the hidden expenses society pays for externalities such as damage from floods and heat waves. This approach aims to shift the burden of emissions onto those responsible for them. It also acts as a catalyst, mobilising investments in clean technologies and market innovations that pave the way for a low-carbon economy (World Bank, 2023a).

The most common forms of carbon pricing are ETS and carbon taxes. An ETS allows emitters to trade permits to meet emission targets. In contrast, a carbon tax directly charges a fee on carbon emissions, typically through a set tax rate on GHGs or the carbon content of fossil fuels. An ETS can be implemented in two primary ways: (i) cap-and-trade (CaT) systems, which impose strict absolute limits on total emissions and distribute allowances equivalent to that cap; and (ii) baseline-and-credit systems, which define baseline emissions for individual entities and award credits for reductions below that level. Both mechanisms aim to create a market that incentivises decarbonisation (World Bank, 2023a). The process of distributing emission allowances can involve either free allocations or auctions. Free allowances can be distributed based either on historical emissions (grandfathering/grandparenting) or performance indicators (International Carbon Action Partnership, n.d.). Although these can help offset potential competitiveness issues arising from carbon taxes on domestic products, they may also weaken the incentive to decarbonise (Burnett et al., 2024). Carbon markets can exist in either a regulated or voluntary form. Governments establish mandatory compliance and create a market for pollution permits in regulated markets. These regulated markets, estimated at a value of one trillion dollars annually, encompass a quarter of global emissions, making them much bigger players in driving climate action compared to voluntary markets, currently valued at around two billion dollars (Das, 2024).

As of 2023, carbon pricing mechanisms are implemented in areas representing over half of global GDP (54%) and 50% of GHG emissions. Revenues collected through carbon pricing are continuously rising, mainly from the ETS (Figure A). Notably, more than half of the revenues are directed towards green initiatives or development projects, with another 10% going towards supporting households or companies impacted by carbon pricing. The remaining 30%–32% is allocated to general government budgets. It is important to note that while 24% of global emissions fall under some form of carbon pricing mechanism, this figure drops significantly to 6% when considering only emissions taxed at a set price (Fleurence et al., 2023).

Figure A: Carbon Revenues - Global Trend



Source: Fleurence et al. (2023).

While carbon taxes and ETS are gaining traction, indirect carbon pricing policies, such as fossil fuel subsidies, fuel excise taxes and differentiated value-added tax (VAT) rates, have been more prevalent historically. In 2021, a study by the Organisation for Economic Co-operation and Development (OECD) showed that 67 out of 71 assessed countries implemented indirect carbon pricing through fuel taxes, compared to only 39 with carbon taxes or ETS. The World Bank's 2023 State and Trends of Carbon Pricing report highlights that indirect carbon prices through fuel taxes are often higher than direct ones from carbon taxes or ETS. However, this gap is narrowing, with prices in most ETS and carbon taxes increasing by more than 50% between 2018 and 2021 (World Bank, 2023b).

The EU ETS is now in its fourth phase (2021–30) and aims to phase out free allowances, aligning with the phasing in of CBAM. The EU ETS is the most mature global carbon market, though other developed markets (such as the US and UK) are likely to follow suit soon. India, however, is in the nascent stages of preparing its ETS.

2026: CBAM Takes Flight (with Adjustments): This phase marks the start of financial obligations based on the difference between carbon pricing in the EU and exporting countries. CBAM's full implementation with financial obligations is expected in 2026, requiring importers to purchase and surrender "CBAM certificates" corresponding to the embedded emissions of their imports. This system will likely expand to more manufacturing sectors (e.g., textiles, pulp and paper, plastics, and chemicals) in the future. (See Recital 19 of Regulation (EU) 2023/956, along with Annex I of Directive 2003/87/EC *[Official Journal of the European Union,* 2003]).

CBAM represents only an initial step in addressing climate change. It is early to predict whether it will blossom into an effective tool. It will generate political and economic reactions like any other policy, but on a global scale. Its success hinges on several factors:

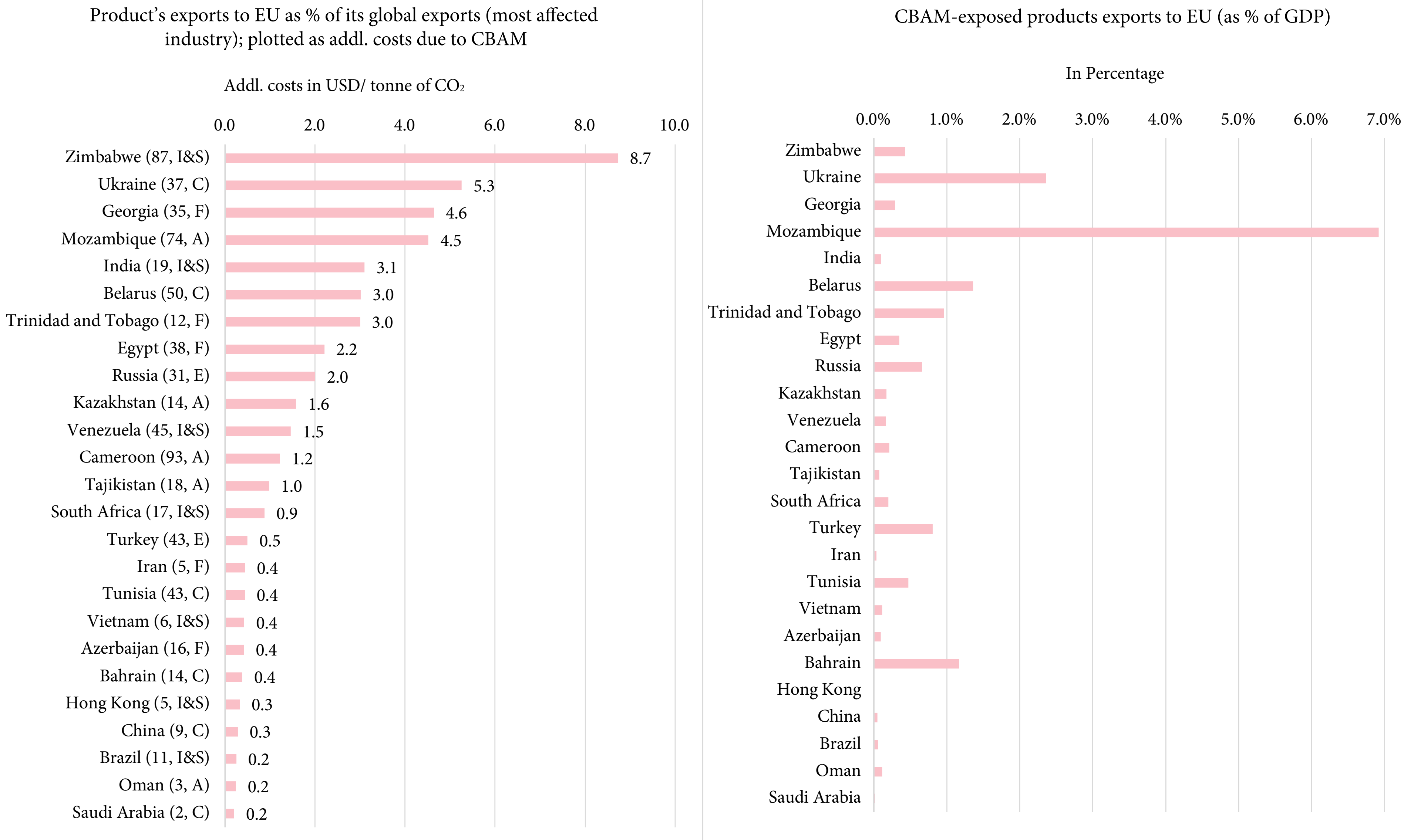
- The EU's own climate ambition: Stricter EU regulations will increase pressure for a robust CBAM.
- CBAM's impact on global trade.
- International cooperation concerning climate action and carbon pricing.
- Development of alternative technologies in carbon-intensive industries: developing cleaner technologies within carbon-intensive industries is essential for long-term sustainability.
- Navigating potential legal challenges concerning WTO compatibility.
- Stringency of regulations in different countries.
- Exemptions and adjustments for developing countries.

3. Pithy Literature Review of CBAM's Impact on Exports, Particularly for India

Numerous studies have assessed CBAM's likely impact on low- to medium-income countries. Along with reductions in carbon emissions, albeit small in some cases, trade and/or GDP are adversely affected in almost all estimates. I&S and aluminium are among the most affected industries. For instance, Pleeck and Mitchell (2023) note that CBAM could lead to a fall in Africa's exports to the EU by almost 14% for aluminium, 8% for I&S, 4% for fertilisers, and 3% for cement, while GDP could fall by 0.5%. Xiaobei et al. (2022) argue that welfare losses for Ukraine, Egypt, Mozambique, and Turkey could range from US$1 billion to US$5 billion. Scoppio et al. (2023) and Luke (2023) identify Africa as the region most likely to be affected by CBAM.

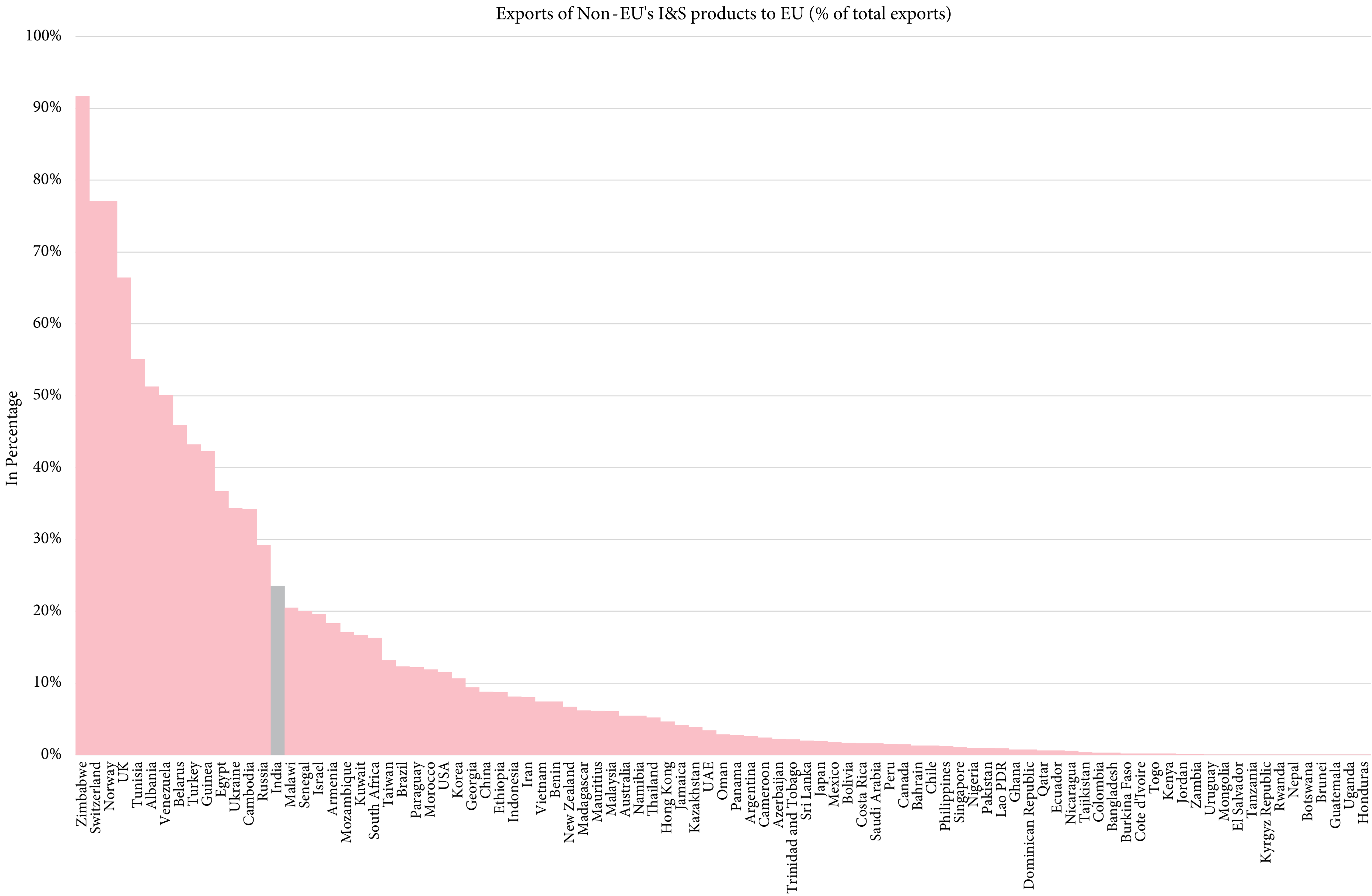
For India, CBAM poses a threat, no doubt, but also offers a proverbial opportunity. Indian steel exports are vulnerable (Figure 9), particularly because of the industry's relatively higher carbon footprint compared to their European counterparts. Illustratively, the average emission intensity of primary steel producers is approximately 2.6 mt of CO_2 per MT of crude steel from the blast furnace (BF) route, predictably higher than the global average (2.3 MT, as per ICRA, 2023). Recent estimates show a significant fall in I&S exports by 2.9% (Grover et al., 2023). It is expected that I&S will attract additional import duty in the range of 3–30% under CBAM, which can materially affect India's exports to the EU. A simulation-based study by Goldar et al. (forthcoming) has shown that the decline could have ripple effects through the economy, adversely impacting backward-linked industries like coal and electricity, while potentially benefitting forward-linked sectors like machinery and automobiles. UNCTAD (2021) confirms that CBAM can significantly affect trade of all those developing countries that use carbon-intensive methods.

Figure 9: India's Steel Industry has Significant Exposure Owing to CBAM, but the Exports to GDP Ratio is Less Likely to be Affected



Source: World Bank CBAM Database [C-cement, F-fertiliser, A-Aluminium, I&S-iron and steel, E-Electricity].

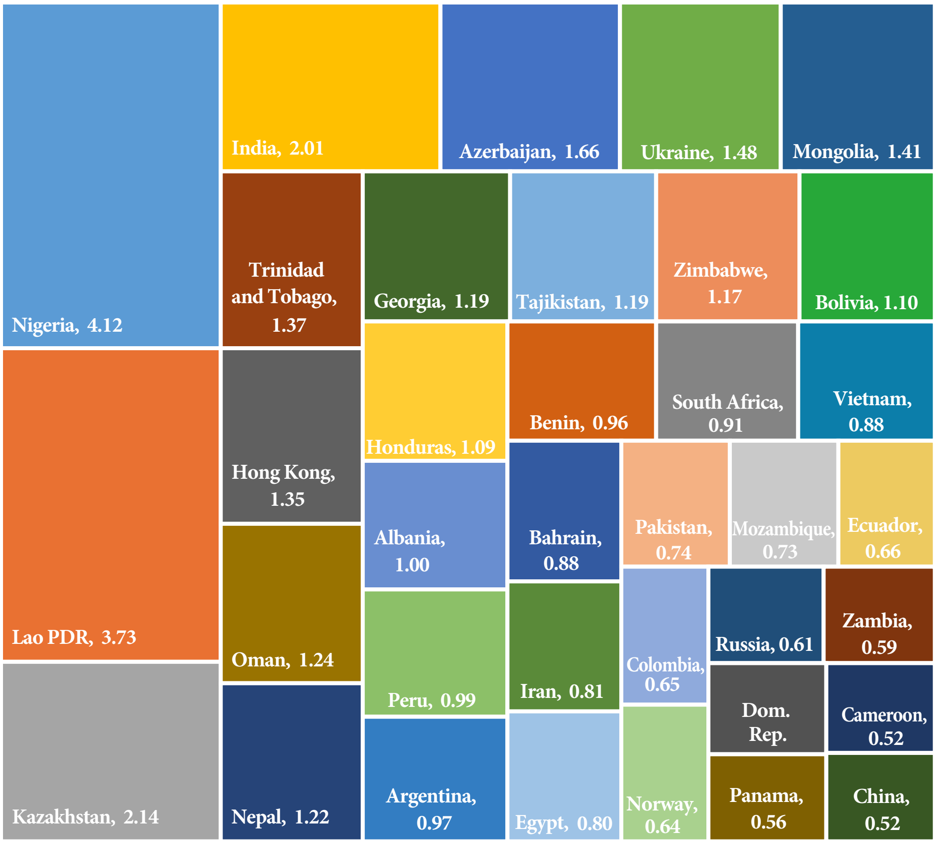
Figure 10a: India's Exports of I&S to the EU are Among the Top Rankers



Source: World Bank.

Figure 10b: India's Carbon Emission Intensity of Steel Exports is Among the Top 4 and Will Bear Significant Costs Owing to CBAM

Non-EU Top Countries' Carbon emission intensity of exports (KG/USD) in I&S Industry



Non-EU	Addl. Cost (USD/ tonne of CO_2)
Zimbabwe	9.20
Ukraine	4.54
India	4.36
Albania	4.32
Egypt	2.35
Venezuela	1.65
Russia	1.32
South Africa	1.23
Mozambique	0.98
Georgia	0.97
Kazakhstan	0.78
Belarus	0.74
Tunisia	0.73
Benin	0.60
Hong Kong	0.55
Malawi	0.55
Vietnam	0.54
Iran	0.52
Turkey	0.46
Nigeria	0.39
Armenia	0.37
Lao PDR	0.34
Azerbaijan	0.33
China	0.31
Oman	0.31

Source: World Bank.

Indian I&S exports to the EU rank among the top 15 globally, and its carbon emission intensity (two kg/US$) makes it the fourth highest in the world. It is expected to bear an additional cost of US$4 per tonne of CO_2 emission due to CBAM imposition (Figures 10a and 10b). On the other hand, exports of South-East Asian economies will not be affected much; Vietnam, Thailand, and Indonesia are likely exceptions (Marquardt, 2023). Park et al. (2023) show a limited effect on Asian economies but single out sectors in countries that will likely be affected, such as I&S in India, fertiliser in Georgia, and aluminium in Kazakhstan. Belletti et al. (2023) argue that EU producers will also be affected in the long run. As CBAM gets extended to include more industries, producers in the EU are likely to lose their right to free emissions allowances and will therefore need to bear the full carbon price of their emissions.

Maliszewska et al. (2023) note the unique case of Mozambique, which exports 95% of its aluminium to the EU. It produces substantial primary aluminium, leading to direct emissions, but since it uses hydropower, it is low in Scope 2 emissions. The study states, "Based on Scope 1 emissions alone, Mozambique is highly exposed in both absolute and relative terms because aluminium produced in the EU is largely recycled. It ranks as the fourth largest emitter in aluminium exports to the EU. However, if Scope 2 emissions are included, its exposure drops to 4.8% in relative terms, placing it eighth."

Conversely, according to Petersen and Walkerhorst (2023), the impact of CBAM on US and China's exports (and GDP) in the early stages of its imposition is expected to be minimal. The study shows that production of emission-intensive products (like oil, coal, and gas) in the US is expected to decline by only 1–3% after the imposition of CBAM. Because these items involve high transportation costs, the EU is likely to import them from nearby destinations. In China's case, while exports of energy-intensive products to the EU may decline post-CBAM, it may be able to increase exports to other countries, resulting in a low or neutral impact on GDP.

CBAM, however, tends to gloss over the principle of CBDR enshrined in the 1992 Rio Declaration, which is essential for the fair treatment of developing countries. The burden of unscrupulous activities of the Global North in the past should not be deflected towards the Global South (Sen, 2023). China and India are in favour of fair treatment.

The literature also indicates that CBAM does not directly restrict trade. It applies a carbon price to imports of specific goods. The World Bank has developed a CBAM exposure index for different CBAM-exposed industries in different countries[4] (Figures 9–11). India's aluminium exports to the EU are only half of its steel exports. Aluminium's carbon emission intensity of exports is just 0.33 kg/US$, and the additional costs borne will be just US$0.2 per tonne of carbon emitted (Figures 11a and 11b). The World Bank's CBAM exposure index does not, however, account for realignment in global value chains because CBAM could affect the purchasing decisions of third countries that are using the primary metal from India and other countries to manufacture products covered by CBAM that are exported to the EU.

That said, the opportunity in CBAM is whether India and other countries are able to initiate their own carbon trading systems or carbon price. Until 2022, carbon pricing was a developed country phenomenon. There are now rising initiatives in many developing economies like India and China, among others. South Africa launched its carbon price, albeit very low, thereby undermining its utility (Pleeck & Mitchell, 2023). KPMG (2023) highlights bureaucratic challenges related to implementation, such that "supply chain disruptions may occur if imported goods are stopped at the border due to imported covered goods not being declared to customs by an authorised declarant or incorrect classification of goods according to the CN codes."

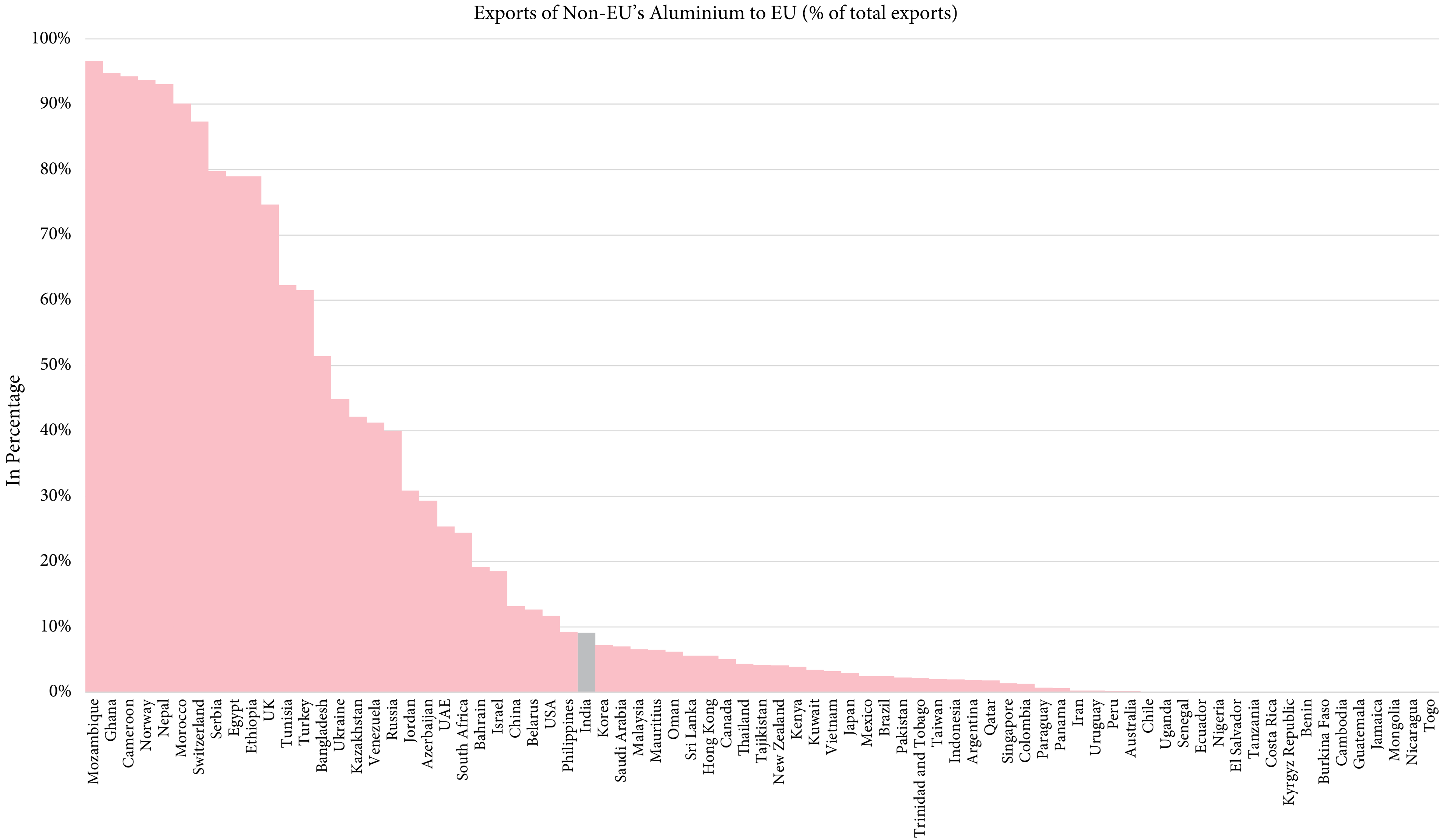
One unambiguous result of the nascent but growing literature on CBAM is its likely adverse impact on smaller economies, particularly in Africa (such as Zimbabwe and Mozambique), in South and Latin America, and in the Caribbean (such as Trinidad and Tobago). The data analysis presented in Figures 9–11 supports this conclusion. It also brings to light the long struggle for climate finance and justice for many low-income and developing countries. At COP15 in 2009, developed countries pledged to contribute climate finance of US$100 billion every year until 2020 (now extended to 2025). The targets have not been met for any year; the maximum offered was US$89.6 billion in 2021 (US$71.6 billion in 2017). Even as the promised climate finance and technology transfers flounder, developing countries are beginning to recognise the merit of raising alternative sources of finance. Raj (2024) suggests using revenue generated from implementing a carbon tax in India for this purpose in the short to medium term.

4. Trends and Development of Carbon Pricing Globally and in India

Given the growing concern around climate change, there is a trend toward carbon pricing initiatives—whether ETS or a carbon tax, or both (see Figures 12 and 13 and Table 3). Considering only national-level initiatives (not sub-national or regional), 42 carbon pricing mechanisms have been implemented (including the regional EU ETS), of which Canada, Mexico, the UK, and Switzerland have both carbon taxes and ETS. More than 25 carbon pricing mechanisms are under development.

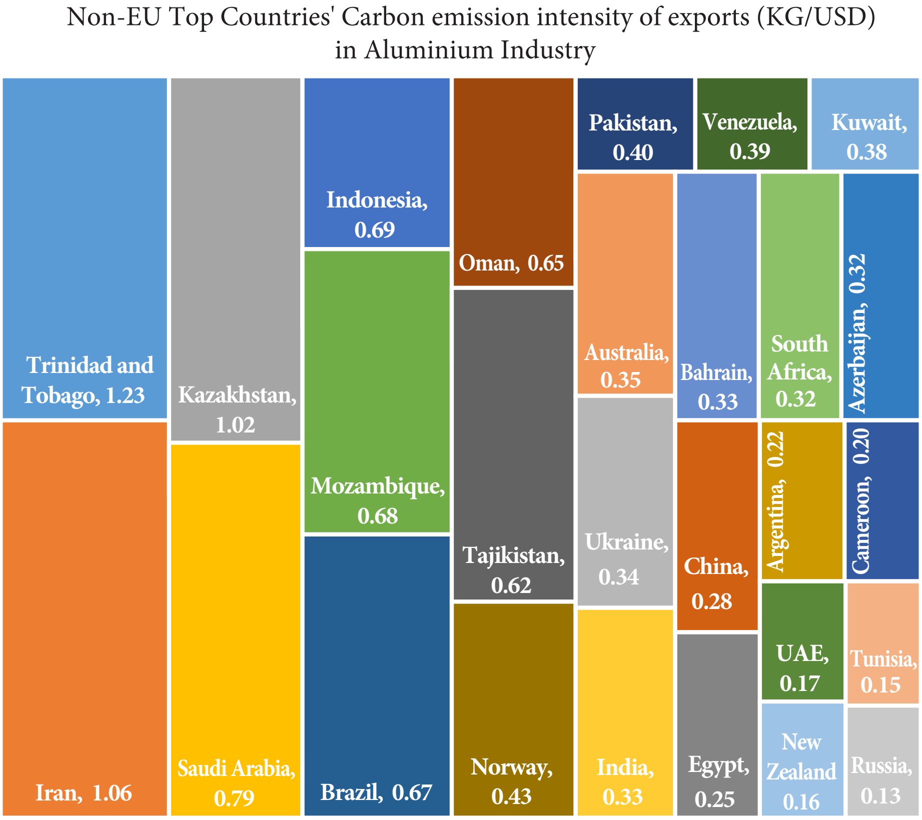
[4] "The index gauges the potential for CBAM to impact exports of carbon-intensive goods for the six selected industries. It is calculated by multiplying the export share of each economy by the embodied carbon payment per dollar of export to the EU (the exporter's emission intensity multiplied by a US$100 per tonne carbon price)." Relative exposure index is also calculated. "A positive relative exposure index indicates that an economy has higher carbon-emission intensity than the EU average, and so will likely have higher costs under CBAM. For example, if Georgia has an aggregate relative CBAM exposure index score of 0.0464, then the additional cost will be US$4.64 per tonne of carbon dioxide." Thus, it can help to compute additional costs of US$ per tonne of CO_2 (Park et al. 2023).

Figure 11a: India's Exports of Aluminium Products to EU are Relatively Lower



Source: World Bank; Additional costs calculated from Relative CBAM Exposure Index.

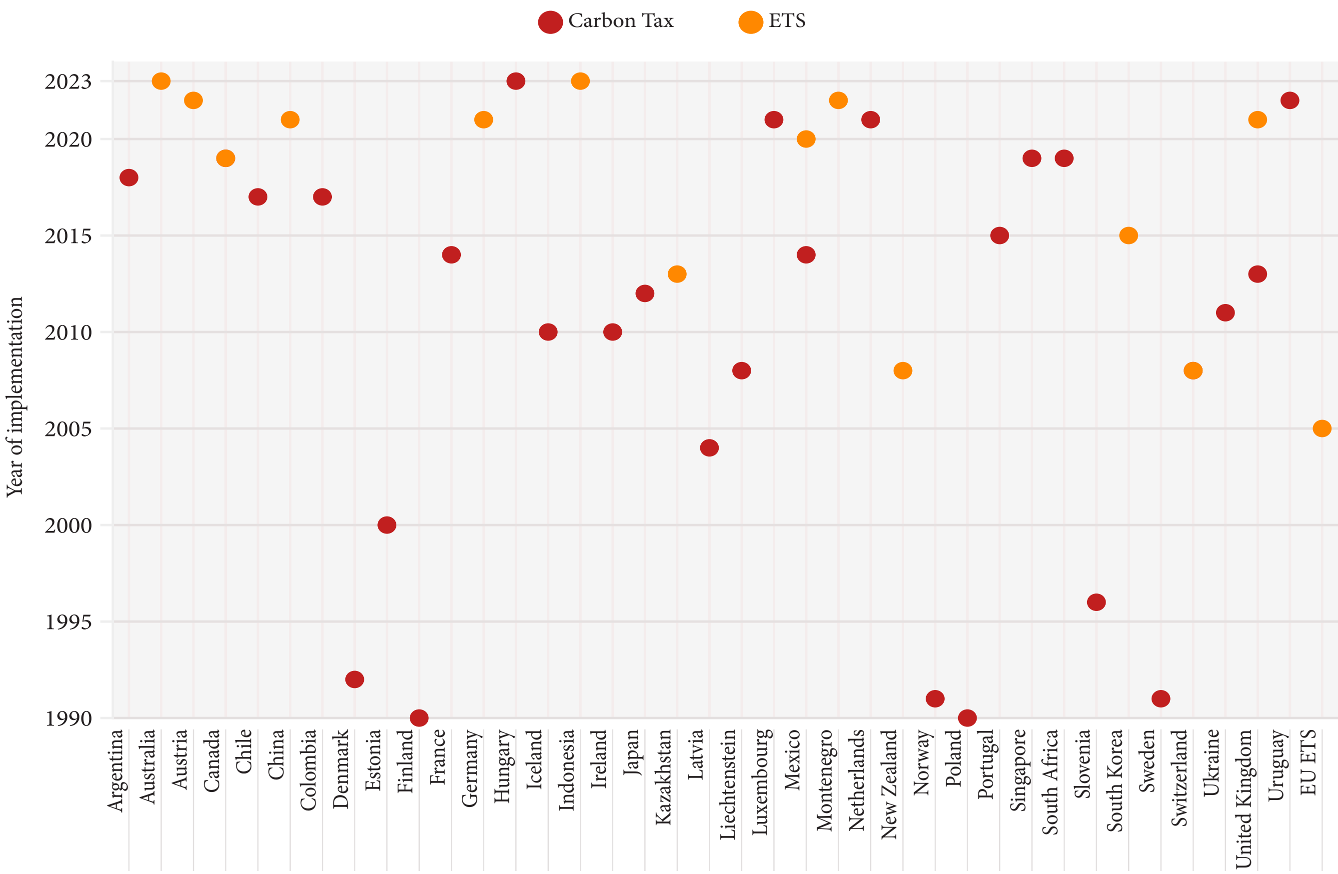
Figure 11b: India is Likely to Face Lower Costs for Carbon Emissions in the Aluminium Industry



Non-EU	Addl. Cost (USD/tonne of CO_2)
Mozambique	5.92
Kazakhstan	4.04
Egypt	1.43
Venezuela	1.32
Cameroon	1.23
Ukraine	1.21
Azerbaijan	0.73
South Africa	0.63
Tunisia	0.52
Saudi Arabia	0.51
Bahrain	0.50
Oman	0.36
China	0.28
Russia	0.27
UAE	0.25
India	0.24
Tajikistan	0.23
Brazil	0.15
Indonesia	0.12
Turkey	0.08
Israel	0.08
New Zealand	0.04
Argentina	0.03
Canada	0.02
USA	0.01

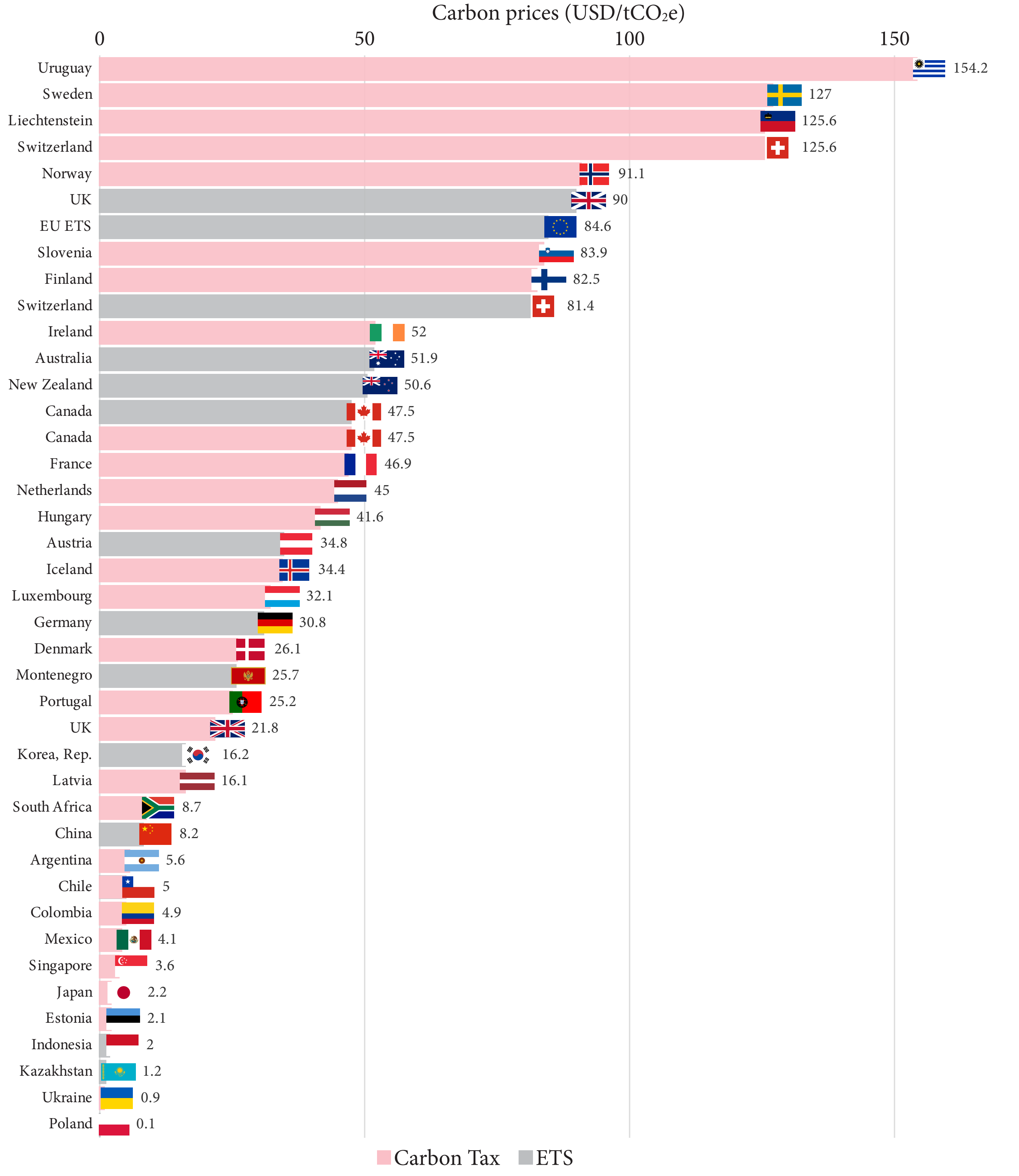
Source: World Bank; Additional costs calculated from Relative CBAM Exposure Index.

Figure 12: Implemented Carbon Pricing Mechanisms (National) Around the World



Source: Author's visualisation with Flourish, using data from Carbon Pricing Dashboard, World Bank and Fleurence et al. (2023) [Note: National level initiatives taken, but regional EU-ETS is also included therein] – This information is as of November 2023.

Figure 13: Carbon Prices of Implemented Carbon Pricing Mechanisms



Source: Author's visualisation with Flourish, using data from Fleurence et al. (2023) [Information as in November 2023].

Table 3: National Carbon Pricing Mechanisms Underway

Country/Region	Type	Status
Albania	ETS	Under consideration
Bosnia and Herzegovina	ETS	Under consideration
Botswana	Carbon tax	Under consideration
Brazil	ETS	Under consideration
Brunei Darussalam	Undecided	Under consideration
Chile	ETS	Under consideration
Colombia	ETS	Under consideration
Côte d'Ivoire	Carbon tax	Under consideration
Gabon	ETS	Under consideration
Georgia	ETS	Under consideration
India	ETS/CCTS	Planning stage
Indonesia	Carbon tax	Under consideration
Israel	Carbon tax	Under consideration
Japan	ETS	Under consideration
Malaysia	ETS	Under consideration
Moldova	ETS	Under consideration
Morocco	Carbon tax	Under consideration
New Zealand	Carbon tax	Under consideration
Nigeria	ETS	Under consideration
North Macedonia	ETS	Under consideration
Pakistan	ETS	Under consideration
Senegal	Carbon tax	Under consideration
Serbia	ETS	Under consideration
Thailand	ETS	Under consideration
Türkiye	ETS	Under consideration
Ukraine	ETS	Under consideration
Vietnam	ETS	Scheduled

Source: Carbon Pricing Dashboard, World Bank (November 2023).

Carbon pricing mechanisms vary in design and scale across countries. For example, in August 2023, Poland's carbon price was less than US$1 per tonne of CO_2 equivalent (tCO_2e), while Uruguay's was the highest at US$154/$tCO_2e$. However, simply implementing a carbon price is insufficient. The price must be substantial enough to discourage activities that generate high emissions. A 2017 report by Nobel laureates Joseph Stiglitz and Nicholas Stern, commissioned to assess the carbon pricing required to meet the Paris Agreement's temperature goals, concluded:

"Countries may choose different instruments to implement their climate policies, depending on national and local circumstances and on the support they receive. Based on industry and policy experience, and the literature reviewed, duly considering the respective strengths and limitations of these information sources, this Commission concludes that the explicit carbon-price level consistent with achieving the Paris temperature target is at least US$40–80/$tCO_2$ by 2020 and US$50–100/$tCO_2$ by 2030, provided a supportive policy environment is in place." (Stiglitz et al., 2017).

Over 70% of covered GHG emissions are priced below US$20/t$CO_2$e, as per Fleurence et al. (2023). Most national carbon pricing mechanisms—31 out of 41—are in high-income countries. While these mechanisms need to be expanded to include emerging economies, the development challenges of the latter also require attention. Carbon pricing policies have shown resilience in the face of various challenges, including energy crises, economic downturns, and geopolitical instability. Unlike in past downturns—when these policies were relaxed, repealed, or reduced—governments have prioritised them through expansion or maintenance (Pryor & Putti, 2023).

The EU has been a global leader in carbon markets. Its ETS is the longest-running one, operating on a CaT system with an annually decreasing cap to reflect new climate targets and ensure emission reductions. It covers almost 40% of the EU's GHG emissions. In January 2024, the EU ETS expanded to include the maritime sector, which is responsible for 3–4% of the EU's total carbon emissions (International Carbon Action Partnership, 2024a). The EU aims to achieve climate neutrality by 2050, with an intermediate target of a net reduction of GHG emissions of 55% by 2030 compared to 1990 levels (European Commission, 2023).

Overall, global responses to the EU's imposition of the CBAM have been mixed. Some countries, like the UK, have announced their own CBAM plans. Within the US, bipartisan support is growing for carbon border taxes (United States Joint Economic Committee Democrats, 2024). The November 2023 EU–Canada Summit reaffirmed the importance and effectiveness of carbon pricing. Both parties committed to addressing carbon leakage concerns and cooperating on the EU's CBAM (EU–Canada Summit, 2023). Canada has also taken steps in this direction, requiring (as of November 5, 2024) steel product importers to provide "country of melt and pour" information to border authorities. Currently, the US is the only other country with this requirement (Global Affairs Canada, 2024).

Australia is also evaluating options. In July 2023, it initiated a review process to assess carbon leakage risks. The review will gauge the feasibility of an Australian CBAM, particularly for the steel and cement sectors. Findings are expected to be finalised by October 2024 and could potentially inform policy options for the government's Net Zero 2050 Plan (Department of Climate Change, Energy, the Environment and Water, 2023).

Developing nations, such as China and India, have voiced concerns about CBAM, labelling it an unfair trade measure that contradicts the principle of CBDR. The African Development Bank has argued for exemptions for African countries, highlighting potential annual costs of up to US$25 billion (Jessop et al., 2023). Singapore has emphasised the need for CBAM to comply with WTO regulations and to be implemented in a non-discriminatory manner (Yin, 2023). Regardless of their stance on CBAM, countries worldwide are actively preparing for a future with border carbon adjustments. The following examines carbon pricing initiatives in four major emitting nations other than India.

A. China

China, the world's largest emitter of GHGs, faces the unique challenge of balancing its reliance on coal with its ambitious climate goals. China is the largest consumer of coal globally, accounting for almost half of global consumption. For instance, in 2022, it used 4.55 billion metric tonnes of coal, which corresponds to over 50% of total global consumption (Statista, 2024a). China is also the leader in renewable energy consumption. In September 2020, President Xi Jinping unveiled China's "30-60 goals" or "dual-carbon goals": achieving peak emissions by 2030 and carbon neutrality by 2060 (Liu et al., 2023). This commitment was further solidified at the 2020 UN Climate Ambition Summit, where China pledged more aggressive policies for 2030. These include a significant reduction in CO_2 intensity (over 65% below 2005 levels), increasing non-fossil fuel consumption in primary energy to around 25%, and boosting forest stock volume by 6 billion cubic metres. These goals were formalised in China's updated Nationally Determined Contributions (NDC). Notably, the updated NDC aims for at least 1,200 GW of installed wind and solar power capacity by 2030, a target likely to be reached ahead of schedule (Liu et al., 2023).

China views CBAM as "regrettable" and maintains that it contradicts principles established by the UNFCCC, the Paris Agreement, and WTO rules (Carbon Brief, 2023). The China Iron and Steel Association (CISA) voiced concerns about CBAM functioning as a new trade barrier under the guise of low carbon, neglecting the varying development stages of different countries and violating the principle of CBDR (Lv & Patton, 2023).

China has had its own national ETS operating since 2021. Currently, it primarily covers the power sector, with plans for future expansion to other industries potentially targeted by CBAM (International Carbon Action Partnership, 2024b). As the world's largest ETS in terms of covered emissions (over 4 billion tCO_2, representing over 35% of China's emissions), it builds upon the successes of eight regional pilot programmes launched between 2013 and 2016 (International Carbon Action Partnership, 2023b): Beijing ETS (2013), Shanghai ETS (2013), Shenzhen ETS (2013), Tianjin ETS (2013), Guangdong ETS (2013), Chongqing ETS (2014), and Fujian ETS (2016).

Unlike the EU ETS, which auctions allowances and plans to phase out free allocations, China's system is intensity-based, granting free allowances to companies based on production levels and benchmarks (International Carbon Action Partnership, 2023b). Reports suggest that the initial focus of China's ETS is on raising awareness of carbon markets, trading and verification mechanisms, and their economic benefits, rather than immediate, significant emission reductions (Xiaoying, 2023).

China has recently taken steps to strengthen its ETS's legal and functional framework. New regulations (effective May 1, 2024) aim to enhance the governance structure and introduce stricter enforcement measures for participating entities, including harsher penalties for data manipulation. Auctions will also be implemented alongside free allocation, and there is a plan for gradual expansion (International Carbon Action Partnership, 2024c). On January 22, 2024, China relaunched the Certified Emission Reduction (CCER) scheme. This scheme allows ETS participants to offset up to 5% of their verified emissions (totalling around 250 million tonnes) by purchasing CCERs. The previous CCER programme, operational from 2012 to 2017, was suspended due to low trading volumes and regulatory issues (International Carbon Action Partnership, 2024b).

B. Japan

Japan utilises a combination of carbon pricing instruments to address climate change. These include a national carbon tax implemented in 2012 and two local ETS—the Tokyo Cap and Trade Programme (CaT), launched in 2010, and the Saitama ETS, established in 2011. The Tokyo CaT programme, the first mandatory ETS in Japan, covers almost 20% of the region's emissions. The Tokyo and Saitama programmes are linked, allowing operators to trade carbon credits for compliance across both jurisdictions (International Carbon Action Partnership, 2023c).

Japan has ambitious climate goals, aiming to reduce GHG emissions by 46% by 2030 compared to 2013 levels and to ultimately achieve net-zero emissions by 2050 (Ministry of Foreign Affairs of Japan, 2021). Japan also has a variety of energy-related taxes imposed at both national and local levels. These include gasoline tax, petroleum and coal tax, liquefied petroleum gas tax, and aviation fuel tax. While the primary purpose of these taxes is not climate change, they are considered "explicit carbon pricing" by the Japanese government because they explicitly incorporate the environmental costs associated with fossil fuels (Hattori & Kondo, 2024).

Currently, there is no national ETS in Japan. However, the Ministry of Economy, Trade and Industry launched the GX-ETS, a national voluntary ETS pilot programme, which runs from April 2023 to March 2026. "GX" stands for "Green Transformation", and the programme is envisioned to have two subsequent phases: 2026–2032 and beyond 2033, in accordance with the "GX Promotion Act". This first phase operates under a "pledge and review" system. Participating companies voluntarily set and disclose emissions reduction targets based on their base-year emissions. Each year, their emissions performance is reported and made publicly available (Hattori & Kondo, 2024). While participation is voluntary, compliance (for those who sign up) is mandatory (International Carbon Action Partnership, 2023a). Japan plans to implement a national-level fossil fuel surcharge on its importers beginning in 2028. The surcharge will be linked to the amount of CO_2 emissions generated from imported fossil fuels (Hattori & Kondo, 2024).

C. United Kingdom (UK)

The UK's target is to achieve net-zero emissions by 2050, as mandated by the Climate Change Act 2008 (Burnett et al., 2024). It uses a two-pronged approach: a carbon tax and a national ETS. Following Brexit, the UK launched its own ETS in January 2021. This CaT system currently applies to energy-intensive industries, power generation, and aviation. While its design mirrors Phase 4 of the EU ETS, the UK ETS has a stricter emissions cap: "From January 1, 2021, the cap for Phase 1 of the UK ETS was initially set at 5% below the UK's expected notional share of the EU

ETS cap for Phase IV of the EU ETS (2021–2030). This equated to around 156 million allowances in 2021 (covering both stationary installations and aircraft operators) and was set to reduce annually by 4.2 million allowances" (UK ETS Authority, 2022), and "As of 2024, it has a cap that is consistent with net zero" (Energy Advice Hub, 2024). The EU, in contrast, employs a linear reduction factor of 2.2% per year until 2030. The UK government is also exploring the potential for future linkages between its ETS and other international schemes (World Bank, 2023a).

The UK's carbon tax primarily targets CO_2 emissions from the power sector and covers all fossil fuels (World Bank, 2023a). The carbon tax is widely credited with facilitating the UK's phasing out of coal in electricity production. By displacing "dirty" coal, it spurred the use of "cleaner" gas to bridge the production gap (Gugler et al., 2023). The primary drivers toward gas, however, were the supply of North Sea oil and the growth of the gas industry. New licences were granted to achieve energy independence, following a decline in the demand for coal and the closure of numerous coal mines (see Energysecurity.Gov.UK, 2024; GOV.UK, 2023). The UK government has moved its coal phase-out timeline forward, aiming to end coal-fired electricity generation by October 2024, a year ahead of the initial 2025 deadline. This commitment signals remarkable progress in reducing dependence on coal and CO_2 emissions. Coal production, which peaked at 292 million metric tonnes in 1913, had fallen to around 2 million metric tonnes in 2019—a 150-fold decrease. During the UK's Industrial Revolution, coal reigned supreme as the primary energy source, accounting for almost half of the UK's energy needs even by 1970 (Ritchie, 2019). By 2022, coal's share of primary energy supply had shrunk to 2.3%.

The UK plans to launch its own CBAM in 2027, a year after the EU's CBAM comes into effect. UK Steel, an industry trade body, raised concerns regarding the one-year lag behind the EU's CBAM timeline, expressing fears of a potential rise in "dumping" of high-emission steel into the UK market after implementation (Varriale & Franke, 2023). The UK's border tax will target imports of iron, steel, aluminium, ceramics, cement, fertiliser, glass, and hydrogen with a carbon charge. According to a House of Commons Library Briefing, the primary goal of the carbon tax isn't revenue generation but rather preventing carbon leakage. It highlights that "a successful CBAM would raise no revenues as it would have prompted other countries to decarbonise at the same price" (Burnett et al., 2024). While similar to CBAM in scope, there are slight differences in coverage and carbon pricing methods. The EU CBAM requires the purchase of emissions trading certificates, which is not mandatory under the proposed UK CBAM. The UK CBAM will also tax indirect emissions from heat, steam, and cooling, along with electricity. Both the EU CBAM and the UK CBAM share a common goal to phase out free allowances within their respective ETSs.

D. United States (US)

The US, the world's second-largest GHG emitter in 2022, faces a significant challenge in reducing emissions. It contributed roughly 11% of global emissions that year, with a total of 6 billion tonnes of CO_2 equivalent (European Commission Edgar, 2023). This represents only a slight decrease (2.4%) compared to 1990 levels. The US also has the dubious distinction of having the highest historical cumulative CO_2 emissions (including land-use change), emitting a staggering 554.8 billion metric tonnes from 1750 to 2022. Close to 2,600 billion metric tonnes of CO_2 ($GtCO_2$) have been emitted globally from fossil fuel combustion and land-use change since 1750, where the share of US is approximately 22% (Statista, 2024b). By contrast, India's cumulative share is 99.4 billion metric tonnes.

Despite these challenges, the US has ambitious climate goals. These include achieving a 50–52% reduction in GHG emissions by 2030 (compared to 2005 levels), transitioning to 100% clean/carbon pollution-free electricity by 2035, reaching net-zero emissions by 2050, and ensuring that 40% of federal climate and clean energy investments benefit disadvantaged communities (The White House, 2021). The Inflation Reduction Act (IRA), the most significant climate change legislation in US history, is projected to play a key role in achieving these goals. By investing heavily in clean energy, the IRA is estimated to reduce GHG emissions by 1 billion tonnes by 2030 (US Department of State, 2023). The act offers a wide range of incentives for clean energy adoption, including 10-year tax credits for electric vehicles and direct air capture and sequestration of CO_2 (Lashof, 2024). This has already spurred a significant increase in clean energy manufacturing projects.

While the US lacks a national carbon tax, several states participate in a CaT system called the Regional Greenhouse Gas Initiative (RGGI). RGGI is the largest operating ETS in the US, currently encompassing Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. Virginia recently left RGGI in December 2023, and discussions are ongoing regarding its potential return (Chanatry, 2024). Established as the first market-based cap-and-invest programme in the US, RGGI sets a regional cap on carbon emissions for participating states. Facilities emitting CO_2 or power plants exceeding the cap must purchase allowances at auctions to cover their emissions. Revenue generated from these auctions is reinvested in energy efficiency, clean energy initiatives, and community programmes. The cap is progressively lowered over time to ensure a steady decline in carbon emissions. Since its inception, the 10 RGGI states have achieved a 50% reduction in annual power sector emissions—almost 50% faster than the national average—while generating over US$7 billion for local communities (Regional Greenhouse Gas Initiative, 2024). Several subnational ETS programmes also exist in California (since 2012), Massachusetts (2018), Oregon (2022), and Washington (2023). New York and Pennsylvania are also considering implementing similar programmes.

The recent launch of the EU's CBAM in October 2023 has sparked bipartisan interest in border adjustment mechanisms within the US, aimed at maintaining global competitiveness in domestic markets (United States Joint Economic Committee Democrats, 2024). The Clean Competition Act (CCA), proposed in December 2023, seeks to impose a carbon intensity charge on domestically produced and imported goods that exceed a specific emissions benchmark. Unlike the EU CBAM, the CCA targets both domestic manufacturers and importers with an emissions fee. This fee, however, is not economy-wide but rather applies only to emissions surpassing the industry benchmark, which will decline annually while the fee increases (Elkerbout et al., 2023). Initially set at US$55 per tonne of GHG, the CCA fee will be adjusted annually based on the consumer price index plus 5% (Elkerbout et al., 2023). Another proposal, the Foreign Pollution Fee Act (FPFA), introduced in November 2023, aims to apply tariffs on imported goods with higher emission intensity compared to their US-produced counterparts (Gangotra et al., 2023). Unlike the CCA or the EU CBAM, the FPFA lacks a regulatory programme to directly reduce industrial emissions within the US (Elkerbout et al., 2023). This aligns with the FPFA's primary goal of curbing the import of embodied GHGs in US trade flows rather than prioritising further reductions from domestic sources. The FPFA also differs significantly in its fee structure, employing a variable ad valorem fee rather than the fixed or intensity-based charges used by the CCA and the EU CBAM.

India's Carbon Market—A Summary

In August 2022, India strengthened its commitment to climate action by updating its NDC. The revised NDC aims for a significant reduction in the emission intensity of India's GDP—a 45% decrease by 2030, compared to 2005 levels. Additionally, it targets achieving 50% of cumulative electric power installed capacity from non-fossil fuel sources by 2030 (Press Information Bureau, 2023d).

The Indian Carbon Market (ICM) is being developed to price GHG emissions through the trading of Carbon Credit Certificates (CCCs) (Press Information Bureau, 2023c). The basis for ICM is the Energy Conservation (Amendment) Bill 2022, which came into effect on January 1, 2023. The CCTS was notified in June 2023 (Press Information Bureau, 2023b). This notification established the National Steering Committee for the Indian Carbon Market (NSCICM), designating the Bureau of Energy Efficiency (BEE) as the administrator of the ICM (Ministry of Power, 2023a).

In December 2023, an amendment notification introduced the offset mechanism. This mechanism allows non-obligated entities to register their projects for accounting GHG emission reductions in exchange for CCCs (Ministry of Power, 2023b). Obligated entities are registered under the compliance mechanism; that is, they are under a legal obligation to restrict their carbon footprint to the prescribed level; non-obligated entities are not. Since non-obligated entities do not have assigned emission targets, the BEE (in collaboration with relevant technical committees) is empowered to determine the sectoral scope and methodologies for the offset mechanism (Ministry of Power, 2023b). Once the BEE establishes these standards, Indian entities can validate their carbon credits domestically, eliminating the time and cost associated with using overseas agencies (Ramesh, 2023).

The CCTS caters to both voluntary and compliance segments. The compliance market is expected to be launched in 2025–2026, while a specific timeline for the voluntary segment remains to be determined.

India has experience with instruments like Perform, Achieve, and Trade (PAT) and Renewable Energy Certificates (RECs) that share similarities with carbon markets. These instruments aim to promote energy transition and regulate energy consumption. The PAT scheme, launched in 2012, offers incentives to reduce energy intensity. Designated Consumers (DCs) receive mandatory energy intensity targets based on their sector's performance. Those exceeding the target (that is, those consuming less energy per unit of production) earn tradable Energy Saving Certificates (ESCerts); those missing their targets must purchase ESCerts. The PAT scheme also established a system for monitoring, reporting, and verifying (MRV) energy consumption and the performance of DCs. This scheme helped develop an ecosystem to assess the baseline and verify performance by means of Accredited Energy Auditors (AEAs) with the necessary technical expertise and capacity. However, challenges emerged related to an oversupply of ESCerts and a lack of integration with international compliance or voluntary markets. Subsequently, the price of ESCerts fell. Another issue was the lack of provisions for voluntary participation (BEE, Government of India, 2022).

RECs were introduced in 2010 by the Central Electricity Regulatory Commission (CERC) under the Electricity Act, 2003 (Bajaj, 2023; Gulia et al., 2023). They are tradable instruments that facilitate meeting a percentage of procurement through renewable energy sources, as mandated under Renewable Purchase Obligations (RPOs). Obligated entities (like DISCOMs and large captive generation plants) can use RECs to address shortfalls in their RPO compliance. Inter-state facilitation of RECs was intended to bridge the gap between States with and without renewable energy potential, allowing obligated entities to meet their RPOs by buying RECs from any State. However, the REC scheme encountered challenges, primarily due to the falling prices of RE sources (both REC-Solar and REC-Non-Solar), which imposed an additional cost burden on DISCOMs without commensurate benefits (BEE, 2022; Tongia, 2023). Other issues included an oversupply of certificates, weak enforcement, and modest purchase requirements.

These nascent challenges with the PAT and REC schemes resemble the experience of the EU ETS in its first phase, where a surplus of allowances led to the price falling to zero (European Commission, n.d.). Another challenge related to these market-based mechanisms is that their measurement is not stated in CO_2 equivalent but in tonnes of oil equivalent (PAT) and MWh (REC), which discourages cross-linkages (BEE, Government of India, 2022).

The BEE has proposed a unified ICM to encompass the existing PAT and REC schemes, issuing certificates in tonnes of CO_2 equivalent and streamlining MRV. Another significant development involves a decision by the National Designated Authority for the Implementation of Article 6 of the Paris Agreement (NDAIAPA). This stipulates that India will trade carbon credits internationally (before meeting its NDC) only if it receives high-value-added new technology or appropriate financial investment.

India's growing aspirations and development needs necessitate investments in decarbonisation. For example, India's target to produce 300 million tonnes of steel annually by 2030 cannot be separated from domestic environmental consequences or CBAM imperatives. As India refines its carbon market strategy, careful consideration needs to be given to the choice of pricing mechanisms. While carbon taxes offer greater certainty regarding price, revenue generation, and ease of administration, ETS provide more control over emission levels and the achievement of emissions targets (Parry et al., 2022). India's carbon market policy mix will therefore need to align with both its immediate needs under CBAM and its long-term decarbonisation goals.

5. Response of Indian Steel and Aluminium Firms, Including Case Studies

The immediate burden of the EU's CBAM will be borne by firms involved in producing and exporting steel and aluminium products—the two most affected industries in India. The new carbon tax will impact approximately 9,000 tariff lines, accounting for more than 35% and 25%, respectively, of steel and aluminium exports from India to the EU (GTRI, 2023).

The climate objectives of CBAM are seemingly virtuous; firms affected by it will need to prepare for the change or bear the burden of non-compliance. This study examines secondary data and conducts surveys of steel and aluminium producers, industry associations, as well as interactions with policymakers and legal consultants to gain insights. The approach employed is mixed-methods and is focused on two case studies, one each for steel and aluminium producing and exporting firms. The results suggest both challenges and opportunities for firms and policymakers to adjust and comply with the CBAM regime.

A fundamental question concerning CBAM in India is the distribution of the burden of compliance between firms, government, and other stakeholders. How much of the burden should the government bear? Another debate concerns carbon pricing. Will India adopt an ETS similar to the EU's or launch a full-fledged CCTS and/or introduce a domestic carbon tax as an alternative to the EU's CBAM? The lack of clarity around CCTS and the possibility of a carbon tax replacing or complementing it has created ambiguity.

The survey feedback reinforces the lack of clarity concerning the specifics of the CCTS for firms of all sizes. The ambiguity stems from the government's limited public outreach on the scheme's provisions. While the CCTS notification was issued in 2022, detailed information regarding its precise functioning remains undisclosed. Industry perceives the CCTS as a nascent system under development and thus any prediction around it will be speculative at best. Besides, industry players evinced a marked lack of enthusiasm about its potential effectiveness and/or the possibility of cost increases. It has been slow off the blocks. However, unlike the EU's CBAM (which focuses solely on carbon), the CCTS is broader because it sets emission reduction targets across the entire spectrum of GHG emissions. Initially, the scheme covers steel and cement, with aluminium expected to be included by 2025 or 2026, with varying reduction targets.

The CCTS focuses on efficiency improvements as opposed to a rigid emissions cap. A number of respondents support the establishment of a robust legal and regulatory framework for carbon emissions in India before implementing either a CCTS or a carbon tax. Another key question concerns the integration of the CCTS with existing decarbonisation instruments like the PAT scheme, the Green Credit Rules (offering tradable Green Credits or GCs), and RPOs. Will GCs be eligible to mitigate CBAM's impact? Despite the uncertainty, a clear consensus emerged from the survey: Most respondents favour the implementation of an Indian carbon tax by subsuming existing energy and environmental taxes, such as those listed by respondents while filing the surveys for the Remission of Duties and Taxes on Exported Products (RoDTEP) scheme. Existing taxes include the Coal Cess, which has evolved into the GST (Goods and Services Tax) Compensation Cess post-GST and now applies to a wider range of items beyond coal, potentially diminishing its relevance as an environmental or energy tax. Further, the rechristening of the Coal Cess as the GST Compensation Cess also changes its effect on integrated steel players and secondary manufacturers. While the former is eligible for a refund via exports, the latter is not, stoking doubts about whether this cess will be eligible for a deduction under CBAM.

Steel and aluminium industry stakeholders (the two industries most affected by CBAM in the immediate term) strongly recommend imposing the tax domestically and using the revenue to promote decarbonisation. This approach aims to transform CBAM from a potential non-tariff barrier (NTB) into an opportunity for domestic industry improvement. From all accounts, this route is compatible with the CBAM regime and would be acceptable to the EU. Determining the appropriate domestic carbon tax rate remains the central question.

While the challenges arising from CBAM imperil exporting firms in the relevant industries, these are asymmetric by industry type and firm size. The steel and aluminium industries are differently placed. For instance, steel production largely relies on BF technology, which uses coal as its primary feedstock. The industry is switching towards increased use of electric arc furnaces (EAFs) powered by renewable energy sources and is even exploring green hydrogen as a potential fuel option. Aluminium production, however, has progressed more slowly globally, with smelters continuing to rely heavily on coal. Our survey indicates a low likelihood of replacing coal in the aluminium smelting process in the short term. However, unlike steel, the heating aspect of aluminium production is limited to alumina refining, which is currently not subject to CBAM. The case studies later offer more detail.

Even before CBAM was announced, large firms like Vedanta Aluminium and Kalyani Steels had begun investing in Environmental, Social, and Governance (ESG) (since 2019–2020) and using renewable sources in production. Most large entities were able to report emissions for the first quarter ending in January 2024, as mandated by CBAM. On the other hand, MSMEs are more vulnerable, facing challenges related to reporting, verification, and audits, besides facing high costs for introducing renewable energy or alternative fuels into production. The survey shows that at least 1,000 MSMEs export steel and steel products, mostly belonging to the HS (Harmonised System) 73 category.[5] Meeting standards and reporting requirements is, unsurprisingly, more demanding for smaller firms. Lack of awareness is another significant constraint.

Large firms have sorted most compliance issues, especially on direct emissions. At the medium scale, companies with a turnover of around Rs 400 crore have initiated energy audits. These audits, though expensive (costing up to Rs 15–20 lakh per audit), are useful for market preservation and expansion. The problem is that SMEs cannot afford to bear such expenses. Another claim made during the survey was the reluctance of large firms to share the necessary data with SME buyers for the latter's compliance with CBAM requirements. This is not justifiable. Further, there are overall concerns about data protection. India's data protection regime is new, and the transmission of data overseas to meet CBAM requirements will need to comply with local laws.[6] A balance is needed in this regard. For its part, the Ministry of Steel has approved 13 task forces to define the roadmap for green steel, in a step towards lowering the industry's carbon emissions.

In short, large Indian firms have internalised CBAM legislation despite the challenges and risks. For example, Tata Steel, one of India's leading steel producers, has advocated for a 'safeguard mechanism' similar to CBAM. This mechanism would protect domestic firms from imports from countries lacking carbon regulatory frameworks. JSW Steel Ltd. is prepared to embrace CBAM and plans to respond to the EU's CBAM by establishing a green steel manufacturing facility by 2030. Vedanta Aluminium, one of the largest aluminium producers in India, has used renewable energy and launched low-carbon green aluminium, branded as Restora (GHG emission intensity less than 4 tCO_2 equivalent per tonne of aluminium, which is the global threshold), and ultra-low-carbon Restora Ultra brand (near zero) in 2022–2023. Kalyani Steels Limited also launched two green steel brands: KALYANI FeRRESTA (GHG emissions less than 0.19 tCO_2 equivalent per MT of crude steel) and KALYANI FeRRESTA PLUS (net-zero emissions). However, it is essential to verify whether these new brands bring a change in actual emissions. How other firms respond, especially MSMEs, will also be critical.

Some other relevant information also emerged during the literature review (Gulia et al., 2023) and our survey. Tata Steel is ready to adopt carbon storage and use hydrogen across its value chains. It is the first company to adopt carbon capture technology (it has commissioned a 5-tonne-per-day plant at Jamshedpur) and promote the concept of a circular economy within its production value chain. Vedanta aims to minimise waste by revamping its aluminium scrap collection and processing capabilities. It has partnered with IIT Bombay to develop technologies to increase the use of green hydrogen in production. ArcelorMittal has signed an agreement with Siemens Gamesa for the supply of wind turbines in Andhra Pradesh and has launched a 989 MW wind–solar hybrid project. Jindal Steel and Power has also signed a deal with Greenko to obtain 1,000 MW of green power for its plant in Odisha. Nevertheless, the definition of "green power" remains elusive, as Tongia (2023) underscores. The introduction of factors like additionality, deliverability, and time matching further exacerbates the challenges in establishing a clear and universally accepted standard.

In summary, the key challenges, opportunities, and pathways for India attributable to CBAM include:

- Traditional steel production in India relies heavily on coal, which significantly contributes to carbon emissions. India also lacks reserves of coking coal and mainly imports it. India has abundant iron ore, which will continue to be exploited. However, the lowest carbon intensity comes from using EAFs and scrap. At the same time, the challenges therein are several:
    - High use of BF technology. If India goes with the EAF route, its CO_2 emissions will decline to around 2 metric tonnes per tonne of steel compared to 2.2–2.8 metric tonnes when using BFs.
    - Limited scrap availability to replace coal. India lacks sufficient domestic scrap, increasing its reliance on imports (Figure 14, left panel). In 2022, India was the second-largest scrap

[5] The Harmonised System is a standardised numerical method of classifying traded products. It is used by customs authorities around the world to identify products when assessing duties and taxes and for gathering statistics.

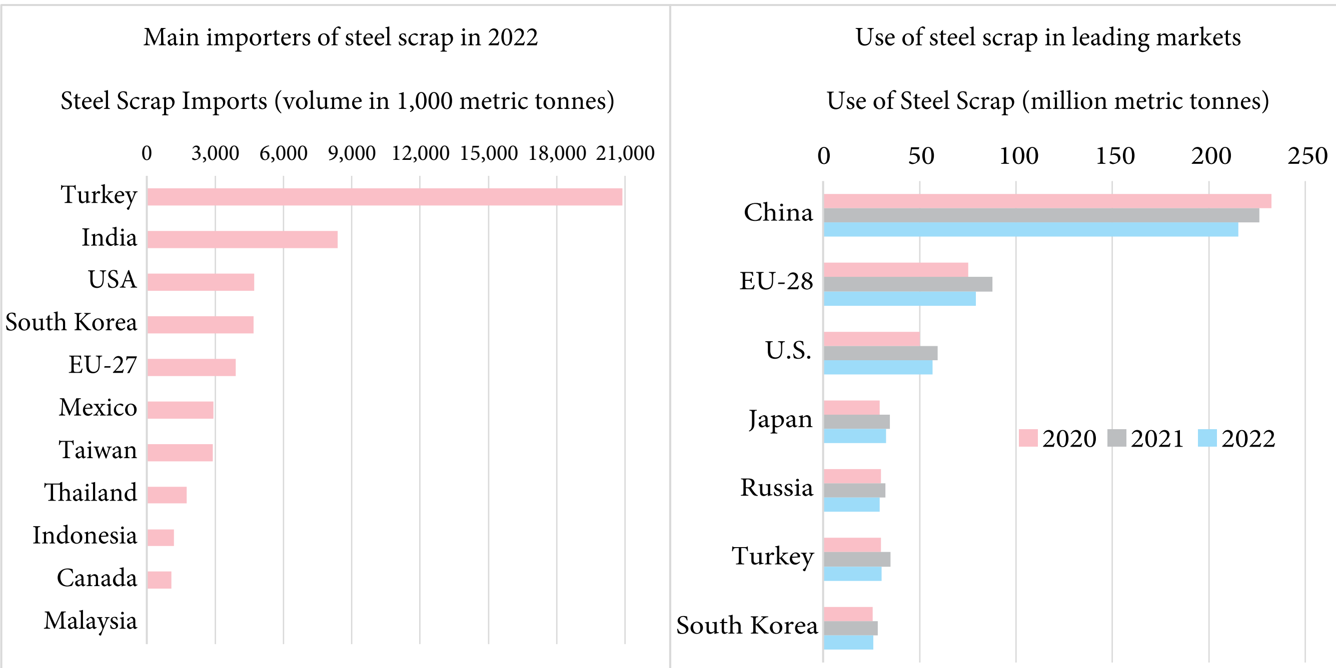
[6] In early August 2023, India passed the Digital Personal Data Protection (DPDP) Act, 2023. The new law is the first cross-sectoral law on personal data protection in India and has been enacted after more than half a decade of deliberations.

importer. Many countries are also using high amounts of scrap (Figure 14, right panel) and are likely to increase their use of scrap to meet CBAM requirements. This trend will likely limit future scrap import options for India.

This situation presents both a challenge and an opportunity for India. To achieve its ambitious goal of 300 million tonnes of steel production while meeting emissions norms, India will need a significant amount of scrap. While traditional suppliers (like the Middle East, the EU, the US, and Southeast Asia) currently exist, these countries are also under pressure to produce greener steel, leading to increased domestic scrap usage. India is currently analysing its scrap demand for the next 10 years (the final report by the Ministry of Steel is forthcoming). However, it is noteworthy that India already generates some scrap domestically; around 20% of every tonne of steel produced is retained as scrap. Additional scrap comes from further steel processing and end-of-life products (like automobiles). Encouraging the efficient collection and recycling of domestic scrap is a cost-effective and carbon-saving solution for the Indian steel industry.

The Vehicle Scrapping Policy, 2019, offers scope for improving scrap availability in the long term. It could generate an additional 25–30%. As the scrappage policy develops, more scrap will become available domestically. This policy is linked to the life of a vehicle. For example, in the National Capital Territory of Delhi, a diesel vehicle has an assigned life of 10 years, while a petrol vehicle has been allowed 15 years. Besides, scrap is obtained from old buildings, fast-moving consumer goods (FMCG), and dairy products. As EAF capacity is expanded, demand for scrap will increase, as steel scrap is the main feedstock for EAFs. Some firms could also deploy direct reduced iron (DRI) technology in which renewable energy or green hydrogen can be used. DRI requires lower operating temperatures and much less coke (or none) during the iron reduction process, thus representing a significant improvement in both energy consumption and emissions (Gulia et al., 2023).

Figure 14: India is the Top Net-Importer of Scrap



Source: Statista [Left panel: Top exporters in 2022 are EU-27, the US, UK, Japan, Canada, Australia, Mexico and Singapore, in this order; Right panel: India's data in terms of use of scrap for steel production is not available on this database; However, it is available that in 2023 "scrap consumption for crude steel production amounted to approximately 25-26 million (26-30 mnt) metric tonnes, with roughly 10 million metric tonnes being sourced through imports and the remaining 15 million metric tonnes coming from domestic supplies." (SteelMint, 2023) - thus India's consumption of domestic scrap is just 15 million metric tonnes].

- Hydrogen is considered the best alternative fuel for EAFs, but it is currently not scalable and is very expensive. Only small- to medium-scale start-ups occupy this space at present. For instance, Hygenco India is said to be the first commercial hydrogen-producing company, and it has signed a memorandum of understanding (MoU) with Jindal Steel. A study by Gulia et al. (2023) argues that hydrogen costs are high and will require active policy support to scale. It is also conjectured that it cannot become the primary route for steelmaking in India, at least not until 2050. Electrolysers are still an emerging technology and are mainly used in prototypes by Indian Institutes of Technology (IITs) and start-ups.

- Biochar is another upcoming alternative that technology startups are exploring. It is charcoal made from organic or biogenic materials (like coconut shells). Its effective carbon footprint is considered to be zero because it is only reprocessing environmental CO_2 in a seasonal cycle. Biochar, with the right feedstock selection, can be a good blend with coke and even cheaper than hydrogen. With a bio-alternative to coal, companies can use it in the BF, thereby reducing carbon emissions. For instance, EarthOnly, a Gurgaon-based decarbonisation solutions startup, is developing agroforestry and biochar projects in India supported by carbon finance. It is also examining partnerships with the steel industry to pilot test the use of biochar as an additive to create a low-cost solution to comply with the CBAM. Biochar is stated as a low-cost alternative in the transition to CBAM compliance.

- Carbon capture, utilisation, and storage (CCUS) technologies are considered effective for achieving a clean energy transition. However, due to the high cost and difficulty in scaling, global deployment of CCUS is slow. India also lacks the capacity and data for potential geological sites for storing items like natural gas (Gulia et al., 2023).

- Under CBAM, carbon capture is only allowed to be deducted from an installation's emissions when the captured carbon is either geologically stored for the long term or used in manufacturing goods where CO_2 is permanently chemically bound. In other words, "carbon should not enter the atmosphere under normal use, including any normal activity taking place after the end of the life of the product." The products that fulfil the second criterion will be defined in an implementing act under the EU ETS Directive (Article 12(3b)). The latest EU ETS Directive (Version March 1, 2024) is available at the *Official Journal of the European Union* (2024).

The above discussion suggests that opportunities for India in the transition to CBAM include (i) shifting to renewable energy sources, such as solar and wind power, which can significantly reduce the industry's carbon footprint (China's success in hydropower is an example to support this), and (ii) policy support to reduce import dependence, such as a vehicle scrapping policy that can increase domestic scrap availability in the long run for steel production.

India needs to be proactive in meeting the obligations imposed by the EU's CBAM. Other mature markets are likely to follow suit, moving towards an effective global market for carbon. In such a scenario, the unfairness of CBAM, to the extent it disturbs CBDR, and its incompatibility with existing multilateral rules are at best distractions. At worst, going down this route will crowd India out from its export markets. There is a window available for exploring opportunities, and more so because the EU will likely take considerable time to fathom the processes of different countries for each sector. All exporters across the world will provide data to the EU of their coal usage, its calorific value, giving massive data to the EU to mine and decide when and where to increase the scope.

The rest of the paper is devoted to a case study each of JSW Steel and Hindalco, large steel and aluminium producers respectively, with a significant export presence in the EU, among other countries. These firms were purposively chosen for their size, export orientation, and capacity to absorb shocks like CBAM. These cases inform their strategy for carbon reduction and plans for using RE. Lessons from the cases and from the survey discussed above are presented in the final concluding section.

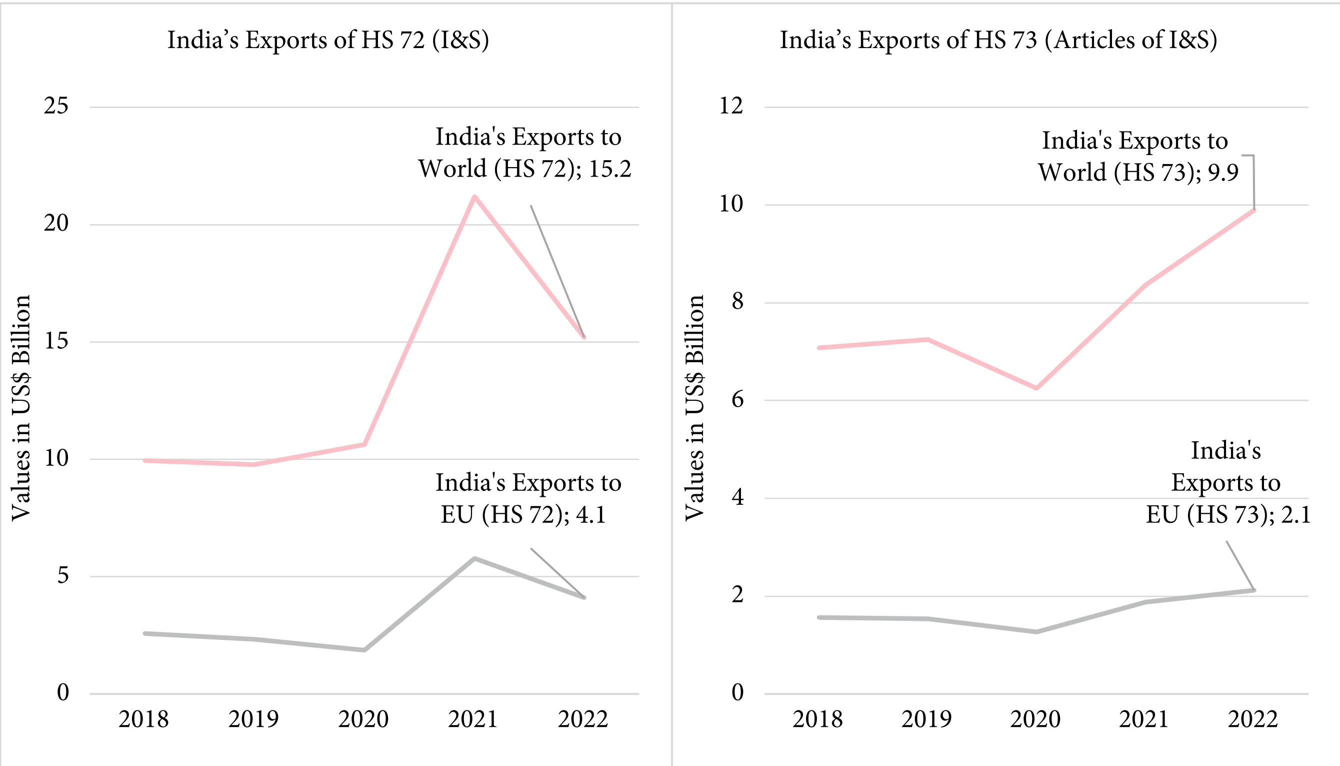
5.1. Decarbonising Steel: The Case of JSW Steel

Any growing economy relies heavily on steel because it is the foundation of infrastructure and industrial development. Despite being the world's second-largest steel producer, India confronts a complex dilemma. Steel production generates severe negative externalities, accounting for approximately 12% of India's GHG emissions. This poses a significant challenge, considering steel's relatively modest contribution to GDP at 2% (The Free Press Journal, 2023). This essential paradox highlights the need for a sustainable steel industry—one that balances growth with environmental responsibility. India has recognised the danger inherent in the situation and has established 13 task forces to promote green steel production and limit related emissions (Press Information Bureau, 2023a).

India's global exports of HS 72 (I&S products) doubled between 2018 and 2021 and have declined since then. HS 73 (articles of I&S) exports have also grown, but the increase has been at a slower pace. Large firms have a stronger presence in the HS 72 export market. This is due to factors like huge capital investment and the attendant economies of scale in steel production. The EU is an important export destination for India's steel products. The share of India's HS 72 exports going to the EU increased from 26% in 2018 to 27% in 2022. The share of HS 73 exports decreased marginally, from 22% in both 2018 and 2021 to 21% in 2022 (Figure 15).

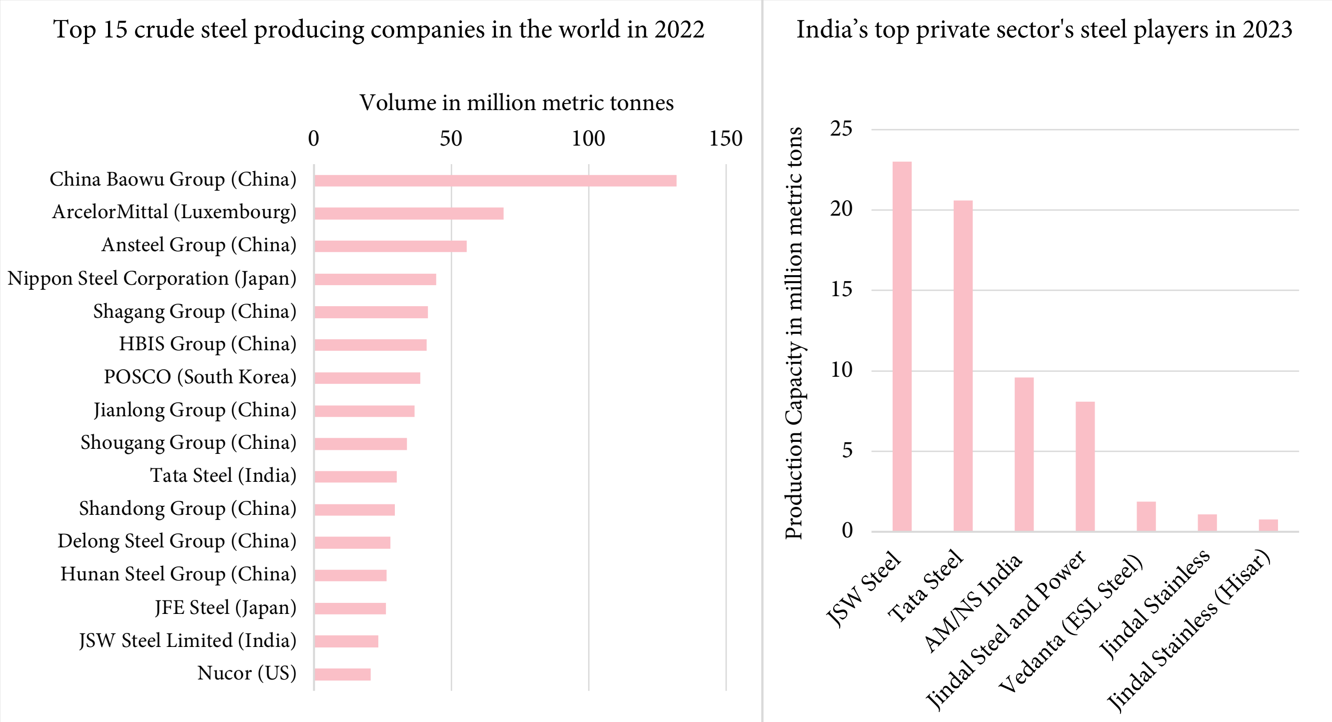
JSW Steel and Tata Steel are major steel producers and are among the top exporters of crude steel. JSW Steel has the largest production capacity and is the leading private steel producer (Figure 16).

Figure 15: India Significantly Exports I&S Products Globally and to EU



Source: WITS Software.

Figure 16: India is Among the Top Five Crude Steel Producing Countries with Presence of its Private Players Either Standalone, viz. JSW and Tata Steel, or in Collaboration with Other Countries' Players



Source: Statista database [In left side panel, please note that China Baowu, Ansteel, & Nippon also includes tonnage of Xinyu Steel; Benxi Steel; & of Nippon Steel Stainless Steel Corporation, Sanyo Special Steel, Ovako, 40% AM/NS India and 31.4% USIMINAS; respectively; ArcelorMittal covers 60% AM/NS India (former Essar Steel); Also, note that global ranking of companies is available for 2022, whereas India's ranking is for 2023].

The steel industry has traditionally used the BF route, which requires heavy doses of coal and iron ore. The shift towards EAF, which emits less CO_2, is visible but slow. For instance, alloy steel producers that constitute about 10–15% of the total capacity have a presence in high-end sectors (such as automobiles, defence, aerospace, and nuclear). Newer types of fuels are being increasingly used in the EAF facility (such as hydrogen and renewable energy). Kalyani Steel, Tata Steel, Jindal Steel and Power, and JSW Steel are equipped to embrace scrap and clean energy in production to meet sustainability goals, among other objectives.

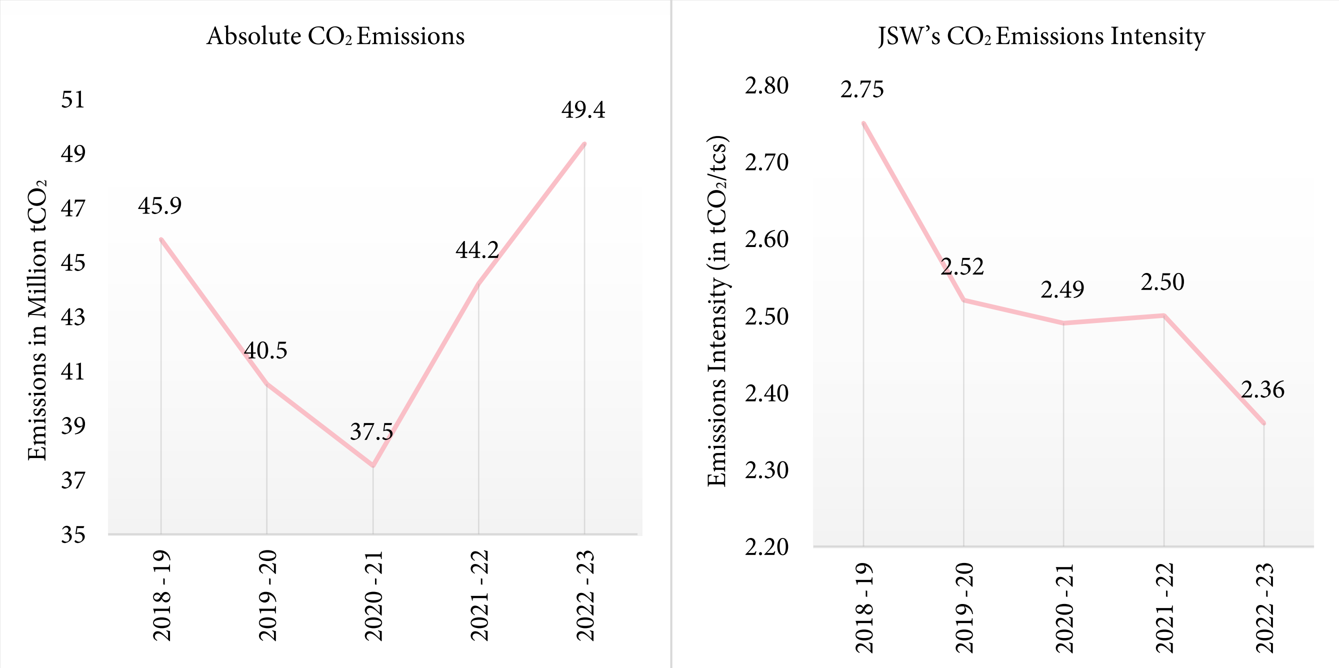
Although the Indian steel industry has significant potential for expansion, the target of 300 million tonnes by 2030 appears ambitious. Currently, the industry is estimated to have reached 125 million tonnes (whereas China is at 900 million tonnes). China's per capita steel consumption is approximately 600 kg, while in India it is at a mere 75 kg, as per industry estimates obtained during the survey. India has a long way to travel, but this demonstrates the enormous potential. Nevertheless, an illustrative computation of the obligation under CBAM for the industry is given in Box 3, which shows taxable emissions of approximately 2.3 tCO_2 per tonne of hot-rolled steel.

JSW has a current capacity of 29.2 MTPA and is pioneering investments in sustainability. In the 1990s, JSW Steel was one of the first adopters of Corex technology, an environmentally friendly smelting process (JSW Steel, n.d.). In 2022–2023, JSW's market share was nearly 23%, and it has an ambitious plan to expand capacity to 50 MTPA by FY2030–2031. JSW is committed to balancing growth with environmental responsibility. It is also the only practical way forward.

JSW Steel has reduced its CO_2 emissions intensity by 30% since 2004–2005 (when it was 3.39 tCO_2/tcs) and in 2022–2023, it recorded an intensity of 2.36 tCO_2/tcs, although there has been a rise in absolute emissions by 8 million tCO_2 between 2018 and 2022 (Figure 17).

To maintain this pace, JSW has set an ambitious target of achieving 42% reduction in carbon emission intensity by FY30 from 2005 levels (JSW Steel, 2024c). This target aligns with the Sustainable Development Scenario (SDS) of the International Energy Agency (IEA), as well as India's NDCs (JSW Group, 2023).

Figure 17: JSW Steel's Carbon Emissions Intensity Declined in Last Five years, but Absolute Emissions Continue to Rise Since 2020



Source: JSW ESG Databook 2022-23; JSW (2023a, 2022a). (Note: Cover Scope 1 and Scope 2 Emissions).

JSW's export share decreased by 15 percentage points between 2021–2022 and 2022–2023, mainly owing to the imposition of export duty in May 2022, subdued global markets, China's pursuit of aggressive pricing, and an increase in coking coal and iron ore prices (JSW Steel, 2023a; Suri & Chaliawala, 2024). The company's exports, however, revived in the fourth quarter (by 144% quarter-on-quarter) due to the removal of duties.

JSW's readiness to embrace technology for the sake of sustainability reflects the reality of a competitive global market that is increasingly demanding sustainable practices. JSW is also recycling materials to the tune of 12% (JSW Steel, 2023a), thereby reducing reliance on virgin resources and curtailing the environmental impact of mining activities. The firm plans to increase renewable energy sources in its total energy portfolio to 80% by 2030 (from its existing share of approximately 50%) (The Free Press Journal, 2023). This will help to reduce the carbon footprint and insulate it from price fluctuations in the fossil fuel market, providing a hedge against future uncertainties. JSW Steel has committed to becoming carbon neutral by 2050 (for India, the target is 2070). It aims to reduce specific energy consumption by 19% to 5.65 Gcal/tcs by 2030. Such goals are likely to be met by using disruptive technologies (e.g., green hydrogen, CCUS), increasing scrap usage in steelmaking, and reducing fossil fuel usage (JSW Steel, 2024c).

JSW Energy (another firm in the group) plans to expand its renewable portfolio to reach a capacity of 10 GW, constituting 68% of its total portfolio by 2025. By 2030, it aims to increase the level to 84%, achieving a total capacity of 20 GW, with all capacity additions exclusively in the RE sector (JSW Group, 2024).

The JSW Group's sustainability strategy is visible and, to a large extent, responsive to global realities. For a company with a market capitalisation of over US$25 billion, it is perhaps the only utilitarian route to take. The seven key elements that they admit drive sustainability are leadership, stakeholder engagement, communication, planning, improvement, monitoring, and reporting (JSW Group, n.d.). Environmental considerations cut across functions, and JSW's Environmental Management System helps take proactive measures to conserve biodiversity and promote environmental conservation efforts (JSW Steel, 2024b).

JSW's journey toward decarbonisation has largely been driven by technological innovation and its first-mover advantage in many areas of sustainability (see Appendix B). It is also proactive in responding to global developments and has already set plans to address the CBAM challenge by aiming to scale up green steel manufacturing units. The announcement of CBAM for JSW Steel has not been disruptive; due to its size and scale, it had already made plans for sustainable production. CBAM has reinforced this ambition. JSW Steel has installed a carbon capture and storage facility at its DRI plant in Dolvi, with a capacity of 100 tonnes per day. The captured carbon will be repurposed in the food and beverage industry (Press Information Bureau, 2023a). According to JSW Steel's Chief Sustainability Officer, the company has institutionalised sustainability in all aspects of its functioning, from corporate governance to technological innovation and corporate social responsibility (CSR) initiatives (Prabodha Acharya, The Free Press Journal, 2023). JSW Steel has decoupled growth from emissions but not from societal and environmental needs. In that spirit, JSW will do well by assisting its MSME counterparts with technical and other forms of assistance to cope with the CBAM challenge.

5.2. The Case of Indian Aluminium and Hindalco's Storyline

India is the second-largest producer of smelter aluminium (see Box 2 for information on the value chain). Among private companies, Vedanta and Hindalco are the top two producers (see Figure 18). Both are integrated metals and mining companies. Vedanta Aluminium Co. Ltd. has plants in Odisha (at Jharsuguda for aluminium production and at Lanjigarh for alumina production). On the other hand, Hindalco has plants spread across different states, such as Aditya and Hirakud in Odisha; Mahan in M.P.; and Renukoot in U.P. Hindalco's installed capacity in 2021–2022 in alumina was 3 million tonnes (with plants at Renukoot [Uttar Pradesh], Belagavi [Karnataka], Muri [Jharkhand], and Utkal Alumina [Odisha]), which is higher than that of Vedanta at 2 million tonnes (according to the Indian Minerals Yearbook 2022, released by the Indian Bureau of Mines, Ministry of Mines [Indian Bureau of Mines, 2024]). Both companies have been undertaking different sustainability practices since 2019–2020 and, like JSW Steel, are well-informed and well-prepared for CBAM. This section presents results for the industry (mostly applicable to both companies), followed by a case study on Hindalco (see Appendix C for its initiatives).

BOX 2: Understanding the Aluminium Value Chain in India

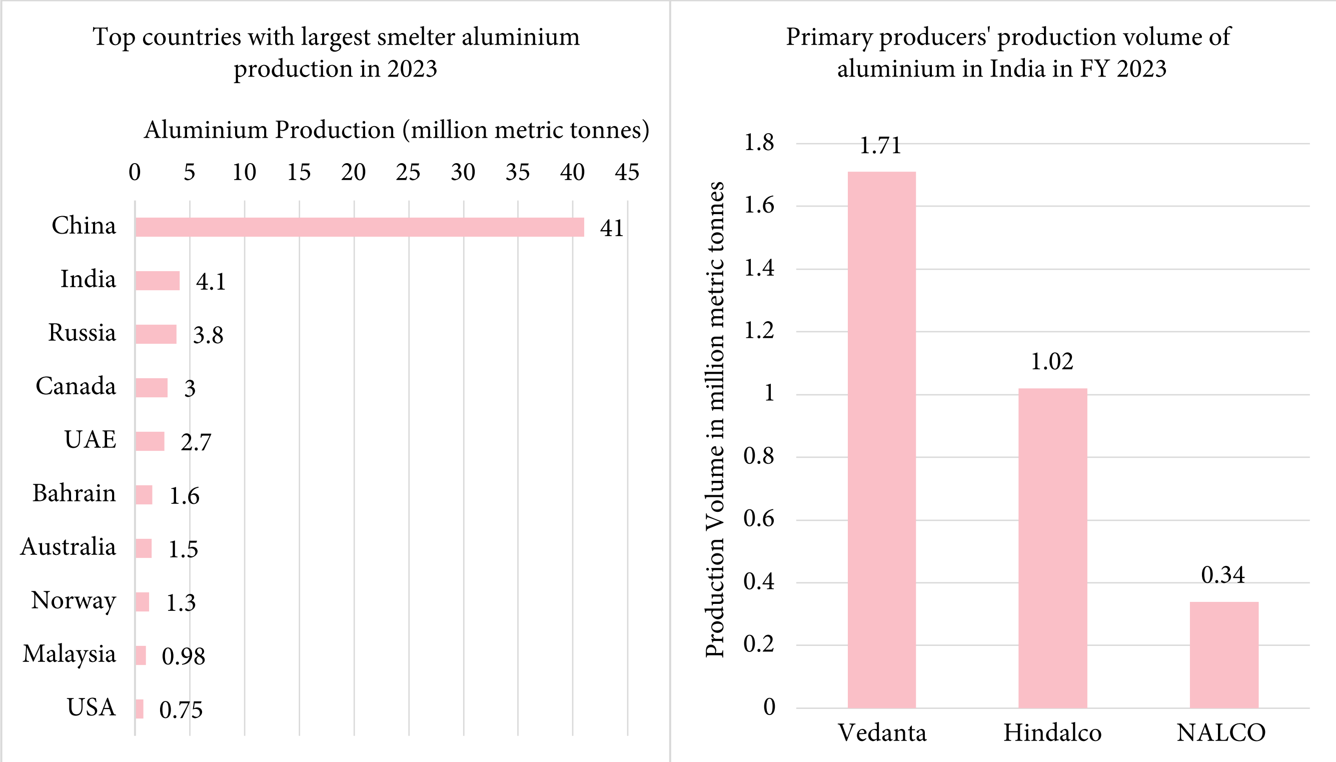
The start is extracting bauxite ore, followed by refining it into alumina. An electrolytic process then transforms alumina into hot metal (primary aluminium) with a purity of 99.9%. The use of a smelter, however, requires vast capex of around Rs 50,000–60,000 crore. This is a capital-intensive upstream segment mainly covered by HS code 7601 (unalloyed and alloyed aluminium). It is dominated by Vedanta, Hindalco, and NALCO. Hot metal is then converted into ingots, bars, and wire rods. The midstream stage, covered by HS codes 7604–7608,[7] is the stage of processing that encompasses extrusions (used in construction, automobiles, etc.) and rolled products (further processed into panels and foils). While smaller players such as MSMEs tend to participate in the extrusion market, rolled products require significant capital investment, making it a domain of major producers like Vedanta and Hindalco. Finally, the downstream stage (HS codes 7609–7916) encompasses the creation of finished aluminium goods such as automobiles, utensils, and other consumer products.

Since CBAM applies to all aluminium products (entire Chapter 76) except scrap (HS 7602), it presents a challenge to all aluminium producers and exporters. In 2022, of India's total direct global exports of HS 76 of about US$10 billion, almost US$2.5 billion were exported to the EU (Figure 19), reflecting an exposure of more than 25% (it has increased from 15% in 2018). Of US$2.5 billion, 84% belongs to HS 7601, i.e., primary aluminium, covering large firms whose main focus is primary aluminium production. The aim, therefore, is not to let the imposition of CBAM affect India's burgeoning exports of aluminium (dominated by HS 7601) to the EU.

It is noteworthy that the available CBAM impact assessments do not account for realignment in global value chains, because CBAM could affect the purchasing decisions of third countries who are using primary metal from India and other countries to manufacture products covered by the CBAM and export to the EU. For instance, there could be a situation where HR steel is exported from India to an ASEAN country. The importer uses such sheets to manufacture items covered by Chapter 73. The goods manufactured are then exported to the EU. CBAM could thus also affect the purchasing decisions of importers located in such third countries.

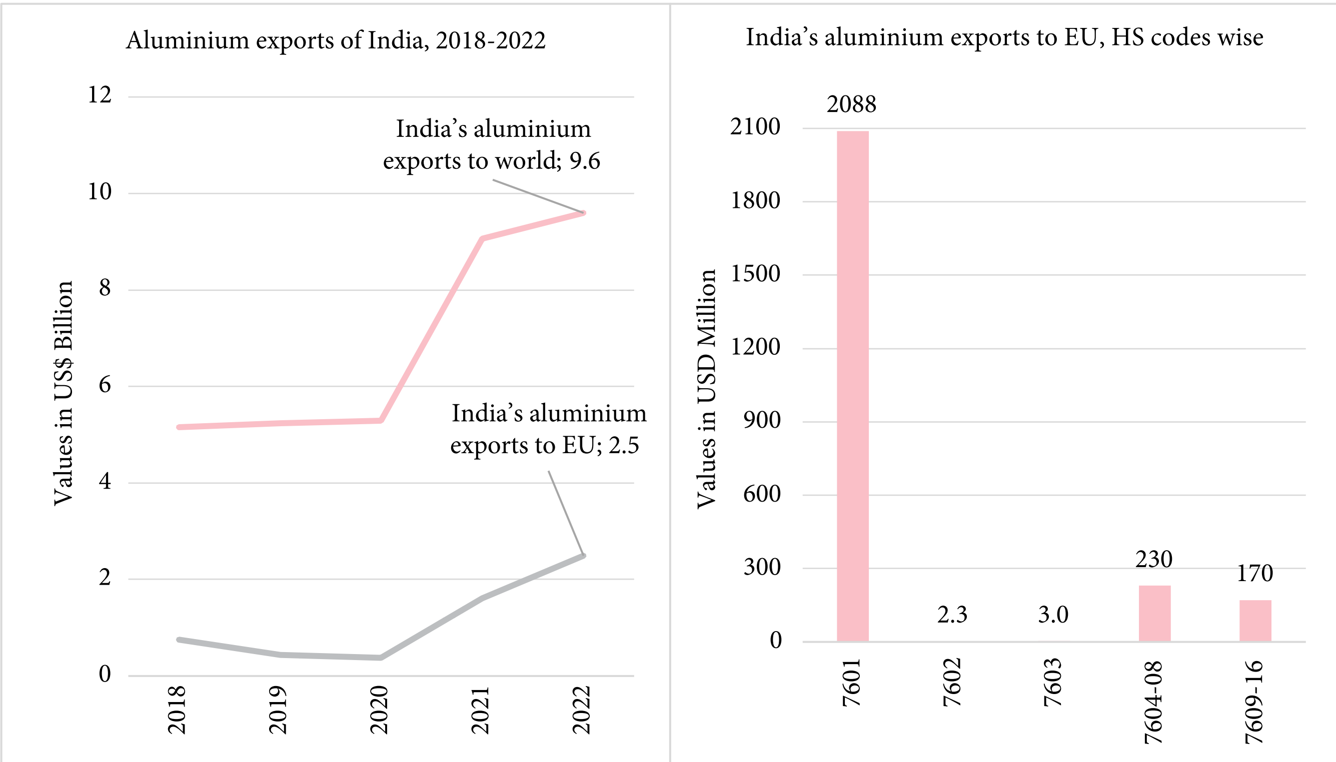
[7] HS 7604 deals with extrusion, HS 7605 with wire rods, HS 7606 with rolled products, HS 7607 as foils, and HS 7608 as some forms of extrusions, tubes, and pipes. Note: HS codes prior to HS 7604 refer to primary aluminium (HS 7601), waste (HS 7602), and aluminum powders and flakes (HS 7603).

Figure 18: India is the Second Largest Aluminium Producer in the World, with Ranking of Vedanta and Hindalco as Top Two Private Producers in this Industry's Value Chains



Source: Statista database.

Figure 19: India is Major Exporter of Aluminium, Mainly of HS 7601 (Primary Aluminium)



Source: Source: WITS Software.
Note: See BOX 2 for product codes HS 7601-7616 description.

India's aluminium exports to the world have nearly doubled since 2020, reaching US$9.6 billion in 2022 (Figure 19). 25% of the exports go to the EU, where local capacity falls greatly short of demand.[8] This reaffirms the significance, opportunity, as well as the challenge of CBAM for the Indian aluminium industry.

One major challenge is that almost all aluminium production is coal-fired, except for a few plants that use sources like hydropower (e.g., in Canada, Poland, and China) or natural gas (e.g., in Middle Eastern countries like the UAE). Nuclear energy can also be used for green production but requires an uninterrupted supply of electricity. In India, the availability of both hydropower and nuclear power is a challenge. The concern is heavy reliance on coal-fired captive power plants (CPPs) to meet energy demand for smelting.

The smelters cannot be easily migrated towards renewable power because of the vast investments and technical requirements of ensuring consistent power supply without compromising purity and output. Discussions revealed that Indian aluminium producers are struggling to adopt RE for smelting. Some pilot projects show that while it might be possible to use RE for ancillary processes, these would cover approximately 7–8% of the total requirements. The remainder would still be dependent on legacy supply. Therefore, emissions attributable to aluminium may remain higher.

On the other hand, the short-term impact of CBAM on aluminium is likely to be limited (see also Majumder, 2024). India's annual aluminium production (approximately 4–4.2 million tonnes) is far behind China, which produces over 40 million tonnes. In 2023, China accounted for almost 60% of the global smelter aluminium production (approximately 70 million tonnes), while India's share was only 6%, followed by Russia (Visual Capitalist, 2024). At the same time, India exported more than half of its aluminium production (approximately 2–2.5 million tonnes). The survey further revealed that the per capita consumption of aluminium in India is around 2.8–3 kg, while that of China is 30 kg. Although aluminium is three times more expensive than steel, it is also three times lighter, non-corrosive, 95% recyclable, and has a lifespan of almost 140 years. The long-run benefits of aluminium should, therefore, not be underestimated.

Significantly, the exact tax under CBAM that will be charged from January 2026 is only to direct emissions (Scope 1). Indirect emissions are not liable at this time. This will reduce the impact of CBAM on the aluminium industry until 2026. The initial impact of CBAM will, therefore, be limited, providing temporary respite for aluminium producers. Under CBAM, coal and bauxite mining are not included in the levy. Bauxite-to-alumina production, anode production, alumina refining, and the coal-fired electricity used by captive power plants are also not covered under embedded emissions. Only smelting and process emissions related to conversion into sheets, foils, or extrusions are subject to the tax (see Box 3 for the computation). Power generation falls under Scope 2 and is only required to be reported at this time (and is, therefore, not taxed in 2026). This is due to an internal EU practice of providing state aid to power consumers. Until these get outlawed in the EU, there will be no tax on carbon emissions due to power generation.

[8] The output capacity for aluminium in Europe was over four million tonnes in 2021–22 (Reuters, 2022), while regional demand for primary aluminium is nine million tonnes per year (expected to double by 2050; see European Aluminium, n.d.).

BOX 3: Estimates of CBAM Impact

Illustration of the computation of the CBAM obligation:

Obligation (USD per tonne of product) = {(Installation Emissions in tCO_2 – Free Allowance in tCO_2)* Tonnage* EU ETS Carbon Price in USD per tCO_2} – Carbon Price paid in Exporting Country (in USD per tonne of product)

Steel

Eurometal (relying on Goldman Sachs analysis) estimates that the taxes from the CBAM are projected to range between USD 102–190 per tonne (Eurometal, 2024). This would represent 15–28% of the current hot-rolled coil prices. The free allowance benchmarks for the period 2021–2025 for hot metal currently stand at 1.288 tCO_2.[9] If we assume that the EU ETS carbon price is US$100 per tonne, and that no carbon price is currently payable in India, and plug the Eurometal estimates as well as the free allowance into the above equation, we can estimate that the taxable emissions are approximately 2.3 tCO_2 per tonne of hot-rolled steel.[10]

Aluminium

ICRA estimates that the taxes from the CBAM are projected to range between US$50 and US$140 per tonne of aluminium from 2026 to 2034. This would represent 2–6% of the current aluminium prices (Majumder, 2024). The free allowance benchmarks for the period 2021–2025 for aluminium currently stand at 1.464 tCO_2. If we assume that the EU ETS carbon price is US$100 per tonne and that no carbon price is currently payable in India and plug the ICRA estimates as well as the free allowance into the above equation, we can estimate that the taxable emissions are approximately 2 tCO_2 per tonne of aluminium.[11]

Our survey revealed that Chinese producers declare the GHG emissions for aluminium to be 5–6 tCO_2. This would mean that either the aluminium is recycled or all the electricity used in smelting is from renewable sources. While questions may be raised about the legitimacy of the claim, if accurate, then the long-term impact of CBAM on Chinese aluminium could be much lower because the emissions are 25% of the Indian aluminium emissions.

Moreover, industry stakeholders and legal experts argue that even if a fully functional CCTS is implemented in India as a deduction from the applicable carbon price under CBAM, it is unlikely to make a significant difference. This is because the EU's carbon price would remain much higher than India's. According to experts, India's CCTS may be less than US$10 (GTRI, 2023). The remainder, i.e., US$90, would be the applicable carbon price at the border for India's exporters. A critical question in India is therefore the timing of the introduction of CCTS and its effectiveness. The absence of a clear regulatory roadmap outlining India's path towards zero emissions by 2070 makes it hard to justify a carbon price of $100. Without achieving this carbon price, the potential liability under CBAM will persist. An alternative solution could be the introduction of an additional emissions reduction allowance solely applicable within the ETS framework. The ultimate success of either a CCTS or a carbon tax hinge on establishing a well-defined carbon pricing system, like China's, which is linked to its 2030 and 2070 targets.

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[9] As per Commission's Implementing Regulation (EU) No. 2021/447 of 12 March 2021: the free allowances would be progressively reduced between 2026 and 2034 and would become Nil in 2034.

[10] {(X – 1.288 tCO_2)* 1* US$100 per tCO_2} – 0 = US$102 per tonne of steel (using Eurometal estimates) would mean X = 2.308 tCO_2.

[11] {(X – 1.464 tCO_2)* 1* US$100 per tCO_2} – 0 = US$50 per tonne of aluminium (using ICRA estimates) would mean X = 1.96 tCO_2. This is very different from other public albeit incorrect estimates, which assume that CBAM liability would arise on the entire 19-20 tCO_2 emitted in anode production, refining, and electricity component of smelting. See, Jagota (2023) which relies on CRISIL estimates that tax could be as high as US$1500-US$1600.

While the short-term impact of the EU's CBAM on the Indian aluminium industry is small, the bigger test lies beyond 2026. The EU will review the legislation before 2030 and will eliminate the free allowance system by 2034. Furthermore, the scope of the CBAM could be broadened to encompass indirect emissions, such as those associated with electricity generation. This expansion would significantly increase the impact on aluminium exports, potentially making them less competitive in the EU market. It would also substantially increase the compliance burden for Indian aluminium exporters. Unlike steel, which has been utilising renewable sources and scrap to produce green steel, the Indian aluminium industry is far behind in migrating to renewables, making it more susceptible to the CBAM in the future.

Moreover, aluminium exporters will need to submit emissions data embedded in the value chain to importing countries such as Japan and Malaysia. India holds more than a 70% market share in Asian countries. Access to US markets will also be subject to this condition.

6. Policy Discussions, Recommendations, and Conclusion

Given India's growth trajectory, a carbon tax and/or a carbon pricing mechanism is de rigueur. The need to reduce fossil fuel dependence and to deal at least in part with the climate crisis in compliance with international commitments is necessary. The benefits will be twofold. First, there will be a direct impact on sustainability and the achievements of the SDGs while also securing reputational effects and international goodwill that can be leveraged. Second, besides being a benchmark for other emerging markets, the road map that India adopts will have a significant public goods effect.

The struggle against (un)fairness embedded in the current global negotiations, i.e., CBDR, ought to be addressed separately. A fair system would require countries to contribute based on their embedded emissions. But implementing this would require the EU to sift through a mountain of data from various countries, each with their own methods. Working out accurate shares of emissions for each country will be a lengthy process, but it's a necessary step towards achieving climate justice.

Sooner rather than later, most countries will either have their own carbon taxes or systems like the ETS or will be well aligned with the EU's CBAM regulation. What's more, CBAM's scope may extend to many other industries, including pulp and paper, chemicals, plastics, textiles, etc., in the future. India's exposure to the EU will also increase if the free trade agreement (FTA) becomes a reality. Thus, there cannot be any escape for India, seeking to enhance manufacturing and lessen or remove the infrastructural bottlenecks. Steel and aluminium will witness a rise in demand. Rather than undermining several good commitments under UNFCCC, one approach will be to internally address adaptation, and mitigation matters and use compliance as a negotiating instrument in climate talks.

This study also challenges the universal applicability of the timeworn EKC hypothesis, which suggests a trade-off between economic growth and sustainability. While the EKC is not completely reversible, technological advancements can help countries decouple these factors, enabling them to pursue economic development without incurring significant environmental damage. Rather than replicating the historical patterns of developed nations (such as the UK and the US), where severe environmental damage preceded significant pollution reduction efforts, a different approach can be adopted: leveraging technology to minimise the environmental impact of industrialisation from the outset. A prime example of the UK's successful transition away from coal-fired power generation toward cleaner energy sources such as gas, bioenergy, and renewable energy, mainly in the past two decades, demonstrates the effectiveness of technological solutions. As advancements in clean technologies continue and sustainability awareness increases globally, other developing countries (particularly in Asia) can follow suit. African and South American nations can learn from best practices to accelerate their own transitions. In essence, the paper recommends exploring alternative clean energy solutions such as wind, solar, or hydropower that can be harnessed at scale using newer or innovative technologies and increasing their decarbonisation initiatives. Nevertheless, the discussions at COP29 will likely mark the efforts to centralise carbon mechanisms, as laid out by the UNFCCC.

At the global level, some policy suggestions include:

1. India needs to up the ante on its participation in international-level negotiations to obtain the right to park its fair share of carbon into the atmosphere. We have not been historical emitters and are primarily the victims of past emissions from many developed nations (like the UK and the US).

Moreover, in the upcoming bilateral FTAs (such as with the EU and the UK), the chapter on Trade and Development ought to deal with environmental and CBAM issues head-on. Notably, CBAM is not a tariff per se, but the manner in which CBAM will impact existing or future trade agreements between the EU and other countries will be crucial for decision-makers. Concerns exist that CBAM could become a protectionist measure, and discussions on how to ensure compatibility with WTO rules and existing trade agreements continue.

2. Another effective strategy would be to learn from successful bipartisan movements related to the environmental domain. For example, in response to CBAM, in February 2024, the US Congress adopted a bipartisan step to pass carbon-based legislation to address the climate crisis and protect US workers and businesses from unfair tariffs. The US Congress passed the Providing Reliable, Objective, Verifiable Emissions Intensity, and Transparency (PROVE IT) Act to encourage American-made supplies and determine CO_2 emissions of CBAM-affected products.[12] The passing of this bill is expected to lay the foundation for the future of CBAM, which could promote efficient low-carbon manufacturing in the US (making it a leader in this field) and encourage trading partners to also adopt a common set of emissions reporting standards. India could also consider forming bipartisan initiatives to manage CBAM-related challenges.

3. The longstanding failure to link trade policy with environmental issues at multilateral forums (such as the WTO) requires new thinking. This can be undertaken at other forums (such as the G20), involving the sharing of best practices, knowledge, and technology among members, especially for MSMEs in developing countries.

4. Industrial policies are here to stay, as evidenced by the US Inflation Reduction Act. Climate change goals are linked to resilient manufacturing growth. It is therefore essential to bring awareness about the standards, digital software, auditing, and reporting requirements for CBAM, and to identify the proper agencies involved in verifying and certifying CO_2 emissions. The EU must nominate the agency in India whose certificates will be acceptable to the EU.

5. There may be better solutions than the broad idea of standardising all compliance and standards at the global level, given the differences in the stages of development in different countries. Unified standardisation at the domestic level and accreditation of skilled new teams of energy auditors and certification authorities who are recognised in most economies (especially in the US and EU) could be a good option. Using better digitalisation tools and software is the right way to collect data for reporting purposes.

In addition, there are several short-to-medium term policy steps that must be undertaken within India. Based on secondary data and the survey, the study suggests the following:

- A three-step practical approach can be followed to promote greener supply chains and support industry efforts towards decarbonisation. While a horizontal carbon tax might be useful, its huge inflationary impact necessitates a more targeted solution. The three key steps are:

  a) **Data Collection:** Companies importing and producing steel and aluminium products (HS 72, HS 73, and HS 76) should consider filing "mirror declarations," with Indian authorities, emulating the information submitted under the EU's CBAM system. These declarations would include data on emissions.

  b) **Carbon Tax Collection:** Based on the information in these declarations, a domestic carbon tax would be calculated and levied on India's exports to the EU. This tax would be equivalent to the CBAM amount, ensuring consistency with EU regulations. This approach also conforms to WTO regulations concerning export taxes. Article 1 of the GATT Agreement permits such taxes as long as they do not distort competition. Since the final price for EU consumers remains unchanged, only the point of tax collection is shifted, upholding WTO principles.

  c) **Revenue Utilisation:** Revenue generated from the carbon tax could be used as seed capital to support green initiatives within the supply chain. For example, investments in carbon capture technologies, energy storage solutions, and tax breaks for research and development expenditures incurred by large companies

[12] It was a bipartisan vote of 14-5.

and MSMEs are some options. These do not violate WTO subsidy provisions.

Furthermore, analysing declarations from other countries could help identify India's comparative advantages in terms of decarbonisation. The EU's CBAM Regulation 2023/956 Annex IV also offers default emission values to be used when actual values are unavailable. These values are calculated using a country-specific factor and a mark-up. Recognising that the EU needs time to refine this system, India can leverage the aforementioned "mirror declarations" to create its own product-wise and company-size-wise default value table. This table could then be negotiated with the EU as an alternative to their default values during intergovernmental discussions.

- The government must intervene to implement compulsory audits for every producing organisation and prepare a database showing how many have complied, who are in the process of doing so, and the barriers to doing so. A solution-oriented approach helps only if barriers have been identified.

  Given the uncertainties surrounding India's carbon pricing mechanism, implementing a domestic carbon tax by repurposing existing energy and environmental taxes on exported goods should be considered. The list of eligible taxes could be ascertained from taxes not subsumed within the GST and used to prepare data submitted to the government while adopting the RoDTEP scheme. On balance, this seems a potentially reliable approach. Revenue generated from this carbon tax could then be used to establish seed funding. However, the lack of clear government guidance makes the exact implementation strategy complex. The coal cess, which has become a GST compensation cess post-GST and now applies to a wider range of items beyond coal, potentially diminishes its relevance as an environmental or energy tax. This change alters its effect on integrated steel players and secondary manufacturers, where the latter cannot get a refund of this cess on exports, creating doubts over whether it will be eligible for a deduction under CBAM.

  One potential solution involves leveraging the RoDTEP sample form, which was distributed by the Ministry of Commerce to EPCs during the scheme's launch. This form required members to detail taxes paid at various levels (municipal, local, and State) on their finished exported products, including transportation charges and fuel costs. Because these data are likely still available with relevant authorities, they could be used to identify energy and environmental taxes. This information could then be used to determine an appropriate carbon tax rate for India.

  This proposal for a domestic carbon tax raises the question of how to reconcile it with the existing notified CCTS. While some countries have both ETS and carbon taxes, their designs differ significantly and combining them might not optimise the benefits of a dedicated carbon tax system. The CCTS uses a market-driven approach with emissions caps and tradable CCCs or sets specific reduction targets. A carbon tax, in contrast, is a fixed levy (based on the carbon content of a product) that generates predictable revenue. Additionally, implementing and managing a carbon tax is generally considered easier than establishing and administering a carbon trading market under an ETS, which can take years to mature.

  India's CCTS also faces the challenge of integrating PAT-based energy-equivalent credits, RPO-based renewable energy credits, and potentially other schemes to avoid duplication of efforts. Furthermore, survey data suggest that the average carbon price in the EU's ETS is around US$70–100 per tonne, while India's carbon tax might be lower than US$10, which is vastly different. The question of how a domestic carbon tax would be incorporated into the CCTS remains unanswered, creating confusion for both the government and industry. Adding to the complexity, most industry players view the CCTS as an unattractive option due to the lack of domestic expertise and technological advancements in carbon trading. The steel and aluminium industries exhibit structural variations, with aluminium currently excluded from the CCTS. We suggest moving ahead with an export or carbon tax as a priority, sequentially followed by progress on the CCTS front.

- The study emphasises the critical role of RE in reducing carbon emissions within the steel and aluminium industries. Strict adherence to increasing RE usage in production processes is vital. The government can play a supportive role by:

a) **Facilitating RE Project Development:** Incentives and streamlined procedures for industries to establish or access RE projects (solar, wind, and hydropower) are essential. These resources require specific geographical conditions and infrastructure for efficient harnessing.

b) **Strengthening Regulations for Mandatory RE Obligations:** Robust regulations are needed to enforce India's carbon tax and establish mandatory RE usage in steel and aluminium production. These obligations can serve as specific minimum targets of RE usage or specific emissions reduction targets (the latter aligning with the intended purpose of the CCTS). Both public and private companies can be subject to these obligations, with penalties for non-compliance and incentives for exceeding targets. Incentives could include tax breaks or seed capital for further investments in clean energy solutions.

c) **Alternatively, Revamping RPOs Compliance:** The existing RPOs can be foundational. Stringent enforcement with fewer waivers can ensure that a mandated percentage of electricity comes from RE sources. Addressing the issue of low compliance by distribution companies (discoms) and the practice of shifting RPOs to future years is crucial. The success of the Central Government's escalating RPO targets (21% in 2021–2022 increasing to 43% by 2030 for solar and hydro) depends on effective implementation. This suggests aligning RE targets with the RPO mandates, which aim for a significant increase in RE usage by 2030.

d) **Expanding Renewable Energy Initiatives:** The recently launched PM-Surya Ghar Muft Bijli Yojana programme gives valuable insights. It offers free energy up to 300 units per month with the target of 1 crore households. The scheme proposes utilising vacant space on rooftops by installing solar panels of up to 3 KW capacity. It demonstrates the potential of government initiatives in fostering RE adoption. Similar programmes targeting different RE sources, with well-defined mandatory targets and obligations, could be instrumental in driving a large-scale shift towards renewable energy.

- In addition to RE, other strategies in the march towards decarbonisation of steel and aluminium industries could be as follows:

  a) **More Availability of Scrap is Must:** As India plans to increase its steel capacity to 300 million tonnes, scrap requirements will also increase considerably. India is a net importer of scrap. It is available from the Middle East, the EU, the US, and Southeast Asia, but all countries are under pressure to produce green steel and will use a higher percentage of scrap, leaving less for exports. The Ministry of Steel has analysed the demand for steel for the next 10 years, but that is yet to be published. The Vehicles Scrapping Policy is undoubtedly helpful, as 60–70% of cars are said to be replaceable. The idea is to generate enough domestic scrap, as it has zero emissions. An inventory of old buildings, vehicles, FMCG items, etc., must be made available, and a clear roadmap must be drawn. The scrap derived from steel processing must increase. A dedicated scrap recycling facility can be considered in a few countries, such as the EU, the UK, Australia, the US, etc. It is one of the best alternative solutions with relatively low investment.

  The government can also support FTAs, where India should include the free flow of scrap from partner countries while creating its scrap policy.

  b) **Recycling Must be Promoted:** It will further help to reduce CO_2 emissions. This is more suitable for the Indian aluminium industry, which is said to have a longer gestation period to move to RE sources. Also, aluminium is 95% recyclable. High-level recycling, even for scrap generated or bought, can be done at a larger scale.

  c) **Exploring Alternative Fuels at Scale is Required:** This will reduce costs and establish supply chains for some of the best alternatives like green hydrogen and biochar. An ecosystem needs to be developed in the medium to long run to upgrade the scale of development of alternative technologies for exploring alternative fuels. Here, technical institutions like IITs can work together with industry to coordinate the efforts of start-ups, hiring talent best suited for specialised avenues such as the production of green hydrogen. The government can act as the facilitator. Once economies of scale kick in, the cost of steel and aluminium will decline.

- MSMEs account for almost 35% of crude steel capacity in India and need to be linked to the supply chains of larger players. They must receive data regarding emissions when they import or buy from large manufacturers. It is the responsibility of large producers to facilitate the provision of data in a manner that assuages confidentiality concerns. Technical solutions, such as sharing the installation codes without the need to share actual emissions, are available. The government can offer more dedicated financial support to MSMEs to help them increase production scale, get their products to export markets, raise awareness about CBAM reporting, and make digital software and auditors available for them at minimal cost. MSMEs can access more sustainability-linked bonds and loans from banks dedicated to the cause.
- Another way to bring policy coherence is to monitor CO_2 emissions at each stage of the value chain (from the procurement of raw materials to when goods cross the border). Digitisation could help in downstream activities, reducing lead times and paperwork.

Technological leapfrogging is the ultimate mantra for transforming manufacturing and tackling climate change in developing nations like India. Surveys point to the lack of indigenous technologies and the attendant reliance on imports as a hurdle. India can overcome these challenges through a three-pronged approach:

(i) **Short-to Medium-Term—Technology Sharing:** The free flow of global knowledge and technologies is critical since achieving net-zero emissions is a collective objective. India needs a common platform where technology sharing can happen on a voluntary basis, and governments can sign an agreement to that effect.

(ii) **Long-Term—Developing Domestic Technologies:** Incentivising research and development through tax breaks, grants, and public–private partnerships is paramount. This can foster innovation in crucial areas, including carbon capture, renewable energy generation, improvements in energy efficiency, scrap generation, and advanced recycling facilities. India could aim to develop expertise in a few select technologies (like green hydrogen or biochar production) for future trade deals.

(iii) **Longer Term—Trading Technologies:** After the creation of new technologies, these can be traded for related technologies from other countries. The last two approaches require collective thinking at the B2B, G2G, and B2G levels, foregrounded in collaboration with India's technical institutes like the IITs.

Much like illusory promises made during electoral campaigns in democratic nations, developed countries have failed to meet their climate pledges to developing nations. Global climate compulsions have not disappeared; if anything, these have become more pressing than they were in 2009, when the promise was made. As emerging economies, we need to finance our own climate needs. Having our carbon tax and using revenue (which will be sizeable given India's large population of producers and exporters) as the seed fund may prove to be a boon, and not just a drop in the ocean.

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Appendix

Appendix A: Summary of the Research Framework: Policy and Strategic Options

<table>
<tr><th></th><th></th><th colspan="4">Options Before Firms</th></tr>
<tr><th></th><th></th><th>Continue exporting</th><th>Cessation of Exports</th><th>Change production location</th><th>Others (Own safe-guard mechanisms, plans to green manufacturing, etc.)</th></tr>
<tr><td rowspan="4">Options Before Government</td><td>Do Nothing</td><td>How will firms absorb the EU's carbon tax?</td><td>Can they afford to lose the EU market? What would be that impact?</td><td>Will they move some/all of the production? Where?</td><td rowspan="4">What is the possible extent of greening of manufacturing and safeguard mechanisms? If implemented well, how can these measures help Indian firms manufacture and competitively trade CBAM products?

What about the possibility of linking MSMEs with lead firms?</td></tr>
<tr><td>ETS</td><td>How will it compare to the EU's tax, and how will the difference be dealt with?</td><td>How will the ETS impact production for domestic uses? How can this be mitigated?</td><td>If firms export intermediates and do final output production in the EU, how will ETS costs play out?</td></tr>
<tr><td>Export Tax</td><td>What level of export tax will ensure that Indian exporters are competitive? How might/can the government 'pay back' the export tax to firms? How?</td><td>Will export tax eliminate the competitiveness of Indian exports? What about the volume of exports from firms/countries that do not have to pay an export tax (because they use green energy)?</td><td>Will export tax motivate firms to set up bases elsewhere?</td></tr>
<tr><td>Others (viz. making products competitive, providing relief measures/compensation to the affected exporters, converting existing duties into a carbon tax, etc.)</td><td colspan="3">What other options are available with the govt.?</td></tr>
</table>

Questions for Survey

A. What is your perspective on the impact of CBAM?

1. How will the implementation of CBAM affect exports to the EU? Can Indian companies afford to reduce or cease exports to the EU market?
2. What are specific challenges and opportunities due to CBAM, particularly in the following cases:
   a. Can India successfully fully implement its own ETS like the EU? How will ETS impact production for domestic uses?
   b. Can India have its own domestic export tax on all its exports or a specific export tax on CBAM products exported to the EU? [What level of export tax will ensure that Indian exporters are competitive?]
   c. Will domestic export tax motivate Indian firms to set up bases elsewhere?
3. How do we reach a consensus on the proper way of measuring and reporting carbon emissions?

B. To what extent are Indian companies prepared to adapt to or deal with CBAM implementation and ensure a smooth transition to ETS (Emissions Trading System) or Carbon Tax/Export Tax?

1. What is the company's strategy to ensure better compliance with CBAM in terms of (i) greening the internal production process, and/or (ii) moving some part of production outside India? [viz. How will ETS costs play out if firms export intermediates and do final output production in the EU?]
2. What has been the progress in implementing Internal Carbon Pricing (ICP) mechanisms within existing operations?
3. Has CBAM changed or affected your company's longer-term strategy for a green transition or led you to consider those innovations or technologies that can reduce carbon emissions?
4. How is your company working with ancillary suppliers to address CBAM requirements throughout the supply chain? Have there been any adjustments to sourcing strategies?
5. What about the possibility of linking MSMEs with lead firms to strengthen domestic value chains? [viz. What support can be provided to the MSMEs to make a green transition?]

C. What policy support is needed for a smooth transition?

1. What exact policy support from the government can the company benefit from?
2. What is the level of engagement of Indian companies and industrial associations with government, policymakers and multilateral organisations like WTO) regarding CBAM implementation?

Appendix B: The Jindal Storyline

1982: Helmed by Jindal Iron and Steel Company (JISCO), JSW Group's first steel plant was set up at Vasind, near Mumbai (Singh, 2023).

1990s: As a bold step, JSW became an early adopter of Corex technology—a more environmentally friendly, cost-efficient smelting-reduction process using iron ore and low-grade coal to produce hot metal, compared to traditional BF technology dominated at that time by major players like Steel Authority of India Limited (SAIL) and Tata Steel. This pioneering decision demonstrated JSW's willingness to embrace innovation for a greener future (JSW Steel, n.d.; Datta, 2011).

2002: JSW Steel integrated environmental responsibility into its core operations by adopting a comprehensive Integrated Quality, Environment, and Occupational Health and Safety Policy. This signifies a commitment to employee well-being and a healthy environment (JSW Steel, 2017).

2005: JISCO merged with Jindal Vijaynagar Steel Ltd (JVSL) to form JSW Steel, consolidating its position as a significant player in the Indian steel industry.

2006: JSW expanded its product portfolio with a new 1 MTPA cold-rolled (CR) steel plant, catering to sectors like automotive, consumer durables, and furniture with a more durable and versatile steel (Datta, 2011).

2015: JSW Steel became India's largest steel producer, overtaking the then-market leader Steel Authority of India Limited (SAIL) (Divekar, 2015).

2020: The Board of Directors adopted a "Climate Change Policy", which expanded on the company's commitment to measure and understand its carbon footprint, reduce its contribution to emissions, increase electricity from RE sources, promote climate change prevention amongst suppliers and business partners, and help local communities (JSW Steel, 2020). The company also formed the Climate Action Group (CAG), which comprised experts from various corporate functions. The aim was to facilitate coordinated action on climate change, assess related risks and opportunities, and develop mitigation strategies (JSW Steel, 2023a).

2021: JSW Steel positioned itself at the forefront of green hydrogen by joining the India H2 Alliance (IH2A). IH2A identified steel and cement as "priority industrial sectors" for decarbonisation where early adoption of hydrogen is possible. JSW's Chief Sustainability Officer, Prabodha Acharya, posited that leveraging green steel as a hydrogen product export could be a national strategy for asserting global hydrogen value chain leadership by integrating hydrogen into the industrial supply chain (India Hydrogen Alliance, 2021). JSW Steel raised US$1 billion by issuing sustainability-linked bonds (SLBs) and became the first steel company globally to do so in US dollars (Business Today, 2021). These actions solidify JSW's commitment to clean energy solutions and leadership in sustainable finance.

2022: The world's first steel slag-to-sand facility, boasting an 800 tonnes per-day capacity, was constructed and commissioned at JSW's Vijayanagar Works in June 2022. The initiative led to the recycling of nearly 270,000 tonnes of steel slag waste every year and a net reduction of approximately 100 tCO_2e/annum in Vijayanagar Works' carbon emissions (JSW Steel, 2024a).

JSW Steel earmarked Rs 10,000 crores to increase its use of renewable energy. JSW Steel secured contracts for 1 gigawatt (GW) of RE, with 225 MW commencing operations in April 2022 (PTI, 2022).

"JSW One" was launched as a one-stop digital marketplace for adoption by MSMEs and home solutions.

2023: JSW Steel's flagship decarbonisation project—SEED (Sustainable Energy Environment and Decarbonisation)—was recognised at COP28 as one of the top global Energy Transition Changemakers in "Heavy Emitting Sectors" (Manufacturing Today India, 2023). JSW Steel became a member of ResponsibleSteel™, a coalition of over 150 organisations and a global multi-stakeholder standard and certification initiative for responsibly sourced and manufactured steel, in January 2023 (JSW Group, 2023). In the same year, the World Steel Association recognised it as a Sustainability Champion for the fifth consecutive year. The award is granted based on a comprehensive performance report encompassing material efficiency, environmental management systems, lost-time injury frequency rates, employee training, investment in new processes and products, and economic value distributed, in addition to disclosing the Life Cycle Inventory (LCI) data for the World Steel Data Collection Programme (JSW Steel, 2023b).

2024: JSW Steel has strategically partnered with Coolbrook (a technology and engineering firm based in Finland) to use its RotoDynamic Heater™ (RDH™) technology to reduce carbon emissions at their manufacturing sites at Vijaynagar Works (Hill, 2024). JSW Steel, along with IKEA and Flipkart, is piloting electric trucks in their logistical fleets as part of the Climate Group's EV100+ initiative. The aim is to pilot 50 electric 40-tonne trucks by the end of 2024 and eventually scale up to 500 trucks across all operations in India by the end of 2040 (Climate Group, 2023).

2030: JSW Steel is planning to establish a green steel manufacturing facility with a capacity of 4 million tonnes by 2030 in response to the EU's CBAM (Suri & Mishra, 2023).

Appendix C: The Hindalco Storyline

Founded in 1958, Hindalco Industries, a subsidiary of Aditya Birla Group, established itself as a major force in the metals and mining segment. Valued at US$28 billion, Hindalco is renowned for its expertise in both aluminium and copper. Following its acquisition of Aleris Corporation (through its subsidiary, Novelis Inc., in April 2020), Hindalco became the world's largest producer of flat-rolled products and a leader in aluminium recycling (Hindalco, 2024a). Its subsidiary, Novelis, uses recycled metal for almost 60% of its aluminium consumption (used 2.3 million tonnes of aluminium scrap in 2022–2023) (Aditya Birla Group, 2023; Suri, 2023), significantly reducing the environmental footprint of production.

Hindalco, as an important integrated producer, has a global presence extending across 10 countries. It is actively expanding its RE portfolio, focusing on solar, wind, hydroelectric, and biomass sources. As of 2022–2023, its RE portfolio with such projects accounted for a capacity of 108 MW (Hindalco, 2024a).

Recognising the importance of sustainability, Hindalco has established a robust decarbonisation strategy for aluminium production. This strategy rests on three key pillars (TERI, n.d.):

1. **Reducing Energy Consumption and Changing Energy Mix:** This involves augmenting technology-driven growth (new smelters have AP-360 technology), improving energy efficiency (Utkal alumina refinery is an example), and implementing a greater number of renewable energy projects (viz. "projects at five locations totalling 48.7 MW which include the first Smelter in the country with 30 MW Solar Plant Synchronised at 220 KV with Thermal CPP Set up over a Fly ash filled waste land… projects at different phases of its implementation to take the total renewable capacity to 100+ MW" (TERI, n.d.)).
2. **Future Focus on Downstream Growth and Use of Recycled Aluminium:** Hindalco, through Novelis, is investing significantly in aluminium recycling capacities and moving towards a circular economy model.
3. **Product Stewardship Towards Aluminisation of Global Economic Growth:** Hindalco has pioneered in producing aluminium products which have positive spillover to many other sectors (such as those used to make solar panels, vehicles, buildings, etc.) in terms of CO_2 reduction potential and lower environmental impacts. Other examples are fuel-efficient aluminium bulkers with longer service life and lightweight, fuel-efficient freight trailers (the country's first all-aluminium).

Hindalco's commitment to sustainability is further evident in its ambitious goals. The company has pledged to achieve a 25% reduction in specific energy usage and GHG emissions by 2025, compared to a 2011–2012 baseline. The company targets achieving 300 MW of RE capacity by 2025 and ultimately becoming carbon neutral by 2050 (Aditya Birla Group, 2023). Furthermore, Hindalco is aiming for 30% of its energy mix to come from renewable sources by 2030, with projections suggesting it might even achieve this target earlier due to its innovative pumped hydro project and ongoing sustainability initiatives (Suri, 2024).

Hindalco demonstrates a strong commitment to responsible waste management. The company already recycles 84% of its generated waste and has set a goal of achieving zero-waste landfill status by 2030. It is also exploring cutting-edge solutions like piloting advanced mineralisation technologies for CO_2 sequestration. To further solidify its commitment, Hindalco allocates a significant portion (25%) of its annual maintenance capital expenditure towards sustainability projects.

These goals are backed by concrete actions and positive results. In 2022–2023, Hindalco achieved a significant 20% reduction in specific GHG emissions and a 19% decrease in specific energy consumption when compared to the baseline year (2011–2012). The company is actively expanding its renewable energy capacity with ongoing projects totalling around 71 MW. Furthermore, Hindalco has spent a significant amount (Rs 356.77 crores) on initiatives to maximise waste utilisation.

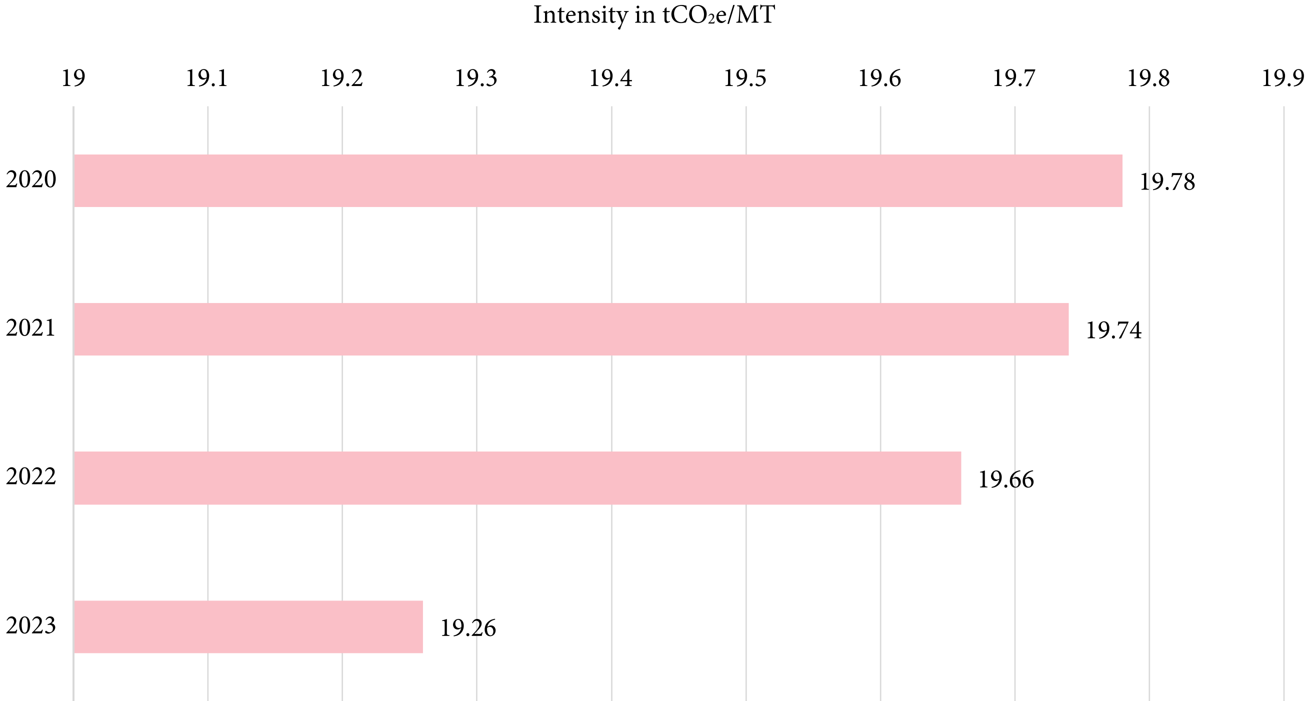
Hindalco effectively implemented an Internal Carbon Pricing (ICP) system that incentivises emission reduction. This system assigns a cost to their Scope 1 and 2 emissions, progressively increasing the price per tonne from US$31 during 2021–2030 to US$43 in 2031–2040 to US$59 for 2041–2050. While the company has increased its renewable energy consumption by 54% compared to 2021–2022, there is still room for improvement. In 2022–2023, RE accounted for only a small portion of their overall energy mix, i.e., 0.91 million GJ compared to 312 million GJ for non-renewable sources (primarily derived from fossil fuels) (Hindalco, 2023a).

Hindalco has established itself as a leader in sustainable practices within the aluminium industry, which extends beyond its traditional operations. Its success can be traced by looking at the timelines:

1. **2020:** Hindalco became the world's first to achieve 100% red mud utilisation across three of its refineries. It entered into a MoU with UltraTech Cement Ltd to find valuable applications for this by-product. It was agreed to deliver 1.2 million metric tonnes of red mud, also commonly referred to as bauxite residue (Bloxsome, 2020). This collaboration exemplifies the commitment to the principles of a circular economy.
2. **2022:** Hindalco entered an MoU with Phinergy, an Israeli leader in metal-air technology, and with IOC Phinergy Private Limited (IOP), which is a joint venture between Phinergy and Indian Oil Corporation. As per the MoU, Phinergy and IOP will collaborate exclusively with Hindalco in India for research and development and pilot production of aluminium plates for aluminium-air batteries, including the recycling process (Hindalco, 2022). This partnership represents a major step towards cleaner energy storage solutions and decarbonising the transportation sector. Hindalco also entered into an agreement with Greenko Group for developing large scale, i.e., 375–400 MW of solar and wind power capacity in Odisha (Suri, 2024).
3. **2023:** The company has been awarded the "Most Sustainable Aluminium Company" title by the S&P Dow Jones Sustainability Indices (DJSI) Ranking for four consecutive years (Hindalco, 2024b). Hindalco also received the Energy Transition Changemaker Award at COP28 for its pioneering round-the-clock renewable energy project supported by pumped hydro storage, a first in the aluminium industry (Aditya Birla Group, 2024). The company also actively advocates for transparency by supporting initiatives that track and report GHG emissions reductions, that is, public tracking of GHG emissions reduction, which is an initiative of the International Aluminium Institute (IAI), encouraging the entire industry to move towards a more sustainable future (Suri, 2023).

   As a result of such initiatives, Hindalco's GHG emission intensity of aluminium has been continuously falling since 2020 (Figure B).
4. **2024:** Hindalco is pioneering India's first copper and e-waste recycling project in Dahej, Gujarat. The company has secured 150 acres for this initiative, aiming to address the issue of e-waste imports due to limited domestic availability of metal extraction and refining capabilities (Indian Chemical News, 2024). This project, with an estimated investment of Rs 2,000 crore, aligns with India's goals of a circular economy by contributing to establishing metal extraction and refining technologies within the country (Business Standard, 2023). The company acquired a 26% stake in Ayana Renewable Power Four, a renewable energy company, for Rs 1.62 crore (The Economic Times, 2024).

Figure B: GHG Emissions Intensity of Aluminium by Hindalco



Source: Hindalco Annual Report 2022-23 (chemicals & specialty alumina are not covered).

5. **Plans for 2025:** Hindalco has announced plans to establish a battery foil manufacturing plant in Odisha to augment support for the electric vehicle (EV) market. Scheduled for commissioning in July 2025, the plant aims to address India's growing demand for battery-grade aluminium foil, which is estimated to reach 40,000 tonnes by 2030. With an investment of Rs 800 crore by Hindalco, the initial production capacity will be 25,000 tonnes. The facility will benefit from a co-located 25 MW solar power plant and access to additional solar energy from a 400 kV National Grid connection (Hindalco, 2023b).

About the authors

Rajat Kathuria is the Dean of the School of Humanities and Social Sciences and Professor of Economics at Shiv Nadar Institution of Eminence. He is the former Director and Chief Executive of the Indian Council for Research on International Economic Relations (ICRIER). He worked with the Telecom Regulatory Authority of India during its Initial years. He was the Co-chair of the T20 Digital Task Force under India's G20 Presidency.

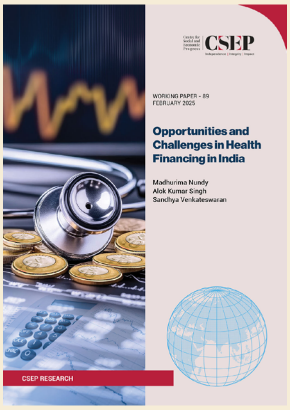
Rajat has over 20 years of experience in teaching and 25 years of experience in economic policy, besides research interests on a range of issues relating to regulation and competition policy. He has worked with the World Bank, Washington DC as a Consultant and carried out research assignments for a number of international organizations, including ILO, UNCTAD, LirneAsia, World Bank, and ADB. He has published in international and national journals, besides in popular magazines and newspapers. He is a founder member of the Broadband Society for Universal Access and has served on the Boards of the Delhi Management Association and the Micro Finance Institutional Network of India. He is on several government and industry committees and has been on the research advisor council of SBI. He has an undergraduate degree in Economics from St. Stephens College, a Masters from Delhi School of Economics, and a Ph.D. degree from the University of Maryland, College Park.

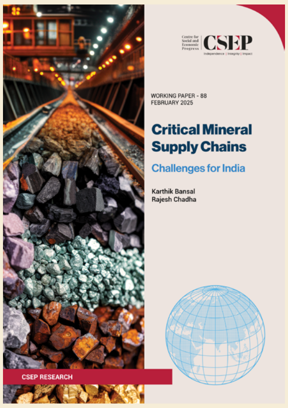
Neha Gupta is an International Trade Economist with 18 years of research experience, specializing in Global Value Chains (GVCs). She holds a Ph.D. in Economics from the Indian Institute of Technology Delhi (IIT Delhi) for her thesis on "Integration of India's manufacturing industries into GVCs." After serving as a Fellow (equivalent to Assistant Professor grade) at the Indian Council for Research on International Economic Relations (ICRIER) for eight years until 2024, she transitioned to consultancy and independent research. During this time, she has collaborated with esteemed organizations such as the Centre for Social and Economic Progress (CSEP), the Japan Economic Foundation, and the Confederation of Indian Industry (CII) on studies concerning the EU's Cross Border Adjustment Mechanism (CBAM), Free Trade Agreements, and manufacturing sector-wise GVC integration. Dr. Gupta represented India as a Panelist at the Japan Economic Foundation's Roundtable Discussion on "What is the Role of the Global South in Times of Turmoil?" on September 27, 2024. Her research interests and work areas encompass a broad range of topics, including GVCs, export competitiveness, industrial and trade policies, production networks, manufacturing (specifically Electronics, Automotive, Textiles & Garments, Steel, and Aluminium), Foreign Direct Investments, studies on Asian economies, supply chain resilience, trade agreements, G20, WTO, the role of the Global South, LDCs, Exports of CBAM-exposed products, and trade in yoga services. She has numerous national and international publications in these areas. Dr. Gupta's prior experience also includes serving as a UNDP Consultant at India's G20 Secretariat (Sherpa Track) within the Department of Economic Affairs, Ministry of Finance, and as a Research Associate at FICCI, New Delhi.

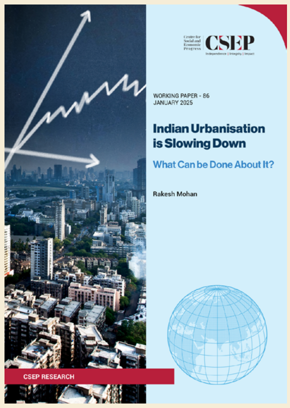
Navya Kumar is a Researcher at the Erasmus Commodity and Trade Centre (ECTC) in Rotterdam, The Netherlands, where she contributes to the center's applied research portfolio and teaching engagements. Her work focuses on the evolving dynamics of commodities trade and sustainability in Europe and beyond, translating complex research into actionable insights for industry stakeholders.

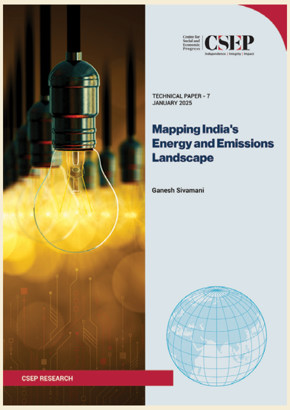
Before joining ECTC, Navya worked at the Institute for Competitiveness (IFC), gaining experience in economic analysis and policy advisory. This background informs her current work at the intersection of international trade, energy transition, and regional development, with a particular focus on carbon markets, critical raw materials, and the trade of ammonia as a hydrogen carrier. In addition to her research projects, she assists in teaching a Scenario Planning course at Erasmus University Rotterdam. Navya was awarded the Erasmus Mundus scholarship and earned a joint master's degree from the University of Glasgow, Erasmus University Rotterdam, and Universitat de Barcelona. She completed her undergraduate studies at Miranda House, Delhi University.

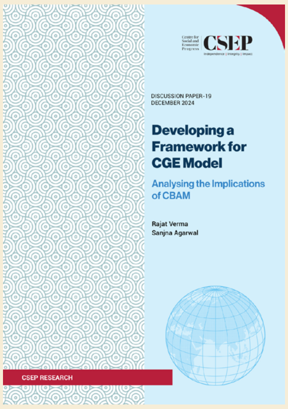
Other publications

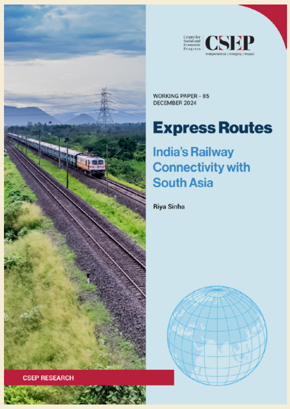


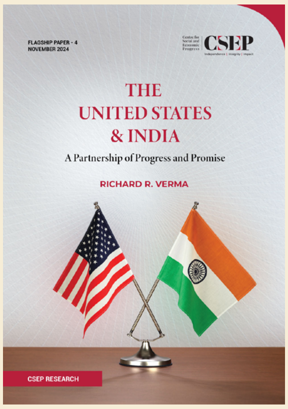


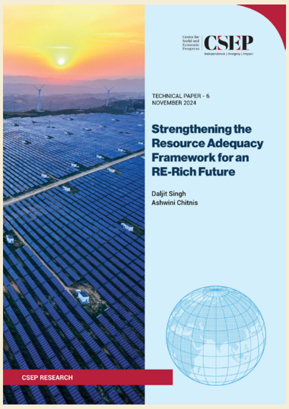


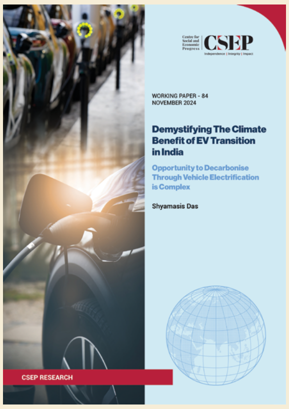


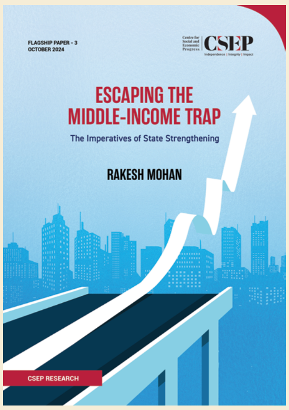


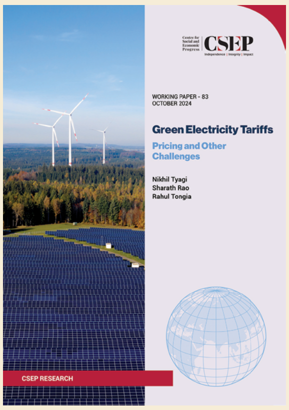


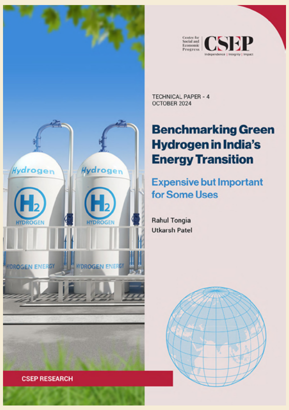


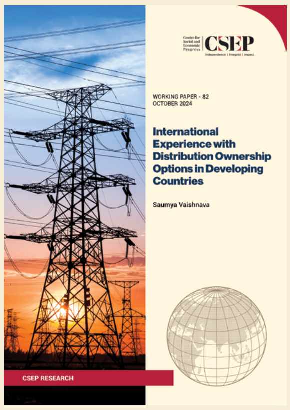












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