EXPLORING INDIA'S GREEN TRADE: A PATHWAY TO SUSTAINABLE ECONOMIC GROWTH

EXPORT-IMPORT BANK OF INDIA

Exploring India's Green Trade: A Pathway to Sustainable Economic Growth

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CONTENTS

Project Team

Export-Import Bank of India	**Environmental Management Centre Pvt. Ltd.**
Dr. Viswanath Jandhyala, Deputy General Manager	Dr. Shilpi Kapur, Senior Vice President
Ms. Alfiya Ansari, Manager	Mr. Gaurao Chopade, Senior Environmental Engineer
Mr. Siddharth Nema, Manager	

LIST OF TABLES

LIST OF CHARTS

Executive Summary

Climate change is a global commons problem where coordinated action across nations produces far greater benefits than fragmented efforts. The combined benefits of coordinated climate action far surpass the aggregate costs. This creates a strong case for international cooperation and shared responsibility.

India, as one of the world's largest and fastest-growing economies, stands at a pivotal juncture. India has already exceeded major Nationally Determined Contribution (NDC) targets well ahead of schedule. With revised NDCs till 2035 expected to be announced by the Government of India, India is reinforcing its commitment to transparency and accountability in climate governance.

By lowering barriers, greening supply chains, and effectively using trade agreements with partner countries, India could integrate sustainability into its manufacturing-led trade to ensure continued growth momentum, while meeting climate goals.

Global Landscape and Trends

The shift from fossil fuels to renewable energy is redefining comparative advantage, which now depends less on resource endowments and more on renewable energy potential, technological capability, and innovation ecosystems. Major economies like China and the EU are already leveraging these shifts through large-scale clean-energy policies such as China's 14th Five-Year Plan and the EU's Green Deal, supported by abundant land and low-cost capital. For India, like a few other major developing economies, the challenge is to raise living standards for a growing population while meeting NDC commitments and adapting to escalating environmental impacts. Aligning trade policy with climate goals could be crucial for India to seize new opportunities and avoid disruptions during the low-carbon transition.

Environmental Goods

As global climate action accelerates, trade policy is increasingly seen as essential for environmental sustainability, with Environmental Goods (EGs) playing a central role. EGs as defined by the International Monetary Fund (IMF) include both goods connected to environmental protection, such as goods related to pollution management and resource management, and adapted goods, which are goods that have been specifically modified to be more "environmentally friendly" or "cleaner"[1]. Various regional grouping/ institutions including WTO and OECD have offered identification and classification of EGs, but lack of consensus among members stalled progress and failed to conclude. This study uses the Asia-Pacific Economic Cooperation (APEC) list of EGs because it better reflects developing-country needs.

[1] Macroeconomic Climate Indicators Dashboard, IMF (https://climatedata.imf.org/datasets/8636ce866c8a404b8d9baeaffa2c6cb3_0/about)

India's Sustainability-Trade Nexus

Sustainability has shifted from a peripheral concern to a central force shaping global trade, driving changes in regulations, market access, supply chains, and financing decisions. Governments are increasingly embedding sustainability criteria into trade agreements and border measures, while businesses are incorporating environmental and social metrics into operations and investment strategies. This shift is visible in the rise of green trade instruments such as carbon border mechanisms, product sustainability standards, and disclosure mandates, which now influence competitiveness across markets. As financiers and investors link trade finance and capital flows to Environmental, Social, and Governance (ESG) performance, sustainability has become a foundational determinant of economic resilience and trade advantage.

India's evolving climate commitments, articulated through its NDCs, reflect this global transformation. Having achieved its initial goals of reducing emissions intensity and expanding non-fossil fuel power capacity well ahead of time, India has now further strengthened its 2030 targets. These commitments support broader ambitions in renewable energy expansion, electric mobility, energy storage, and climate-resilient development while generating opportunities for green jobs and technological innovation. The policy momentum also strengthens India's emerging role in EGs, a sector that aligns economic growth with environmental objectives. By developing capabilities in renewable energy technologies, waste management systems, water treatment solutions, and energy-efficient equipment, India is positioned to capture new export opportunities, as global demand for green technologies rises. At the same time, environmental regulations particularly those introduced by the EU, such as Carbon Border Adjustment Mechanism (CBAM), Ecodesign for Sustainable Products Regulation (ESPR), EU Deforestation Regulation (EUDR), and Corporate Sustainability Due Diligence Directive (CSDDD) are reshaping global trade conditions by making sustainability compliance a prerequisite for market entry. India's strategy to expand EGs exports, enhance supply-chain transparency, and upgrade industrial processes is, thus, tightly linked to maintaining competitiveness.

The recently concluded India-EU Free Trade Agreement aims to facilitate trade in low-carbon goods and technologies, supported by EU technical and financial assistance, though without exemptions from environmental regulations like CBAM. While compliance obligations may impose new burdens on Indian exporters, the provisions in the FTA on cooperation, recognition of verifiers, and potential alignment of carbon pricing systems create pathways to ease adjustment. By integrating sustainability into its trade framework, India could convert regulatory pressures into strategic advantage, reinforcing its position in global value chains, while advancing national prosperity and contributing to global climate goals.

Trade in Environmental Goods

Between 2015 and 2024, global trade in EGs expanded rapidly, driven by rising sustainability commitments and clean-technology adoption. Based on the APEC list of EGs, global exports more than doubled from US$ 246.9 billion in 2005 to US$ 542.5 billion in 2024, reflecting the growing importance of green technologies in industrial transformation and climate policy.

Global Exports: In 2015, China, Germany, and USA dominated EG exports with a combined share of 40.7%, supported by strong industrial capacity, innovation ecosystems, and large-scale deployment of renewable technologies. China's position was further reinforced by its control over rare earth elements and integrated manufacturing chains for solar PV and batteries. By 2024, concentration at the top intensified, with these three economies jointly accounting for 44.1% of global exports. Meanwhile, emerging economies such as

India expanded their participation, with India's share more than doubling from 0.7% in 2015 to 1.6% in 2024, supported by domestic manufacturing initiative like the 'Make in India' and 'Production Linked Incentive' (PLI) schemes and rising global demand for renewable energy equipment.

Global Imports: Global import trends during this period also shifted in response to energy transitions and supply-chain realignments. In 2015, China (accounting for 19.8% of global imports) was the world's largest EG importer, due to its rapid industrialization and renewable-energy drive. However, by 2024, USA (accounting for 16.3%) emerged as the top importer, driven by significant clean-energy investments and policy incentives. China's import share nearly halved as it localized production and became a major exporter. India's share in global imports grew from 1.8% in 2015 to 3.3% in 2024, reflecting its accelerating renewable energy targets and increasing thrust on environmental monitoring, among others. India's EG import bill rose to nearly US$ 18 billion by 2024, with strong demand for advanced analytical instruments, purification systems, and photovoltaic components.

Leading Environmental Goods in Global Trade

Across global markets, renewable-energy-related goods, solid and hazardous waste management equipment, and environmental monitoring instruments emerged as the leading traded segments. Photovoltaic cells experienced particularly rapid expansion, peaking at over US$ 66 billion in global exports in 2023, while machinery used for waste processing and recycling continued to grow steadily. Demand also surged for instruments used in pollution tracking, industrial process optimization, and regulatory compliance driven by stricter global environmental standards and the shift toward circular economy practices.

India's Trade in Environmental Goods

For India, the evolving landscape presents both opportunities and structural challenges. India ranks as the sixth-largest global market for environmental technologies exports[2].

Exports: India's EG exports grew at a CAGR of 12.7% between 2015 and 2024, more than double the growth rate of its overall exports, indicating a gradual shift towards higher-value green manufacturing. India's share in global exports of EGs has gradually increased from 0.7% in 2015 to 1.6% in 2024, amounting to US$ 8.5 billion. The largest export market for India's EG exports was USA, with a share of 34.9% in total EG exports of India, as it is one of the largest solar markets in the world. Other markets for India's EG exports include Germany (5.9%), UAE (4.3%), Saudi Arabia (2.9%), China (2.8%), among others. Key export drivers include photovoltaic modules, electric-motor components, gasturbine parts, and specialized environmental machinery.

Imports: India's EG import bill has risen sharply in recent years, increasing from about US$ 7.2 billion in 2015 to US$ 17.9 billion in 2024. Within EGs, the composition of imports reveals a clear shift towards low-carbon energy equipment, particularly solar value chain products. India's EG imports are highly concentrated, with China alone accounting for 44.1% of total EG imports. Other major import sources include Germany (9.4%), USA (6%), Singapore (5.8%), among others. PV cells and modules emerge as major items, accounting for cumulative imports of around US$ 4.5 billion in 2024, reflecting India's rapid scaling-up of solar generation

[2] International Trade Administration, USA: India Country Commercial Guide (https://www.trade.gov/country-commercial-guides/india-environmental-technology)

capacity under its climate commitments. Machinery, instruments, and parts used for measurement, control, and purification are among the other dominant EG imports for India.

Revealed comparative advantage analysis shows that India holds competitive strength in about one-third of EG categories, particularly in renewable-energy components and industrial machinery, while lacking competitiveness in precision instruments and high-tech analytical devices. Going forward, strategic industrial upgradation, deeper integration into global value chains, and diversification of import sources would be essential for strengthening India's role in the global green economy.

Regional Benchmarking of India's Environmental Goods Trade

Global trade is undergoing a profound shift as sustainability becomes a central pillar of economic policy and international commerce. Countries are aligning trade strategies with environmental objectives, which is creating new opportunities in low-carbon technologies while raising the bar on standards, compliance, and competitiveness. Exporters and policymakers now face a dual challenge of scaling green industries and meeting evolving regulatory and market expectations.

In Asia, this transition is particularly dynamic. The region's rapid industrialization, integration in global supply chains, and diverse economic structures are shaping distinct pathways toward greener trade. Southeast Asian economies alongside India are seeking to balance growth with environmental responsibility by adopting clean technologies, circular economy practices, and greener manufacturing systems. The pace and depth of this shift vary widely, reflecting differences in regulatory maturity, technological capabilities, domestic demand, and resource endowments across countries.

Against this backdrop, understanding India's position relative to its Southeast Asian peers is essential for strategy. Besides India, the study focuses on five strategically important Southeast Asian economies viz. Singapore, Vietnam, Malaysia, Thailand, and Indonesia, within the context of green trade. Across these five countries along, with India, aggregate EG exports rose from US$ 18.1 billion in 2010 to US$ 46.8 billion in 2024 (witnessing a CAGR of 6.5%).

Adapting to Environmental Regulations

Governments and regulatory institutions across major economies are embedding environmental standards into trade frameworks in order to address climate change, resource depletion, and ecological degradation. As a result, environmental regulations are no longer limited to domestic policy measures; they increasingly function as instruments shaping global trade flows and supply chains.

India's approach to environmental regulation is closely linked to its commitments under the Paris Agreement and its Nationally Determined Contributions (NDCs). These policy targets are reshaping domestic environmental regulation, stimulating investment in renewable energy, energy efficiency, and green technologies.

Domestic environmental regulations are also creating demand for environmental technologies and services. India faces persistent environmental challenges, including severe air pollution, water contamination, and waste management pressures associated with rapid urbanization and industrial growth. Government initiatives such as the National Clean Air Programme and stricter emission standards for power plants have accelerated investments in pollution control technologies, water treatment systems, and environmental monitoring

equipment. These regulatory initiatives not only address environmental concerns but also stimulate domestic production and trade in environmental goods such as renewable energy components, filtration equipment, and monitoring instruments.

While domestic regulation is driving internal transformation, the most immediate pressures on Indian exporters arise from environmental regulations implemented by major trading partners, particularly the European Union. Developed economies are increasingly introducing regulatory frameworks that internalize environmental costs into international trade. Unlike traditional trade barriers such as tariffs or quotas, these measures influence market access through sustainability requirements, carbon accounting obligations, and supply chain transparency standards. They apply across a broad range of sectors, including steel, aluminium, textiles, leather, agricultural commodities, and chemicals, thereby affecting large segments of India's export economy.

Among the many regulations introduced, three key regulatory instruments introduced by the European Union illustrate this transformation: the CBAM, the EUDR, and the ESPR which incorporates the Digital Product Passport (DPP). Together, these measures represent a comprehensive framework that integrates sustainability criteria into international trade by imposing environmental performance requirements across the lifecycle of products and throughout global supply chains.

CBAM represents the most direct economic instrument within this framework. Implemented following a transitional reporting phase, CBAM imposes carbon costs on imports equivalent to those faced by European producers under the EU Emissions Trading System. The mechanism initially targets carbon-intensive sectors such as cement, iron and steel, aluminium, fertilizers, hydrogen, and electricity. Importers must report the embedded emissions associated with imported products, including both direct production emissions and indirect emissions from electricity consumption. For Indian exporters, this creates a new compliance obligation requiring verified emissions data and transparent carbon accounting systems. Failure to provide verified data may result in the application of default emissions values based on the most carbon-intensive European producers, significantly increasing compliance costs and reducing price competitiveness.

Beyond carbon pricing, the EUDR introduces strict requirements for traceability in supply chains linked to land-use change. The regulation requires companies placing certain commodities on the EU market to demonstrate that their products are not associated with deforestation after a specified cut-off date. It applies to commodities such as cattle, soy, coffee, cocoa, palm oil, rubber, and timber, as well as derivative products including leather, furniture, and tyres. Compliance requires companies to submit detailed due diligence statements supported by geolocation data identifying the precise origin of raw materials. For Indian exporters, particularly those in leather and agricultural value chains, these requirements introduce new logistical and administrative challenges due to fragmented supply chains and the prevalence of smallholder producers.

The ESPR complements these measures by establishing product-level environmental performance standards. Unlike CBAM and EUDR, which focus primarily on carbon emissions and land-use impacts, ESPR addresses the broader lifecycle sustainability of products. The regulation mandates standards related to durability, repairability, recyclability, energy efficiency, and the elimination of hazardous substances. Compliance is facilitated through the DPP, a digital documentation system that records sustainability attributes and lifecycle data accessible through QR-based tracking mechanisms. Implementation will occur gradually across sectors such as textiles, electronics, furniture, metals, and chemicals over the coming decade.

Together, these regulatory measures signal a fundamental shift in global trade governance. Environmental sustainability is no longer treated as a voluntary corporate commitment or a premium market attribute. Instead, it has become a baseline requirement for participation in international markets. Exporters must now demonstrate compliance with carbon accounting frameworks, sustainable sourcing requirements, lifecycle product standards, and full supply chain traceability. These obligations fundamentally alter the cost structures and operational strategies of firms participating in global trade.

Impact of Environmental Regulations on India's Trade

For India, the implications are particularly significant because many of the affected sectors represent major export industries. Carbon-intensive sectors such as steel and aluminium are directly exposed to CBAM compliance costs. Agricultural and leather exports face traceability obligations under the deforestation regulation. Textile exports, while not directly subject to CBAM, must comply with ESPR's circular economy requirements, including restrictions on hazardous chemicals and mandates for product durability and recyclability. Small and medium enterprises, which form the backbone of India's export sector, may face disproportionate compliance burdens due to limited technological capacity, fragmented supply chains, and limited access to environmental monitoring systems.

Adaptation and Mitigation Strategies to Comply with Environmental Regulations

Despite these challenges, environmental regulations also create opportunities for technological upgrading and market differentiation. Firms that adopt cleaner production technologies and improve resource efficiency could enhance their competitiveness in global markets increasingly shaped by sustainability criteria. Products certified as environmentally sustainable often command price premiums, while compliance with international environmental standards can facilitate access to environmentally conscious consumers and ESG-linked financing. As the global market for green technologies expands, early adoption of sustainable production practices can provide first-mover advantages for Indian industries.

The recently concluded India-EU Free Trade Agreement reflects this evolving relationship between trade and environmental governance. The agreement promotes cooperation in low-carbon technologies, renewable energy development, and sustainable resource management while providing tariff reductions for certain green goods. Although the agreement does not exempt India from compliance with CBAM requirements, it establishes mechanisms for technical cooperation, carbon data verification, and financial support to assist Indian industries in adapting to emerging regulatory standards. These provisions aim to facilitate technology transfer, support decarbonization efforts, and reduce compliance costs for Indian exporters.

Looking ahead, successfully navigating the emerging regulatory landscape will require coordinated action across government, industry, and financial institutions. Strengthening domestic environmental regulation, developing robust systems for emissions measurement and reporting, expanding manufacturing capabilities in environmental goods, and investing in digital supply chain traceability will be essential. Integrating sustainability considerations into trade and industrial policy could enable India to convert regulatory pressures into strategic advantages.

By proactively adapting to evolving environmental standards and strengthening its capabilities in green technologies, India could safeguard its export competitiveness while advancing its broader goals of sustainable development and climate resilience.

Policy Recommendations and Way Forward

In the evolving landscape of global trade, environmental sustainability has become a central priority shaping policies, regulations, and economic strategies worldwide. Following policy recommendations outline a strategic pathway for India to strengthen its leadership and resilience in the global EGs trade ecosystem and become prepared towards the emerging global green norms. These measures include i). establishing a centralised environment trade body tasked to monitor international environmental trade regulations, publish sector-specific reports, and highlight high-potential goods with strong environmental relevance; ii). pursuing Mutual Recognition Arrangements (MRAs) with key partner countries to harmonize technical standards and certification requirements for environmental products; iii). increasing use of AI for enhanced deployment of renewable energy; iv). establishing dedicated export promotion zones for renewable energy technologies supported by infrastructure, logistics, and regulatory facilitation; v). developing green energy corridors to reduce power losses, improve grid reliability, and allow trading of clean energy across regions or even countries; and vi). extending green trade measures beyond environmental compliance to encompass social standards, labour rights, and resilient supply chain governance.

1. Introduction

Climate change is widely recognized as a classic global commons problem. In this context, individual nations often perceive that the immediate costs of implementing climate action, such as transitioning to clean energy, investing in green infrastructure, or enforcing stricter environmental regulations, may outweigh the direct benefits they receive. However, when viewed collectively, the combined benefits of coordinated climate action far surpass the aggregate costs. This creates a strong case for international cooperation and shared responsibility.

As the global narrative shifts from mere awareness to tangible action, the emphasis is increasing on building resilient and regenerative economies that can withstand climate shocks while promoting long-term sustainability. For emerging economies, this transition is particularly critical.

India, as one of the world's largest and fastest-growing economies, stands at a pivotal juncture. India has demonstrated significant progress in meeting and even surpassing some of its Nationally Determined Contribution (NDC) targets under the Paris Agreement. At COP30 in Brazil, the Government of India announced its continued commitment to ambitious climate action. Notably, India's emission intensity has already declined by over 36% compared to 2005 levels[3], attributed to substantial improvements in energy efficiency and low-carbon growth. Furthermore, non-fossil fuel sources now account for more than 50% of India's total installed electric power capacity, currently estimated at around 256 GW, a milestone achieved five years ahead of the 2030 target. This achievement underscores India's proactive approach to accelerating its clean energy transition.

The government also confirmed that revised NDCs till 2035 will be announced, alongside the timely submission of India's first Biennial Transparency Report[4], reinforcing its commitment to transparency and accountability in climate governance.

However, India's climate commitments must not only align with global decarbonization goals but also integrate with its domestic priorities of inclusive growth, circular economy and energy security. The challenge and opportunity, lies in designing policies that deliver climate resilience while advancing development objectives and building resource security. This requires innovatively leveraging green technologies, fostering innovation, and creating policy frameworks that incentivize sustainable practices across sectors. Given its scale, demographic trends, and developmental aspirations, India's approach is poised to significantly influence global climate outcomes.

[3] PIB, Parliament Question: - Nationally Determined Contributions (NDCs) (https://www.pib.gov.in/PressReleasePage.aspx?PRID=2146355&reg=3&lang=2)

[4] GOI PIB release dated November 18, 2025 https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=2191067&reg=3&lang=2

An often-underutilized lever in the global climate agenda is international trade, which has the potential to play a transformative role in accelerating the transition to a cleaner and more sustainable future. Trade has the potential to facilitate access to energy-efficient and low-carbon goods, technologies that advance circular economy, and climate-resilient innovations, enabling countries to scale up their energy transition and adaptation efforts more effectively.

By reducing barriers to green technologies and fostering inclusive, sustainable development, trade could complement domestic climate policies and amplify their global impact. This underscores the need to integrate climate considerations into trade policy frameworks, promote green supply chains, and leverage trade agreements to incentivize low-carbon production and consumption. As India positions itself as a global manufacturing hub, embedding sustainability into its trade strategies will be critical for safeguarding economic growth while meeting climate commitments.

1.1 Global Landscape and Trends

Ensuring a sustainable future for the globe that benefits all countries requires a universal, equitable, and rules-based multilateral trading system, with international trade serving as a key engine of growth and development. This is a defining challenge for the global economy as climate action reshapes traditional trade dynamics. The ongoing energy transition, from fossil fuels to renewable sources, is fundamentally altering patterns of comparative advantage, determining which countries and regions are best positioned to produce and trade goods efficiently in a low-carbon economy. Historically, comparative advantage was largely driven by factor endowments, favouring resource-rich nations. However, the green transition introduces new determinants, placing greater emphasis on renewable energy availability, technological capability, and innovation ecosystems. This shift is inevitably expected to redistribute comparative advantages and reshape global trade patterns.

Major economies such as China and the European Union (EU) are already capitalizing on their potential for renewable energy production and positioning themselves as dominant and competitive players in the emerging renewable energy market through large-scale policy initiatives. China's 14^{th} Five-Year Plan on Modern Energy System Planning and the EU's Green Deal, illustrate the scale of commitment toward clean energy transitions. These economies benefit from structural advantages such as vast landmasses that allow them to harness diverse solar and wind resources, coupled with access to low-cost capital for financing green infrastructure.

India, like other major developing economies, faces a triple challenge of improving living standards for a large and growing population, remaining committed to its NDC goals, and simultaneously addressing the escalating impacts of environmental change. Consequently, for India aligning trade policy with climate objectives will be critical to harness these opportunities while mitigating risks of trade disruptions during the transition.

1.2 Environmental Goods

As global efforts to combat climate change intensify, trade policy is increasingly being recognized as a critical enabler of environmental sustainability. One of the most significant areas of focus within this nexus is the promotion of Environmental Goods (EGs). EGs as defined by the International Monetary Fund (IMF) include both goods connected to environmental protection, such as goods related to pollution management and

resource management, and adapted goods, which are goods that have been specifically modified to be more "environmentally friendly" or "cleaner."[5]

The rationale behind accelerating trade in EGs is clear, as these have the potential to accelerate greener practices, particularly in developing economies where cost remains a major constraint. By facilitating access to clean technologies, EGs trade can help countries meet their climate commitments while fostering sustainable industrial growth.

The identification and classification of EGs within the multilateral trading system began under the Committee on Trade and Environment Special Session (CTESS) of the World Trade Organization (WTO). Between 2002 and 2005, nine member countries submitted proposals outlining products considered environmentally beneficial. To consolidate these inputs, the WTO Secretariat compiled a comprehensive synthesis list of 480 items, encompassing a wide range of goods, from renewable energy technologies to pollution control equipment, based on the submissions received from the nine members who submitted the proposal[6]. However, due to no consensus among the members, progress on this list came to a halt. Till date Environmental Goods and Services (EG&S) do not have a precise definition agreed among the WTO members. However, some WTO members have attempted to resolve this by listing products of interest to them. These products generally fall into six categories, namely, air pollution control, renewable energy, waste management and water treatment, environmental technologies (i.e. emission reduction, heat and energy management, environmental monitoring equipment), carbon capture and storage, and other areas that may deal with disposal, natural resource protection, among others[7].

Following this various regional grouping/institutions have offered to propose definitions for EGs, for instance, the Organisation of Economic Co-operation and Development (OECD) has defined the EG&S industry as "activities which produce goods and services to measure, prevent, limit, minimise or correct environmental damage to water, air and soil as well as problems related to waste, noise and ecosystems"[8].

A better aligned comprehensive list of 153 items in 2009 was submitted jointly by the popularly called 'Friends of Environmental Goods' group, also known as the 'Friends' List'. Parallelly, the Asia-Pacific Economic Cooperation (APEC) agreed in 2012, on a list of 54 EGs, committing to reduce tariff rates on these items to 5% or less by 2015. In 2022, APEC expanded this initiative by adding seven new goods to reflect evolving environmental priorities (so the updated APEC list now has 61 EGs).

In early 2014, WTO agreed to transform the EGs from a multilateral to plurilateral negotiating initiative. The Environmental Goods Agreement (EGA) negotiations were launched in 2014 by 14 members, representing nearly 90% of global trade in environmental goods. Building on the 2012 APEC initiative, which targeted tariff reductions on 54 EGs, the EGA aimed to broaden this list and liberalize trade in a wider range of products. By

5 Macroeconomic Climate Indicators Dashboard, IMF (https://climatedata.imf.org/datasets/8636ce866c8a404b8d9baeaffa2c6cb3_0/about)

6 Synthesis of Submissions on Environmental Goods, WTO (https://www.jmcti.org/2000round/com/doha/tn/te/tn_te_w_063.pdf). The nine members include Canada, the European Communities, Japan, Korea, New Zealand, Qatar, Switzerland, Chinese Taipei and the United States.

7 Glossary, WTO (https://www.wto.org/english/thewto_e/glossary_e/environmental_goods_and_services_e.htm)

8 Environmental Goods, A Comparison of the APEC and OECD Lists, OECD (https://www.oecd.org/content/dam/oecd/en/publications/reports/2005/11/environmental-goods_g17a175b/274615168441.pdf)

late 2015, participation expanded to 18 members[9], covering 46 WTO members collectively, with around 450 products being identified for potential inclusion, spanning renewable energy, energy efficiency, air pollution control, and waste management. Despite significant progress and convergence reported in 2015, and an intensive ministerial phase in December 2016, negotiations failed to conclude due to unresolved differences. While the agreement was not finalized, the process laid important groundwork for future discussions on the trade-environment nexus and reinforced the role of trade in advancing global climate objectives.

The APEC's list forms the basis for the analysis undertaken in this study, as it offers a balanced set of EGs that better reflect the capabilities and trade interests of developing countries. The WTO list, in contrast, is believed to be overly tech-heavy, favouring advanced industrial economies, while the OECD list, though analytically useful, lacks contextual relevance and may not adequately represent the trade realities or environmental priorities of the Global South.

[9] including the European Union (EU)

2. India's Sustainability-Trade Nexus

Sustainability has moved from the margins to the mainstream of global trade, reshaping regulations, supply chains, consumer demand and financing decisions across markets. Governments are integrating sustainability criteria into trade agreements and border measures, while businesses embed environmental and social metrics into their operational processes, supply chain management and investment strategies. This transformation is evident in the proliferation of green trade instruments including border carbon mechanisms, product sustainability regulations, and disclosure mandates, that now shape market access conditions. Simultaneously, financiers and investors increasingly prioritize environmental, social, and governance (ESG) factors, linking access to trade finance and capital with credible sustainability performance. This systemic shift underscores that sustainability is no longer optional but a core determinant of trade competitiveness and resilience in today's global economy.

2.1 India and its NDCs

Nationally Determined Contributions (NDCs) are central to global climate efforts, encapsulating each country's targets to reduce emissions and adapt to climate change impacts under the Paris Agreement. India's sustainability commitment is strongly reflected in its NDCs, which are the foundation of its climate policy framework. As a party to the United Nations Framework Convention on Climate Change (UNFCCC) and its Paris Agreement, India submitted its first NDC in the year 2015 comprising, inter-alia, of following two quantifiable targets:

i. To reduce the emissions intensity of its GDP by 33% - 35% by 2030 from 2005 level; and

ii. To achieve about 40% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030.

These two targets have been achieved well ahead of the time[10]. As on October 31, 2023, the cumulative electric power installed capacity from non-fossil fuel-based energy resources is 186.46 MW, which is the 43.8% of the total cumulative electric power installed capacity. Moreover, India's emission intensity of its GDP has been reduced by over 36% compared to 2005 levels[11].

In August 2022, India updated its NDC according to which target to reduce emissions intensity of its GDP has been enhanced to 45% by 2030 from 2005 level, and the target on cumulative electric power installed capacity from non-fossil fuel-based energy resources has been enhanced to 50% by 2030.

[10] PIB, Ministry of Environment, Forest and Climate Change (https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1987752&reg=3&lang=2)

[11] PIB, Parliament Question: - Nationally Determined Contributions (NDCs) (https://www.pib.gov.in/PressReleasePage.aspx?PRID=2146355&reg=3&lang=2)

Looking forward, India's NDC roadmap emphasizes transformative actions like scaling renewable energy capacity, advancing energy storage and electric mobility, and strengthening climate resilience across agriculture, water, and urban planning. Emerging green technologies such as carbon capture, usage, and storage (CCUS) will be pivotal in emissions reduction efforts. With a population exceeding 1.4 billion, India's NDC commitments also present vast opportunities for green jobs, sustainable development, and leadership in climate innovation, serving as a model for developing countries worldwide.

India's involvement in the accomplishment of these NDC goals encourages domestic producers to innovate and expand in cleaner, greener technologies. This policy driven transformation is reflected in India's growing trade of environmental goods with countries seeking to meet their own climate commitments.

2.2 Environmental Goods and Sustainability

India's expanding engagement in EGs trade[12] represents a strategic opportunity to align commercial growth with environmental imperatives from pollution control and resource efficiency to cleaner production systems. As global demand for EGs accelerates, driven by climate commitments and green industrial transitions, India's ability to strengthen its manufacturing capabilities in this sector will be critical for export competitiveness.

The shift toward EGs signals a transformation from volume-driven to value-driven exports, where sustainability becomes a source of competitive advantage rather than a compliance burden. Building deep expertise across EGs, spanning renewable energy technologies, waste management systems, water treatment solutions, and energy-efficient equipment will enable India to capture higher-value segments of global supply chains while reducing its own environmental footprint.

Moreover, positioning India as a reliable supplier of quality environmental goods can unlock new export markets, particularly as countries implement their NDCs and seek low-carbon technologies. This dual advantage enhancing domestic environmental outcomes while expanding export opportunities makes EGs trade a cornerstone of India's sustainability-oriented trade strategy and a meaningful contribution to global climate action.

2.3 Environmental Regulations Reshaping International Trade

India's strategic focus on climate resilience has explicit implications for trade. As global environmental regulations tighten, markets value sustainable and environmentally friendly goods. India's involvement in the accomplishment of its NDC goals encourages domestic producers to innovate and expand in cleaner, greener technologies. These policy shifts are reflected in India's growing trade of environmental goods to countries seeking to meet their own green commitments.

Connecting these developments, India stands to gain by strengthening its exports of EGs by way of employment opportunities and early trade advantages. This nexus not only benefits India's growth and resilience but also contributes meaningfully to collective international efforts towards addressing climate change.

Environmental regulations are reshaping the architecture of international trade through an expanding web of interconnected mandates established primarily by developed economies, with the European Union

12 Will be discussed in detail in chapter 3

leading this regulatory transformation. Unlike traditional trade barriers that focus solely on tariffs or quotas, these measures internalize environmental and social costs into trade pricing, market access conditions, and preferential treatment. Critically, they apply horizontally across a broad spectrum of traded products including steel, aluminium, chemicals, textiles, leather, agricultural commodities, and are not confined to designated EGs alone.

Key regulatory instruments driving this shift include the Carbon Border Adjustment Mechanism (CBAM), which imposes carbon costs on imports based on their embedded emissions; the Ecodesign for Sustainable Products Regulation (ESPR), which mandates circular design principles and product durability; the EU Deforestation Regulation (EUDR), which requires proof of deforestation-free sourcing; and the Corporate Sustainability Due Diligence Directive (CSDDD), which obligates companies to ensure environmental and human rights compliance throughout their supply chains. Collectively, these measures condition market access and financing on verifiable carbon disclosure, circular economy compliance, responsible sourcing practices, and comprehensive supply chain transparency and traceability. What were once voluntary sustainability commitments or premium differentiators have rapidly evolved into baseline compliance requirements for maintaining competitiveness in major export markets.

This regulatory convergence creates both challenges and strategic opportunities for India. It makes it essential to position EGs trade and environmental regulatory compliance not as separate tracks, but as mutually reinforcing drivers of India's export competitiveness and ecological modernization of the industry. Strengthening EGs manufacturing capabilities enables Indian producers to meet emerging regulatory standards while capturing growing global demand for low-carbon technologies and sustainable solutions. Simultaneously, proactive adaptation to environmental trade regulations can drive productivity improvements, resource efficiency, and innovation across India's export sectors.

Together, these dynamics chart a pathway towards a more resilient, future-ready trade strategy one that aligns commercial success with environmental responsibility. This approach not only safeguards India's access to critical export markets and advances its economic growth objectives but also positions the country as a credible partner in collective international efforts to address climate change. By embedding sustainability into the core of its trade competitiveness, India can transform regulatory pressures into strategic advantages, ensuring that its expanding role in global value chains contributes positively to both national prosperity and planetary health.

The India-EU Free Trade Agreement, concluded in January 2026, establishes a framework for facilitating trade and investment in low-carbon goods, services, and technology through tariff reductions on green goods and liberalisation of services sectors relevant for the green transition. Both India and EU have committed to cooperate on climate change issues, including renewable energies and reducing maritime sector emissions, as well as sustainable management of natural resources and the promotion of a circular and resource-efficient economy. While the EU has pledged technical expertise and financial backing to support decarbonisation of India's steel and aluminium industries, including through its €500 million Green Transition Assistance package, environmental and climate commitments are framed around cooperation rather than binding enforcement mechanisms.

The European Commission confirmed that the FTA does not provide any exemption to CBAM, with no commitment to grant India more favourable treatment than other states. However, India secured several

important provisions: any flexibility or concession that the EU extends to any country under CBAM regulations will automatically apply to India through a Most-Favoured Nation clause, ensuring that Indian exporters receive equivalent treatment without requiring fresh negotiations. Commitments have been secured on enhanced technical cooperation on recognition of carbon prices, recognition of verifiers, as well as financial assistance and targeted support to reduce greenhouse gas emissions and comply with emerging carbon requirements[13]. Additionally, a technical dialogue group will be established to help Indian companies get their carbon data verified and better understand EU rules, with provisions for recognizing India's future carbon pricing system to avoid double taxation. Given the compliance burden that will fall on the Indian industry exporting to EU could face compliance burden under the global environmental regulations such as the EU CBAM. This compliance burden could possibly reduce any potential benefit that could accrue to India, once the FTA comes into force. It is important that the FTA plays an enabling role by aligning standards, improving transparency, and facilitating clean technology cooperation.

[13] India–EU Free Trade Agreement Concluded: A Strategic Breakthrough in India's Global Trade Engagement, Ministry of Commerce & Industry , PIB Delhi, 2026 (https://www.pib.gov.in/PressReleasePage.aspx?PRID=2219065&reg=3&lang=1#:~:text=The%20India%E2%80%93EU%20FTA%20gives,and%20supplier%20in%20global%20trade.)

3. Trade in Environmental Goods of India

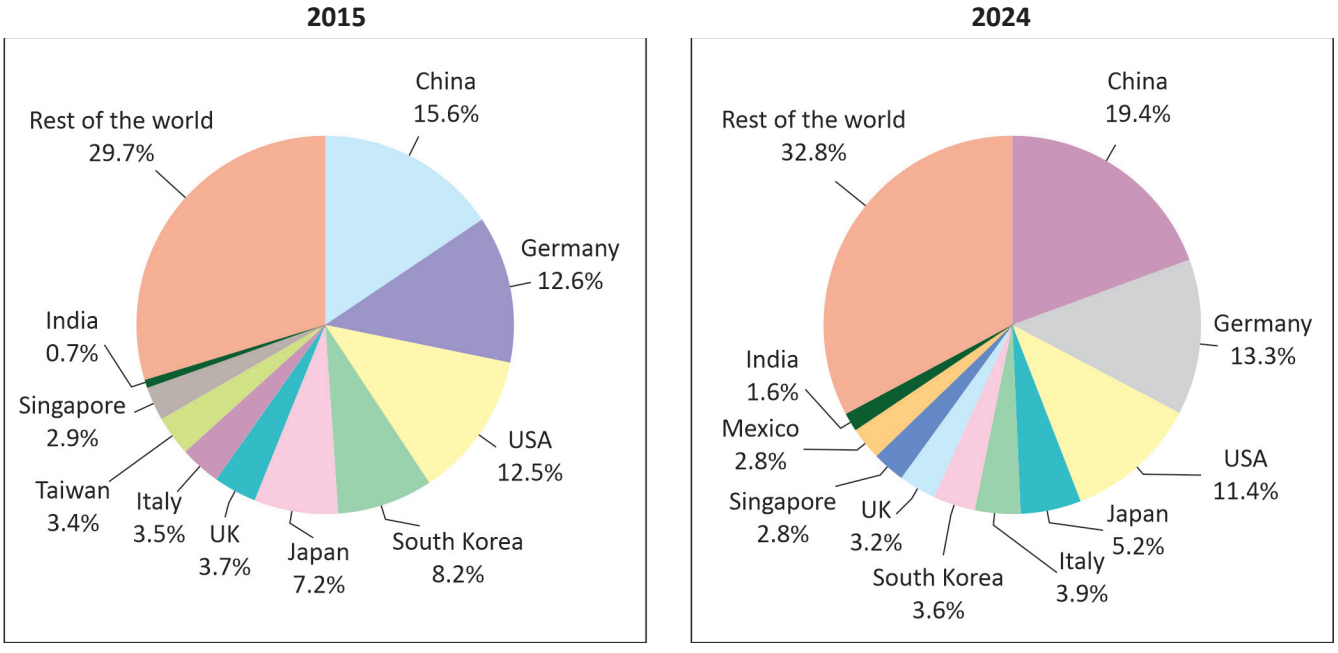
The global trade landscape for EGs has evolved significantly between 2015 and 2024. Based on the APEC list of EGs, the export of EGs has witnessed a remarkable increase more than doubling from US$ 246.9 billion in 2005 to US$ 542.5 billion in 2024. **Chart 3.1** presents country wise share in global exports of EGs during 2015 and 2024.

In 2015, China, Germany, and USA dominated the market with a combined export share of 40.7%, while mid-tier exporters such as South Korea (8.2%) and Japan (7.2%) played a strong role. Smaller contributors like the UK, Italy, Taiwan, and Singapore collectively added diversity, and India held a modest 0.7% share in global exports. China's dominance in the EGs domain is driven by its massive manufacturing capacity, cost competitiveness, and highly integrated supply chains, particularly in clean energy technologies such as solar panels and batteries. Complementing this industrial strength, China is richly endowed with rare earth elements, which serve as critical intermediate inputs for green technology production. Combined with strategic investments and policy support, these factors have positioned China as the global leader in exports of affordable, high-quality EGs.

By 2024, the concentration at the top of export market of EGs intensified. China expanded its lead to 19.4%, Germany rose to 13.3%, and the USA maintained a strong position at 11.4%, pushing the top three's combined share to 44.1%. Meanwhile, South Korea and Japan saw notable declines, while Italy and the UK remained steady. Mexico emerged as a new entrant among the top exporters, and India more than doubled its share to 1.6%, signalling growing participation from emerging economies.

India's growth in EG exports is driven by expanding renewable energy manufacturing, especially solar components, supported by government initiatives like the "Make in India" and Production Linked Incentive (PLI) schemes. Rising domestic demand for clean technologies has created economies of scale, while policy-driven investments and global partnerships have enabled India to strengthen its position in international markets.

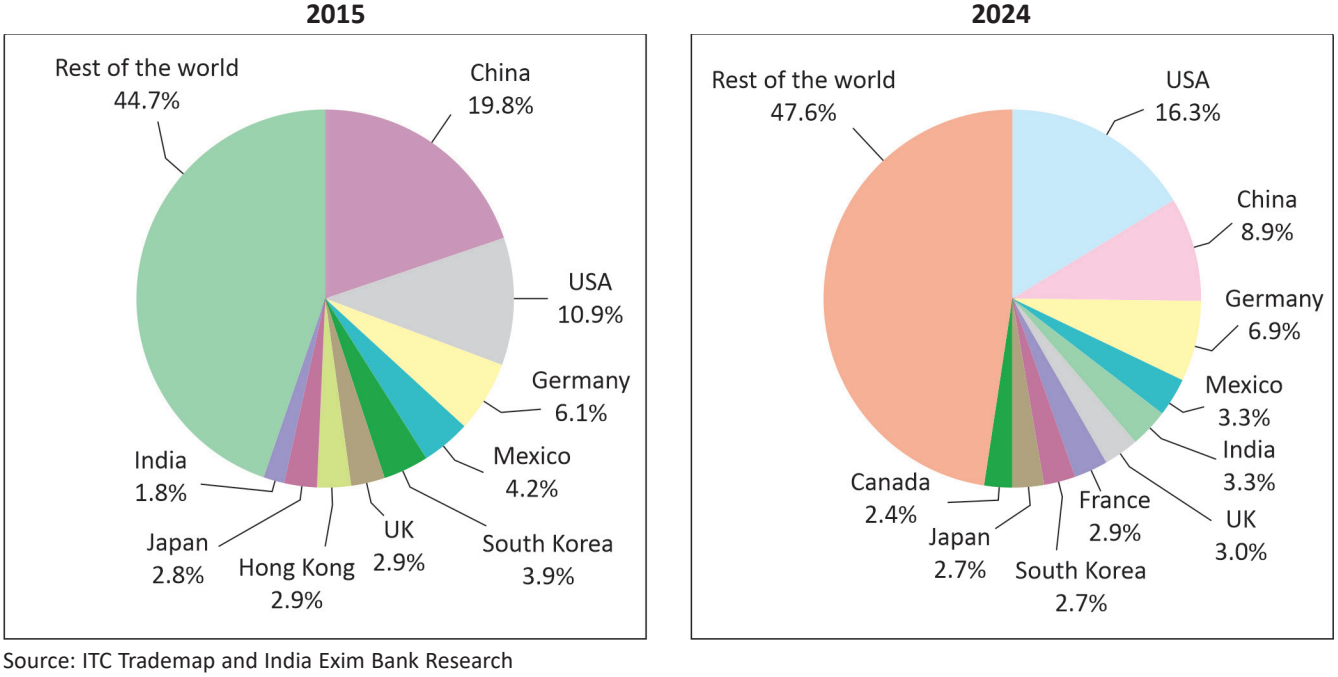
Chart 3.1 Country-wise Share in Global Export of Environmental Goods



Source: ITC Trademap and India Exim Bank Research

The export profile of leading EG exporters depicted in **Chart 3.1** broadly shows greater concentration among leading exporters and increased diversification among smaller players. Recent trends suggest that EGs market is becoming both more competitive and more globally distributed, driven by technological innovation and sustainability priorities.

Chart 3.2: Country-wise Share in Global Imports of Environmental Goods



Source: ITC Trademap and India Exim Bank Research

Chart 3.2 presents country wise share in global imports of EGs during 2015 and 2024. In 2015, China was the largest importer of EGs across the globe, accounting for 19.8% of global imports. This dominance was driven by China's rapid industrialization and aggressive renewable energy expansion, which required large volumes of imported solar modules, wind turbine components, and advanced clean technologies. The USA followed with 10.9%, reflecting its growing demand for energy-efficient systems and clean transport solutions amid early climate policy initiatives. Germany (6.1%) ranked third, supported by its strong renewable energy targets under the Energiewende program, which increased imports of wind energy equipment and smart grid technologies. Other notable importers included Mexico (4.2%), South Korea (3.9%), and the UK and Hong Kong (both at 2.9%), while India held a modest 1.8% share, primarily due to its emerging solar sector.

By 2024, the pattern shifted significantly. The USA emerged as the top importer with 16.3%, driven by large-scale clean energy investments and policy incentives such as the Inflation Reduction Act, which spurred demand for solar panels, EV batteries, and heat pumps. China's share fell sharply to 8.9%, as it localized its clean energy supply chain and became a global exporter of EGs. Germany increased slightly to 6.9%, maintaining strong imports for specialized equipment and raw materials to support its green transition. India's share nearly doubled to 3.3%, reflecting its ambitious renewable energy targets and infrastructure expansion. Other key players included Mexico (3.3%), the UK (3%), and France (2.9%), with Canada entering the top ten at 2.4%.

3.1 Leading Environmental Goods in Global Trade

The leading EGs globally fall under following major categories from the Friends of Environmental Goods list viz. Renewable Energy Production; Air Pollution Control; Waste water Management & Potable Water Treatment; Environmental Monitoring, Analysis & Assessment; and Solid & Hazardous Waste Management & Recycling. Among these, goods related to renewable energy production dominate global exports, particularly items such as photovoltaic cells and gas turbines. While these technologies are essential for clean energy generation, it is important to note that some, like gas turbines, can also be used for conventional power generation from natural gas, a fossil fuel that emits CO_2.

Among the top-performing categories for EG exports, solid & hazardous waste management and recycling continues to lead, with exports of machines and mechanical appliances (HS-847989) increasing from US$ 34.7 billion in 2015 to US$ 57.2 billion in 2024 **(Table 3.1)**. Similarly, parts of these machines (HS-847990) maintained steady growth, reaching US$ 22.6 billion in 2024, driven by global efforts to promote circular economy practices. These trends highlight the growing importance of waste reduction and resource recovery in industrial and municipal systems worldwide.

Renewable energy-related goods have emerged as a major growth driver. Notably, photovoltaic cells (HS-854143) recorded a dramatic rise, peaking at US$ 66 billion in 2023, though declining to US$ 45.3 billion in 2024, possibly due to price adjustments or oversupply in certain markets. The sudden emergence of large exports under photovoltaic cells in 2023 may be attributed to re-classification of the products under the category.

Other components such as parts of gas turbines (HS-841199) and electric motor parts (HS-850300) also showed consistent growth, reflecting the global transition toward clean energy infrastructure and electrification. Environmental monitoring instruments and apparatus have seen steady demand, with exports

of measuring and checking instruments (HS-903180) reaching US$ 27.8 billion in 2024. This growth signals stricter environmental regulations and the need for advanced monitoring systems across industries. Similarly, machinery for air pollution control (HS-842139) and water treatment (HS-842129, HS-842121) recorded healthy gains, underscoring global efforts to combat air and water pollution and ensure safe potable water.

Table 3.1: Exports of Top 15 Environmental Goods Globally (US$ million)

HS Code	Category of Environmental benefit	Product label	2015	2019	2023	2024
Total EGs Exports			**419,166.6**	**448,982.0**	**557,507.8**	**542,516.6**
847989	Solid & Hazardous Waste Management & Recycling	Machines and mechanical appliances, n.e.s.	34,725.9	46,705.5	52,052.2	57,195.6
854143	Renewable Energy Production	Photovoltaic cells assembled in modules or made up into panels	-	-	66,037.7	45,260.1
903180	Environmental Monitoring, Analysis & Assessment	Instruments, appliances and machines for measuring or checking	19,207.7	23,256.1	26,138.2	27,786.2
841199	Renewable Energy Production	Parts of gas turbines, n.e.s.	19,972.2	20,862.4	24,119.5	26,575.8
850300	Renewable Energy Production	Parts suitable for use solely or principally with electric motors and generators	17,034.8	19,560.6	25,420.8	25,312.6
847990	Solid & Hazardous Waste Management & Recycling	Parts of machines and mechanical appliances, n.e.s.	18,463.5	20,920.8	23,010.4	22,558.8
903289	Environmental Monitoring, Analysis & Assessment	Regulating or controlling instruments and apparatus	19,304.4	23,264.3	22,710.4	21,771.4
842139	Air Pollution Control	Machinery and apparatus for filtering or purifying gases	18,146.7	25,173.3	21,453.0	20,760.1
842199	Waste Water Management & Potable Water Treatment	Parts of machinery and apparatus for filtering or purifying liquids or gases, n.e.s.	12,535.4	15,653.6	17,961.3	18,573.5
850490	Renewable Energy Production	Parts of electrical transformers and inductors, n.e.s.	10,701.2	11,891.9	15,497.2	15,921.9

HS Code	Category of Environmental benefit	Product label	2015	2019	2023	2024
842129	Waste Water Management & Potable Water Treatment	Machinery and apparatus for filtering or purifying liquids	8,362.4	9,499.0	12,881.7	15,131.7
902790	Environmental Monitoring, Analysis & Assessment	Microtomes; parts and accessories of instruments and apparatus	10,243.3	13,504.2	14,861.6	14,947.3
903149	Environmental Monitoring, Analysis & Assessment	Optical instruments, appliances and machines for measuring or checking	5,905.6	8,935.9	12,839.9	12,608.9
842121	Waste Water Management & Potable Water Treatment	Machinery and apparatus for filtering or purifying water	7,597.7	9,517.0	12,029.8	12,377.0
841989	Air Pollution Control	Machinery, plant or laboratory equipment, whether or not electrically heated	7,349.8	8,388.5	10,460.1	11,697.7

Source: ITC Trademap and India Exim Bank Research

Note: (i) Categories are based on the Friend's list and Environmental goods based on the APEC 2022 list.
(ii) n.e.s.: not elsewhere specified

For a better understanding of products covered under the HS-Codes in the above table, the same has been elaborated below:

1. **HS 847989** - Machines and mechanical appliances having individual functions, not specified or included elsewhere in Chapter 84. Other than machines & mechanical appliances for treating metal, including industrial catalysers, electric wire coil-winders/ mixing/ kneading/ crushing/ grinding/ screening/ sifting/ homogenising/ emulsifying/ stirring machines; air humidifiers or dehumidifiers (84798920); machines for squeezing radioactive waste (84798950); suction machine; mud scraper; sand suction machine; trash compactor; vacuum extruder for making hollow brick with gangue and fly ash; (Fan) muffler (ex-84798999).
2. **HS 854143** - Photosensitive semiconductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light-emitting diodes (LED): Photovoltaic cells assembled in modules or made up into panels.
3. **HS 903180** - Instruments, appliances and machines for measuring or checking, not elsewhere specified in chapter 90 (excluding optical). These products include inter alia items such as vibrometers (that measure vibrations and assess structural and other effects of such vibrations) and electron microscopes for laboratory and testing applications.

4. **HS 841199** - Components that support gas turbines powered by landfill gas, coal mine vent gas, or biogas. Their use promotes cleaner electricity generation compared to traditional fossil fuel-based plants.
5. **HS 850300** - Parts for electric motors, generators, and related systems. These are critical for operating clean energy technologies such as wind turbines and hydroelectric generators.
6. **HS 847990** - Parts used in the maintenance of waste separation and compaction machinery. These systems aid in resource recovery and enhance the efficiency of solid waste management.
7. **HS 903289** - Automatic regulating and control instruments used in energy and industrial systems. They are vital for renewable energy applications, enabling efficient monitoring and operational control.
8. **HS 842139** - Machinery for filtering or purifying gases through physical, chemical, or electrostatic means. These systems reduce harmful emissions and improve air quality in energy and waste sectors.
9. **HS 842199** - Parts for filtration equipment that purify liquids or gases. Applications include water treatment and emission control, supporting sustainable industrial operations.
10. **HS 850490** - Components of electrical transformers and inductors used in clean energy systems. They enable conversion of direct current from renewables into grid-compatible alternating current.
11. **HS 842129** - Other liquid filtering/purifying machinery includes press filters, PCB etching solution recyclers, reclaimed water treatment systems, ion exchangers, alkali recovery equipment for black liquor, aerators, and electrodialysis devices (excluding HS 84212990).
12. **HS 902790** - Microtomes and parts/accessories (HS 90279000) for instruments and apparatus used in physical or chemical analysis, including devices for measuring viscosity, porosity, heat, sound, light, and similar properties.
13. **HS 903149** - Other measuring and checking instruments (HS 903149) include optical instruments and appliances not specified elsewhere, such as optical grating measuring devices (90314920) and other optical measuring/checking instruments (90314990).
14. **HS 842121** - Household water filters (84212110), industrial devices for heavy metal ion removal, membrane bioreactors, high-rate anaerobic reactors, reverse osmosis systems, water purification machines, and EDI ultra-pure water equipment (excluding 84212190).
15. **HS 841989** - Other machinery, plant, or laboratory equipment (HS 84198990) for treating materials by temperature change (e.g., heating, drying, evaporating, cooling), excluding domestic appliances and furnaces; includes chlorine dioxide generators and similar industrial equipment.

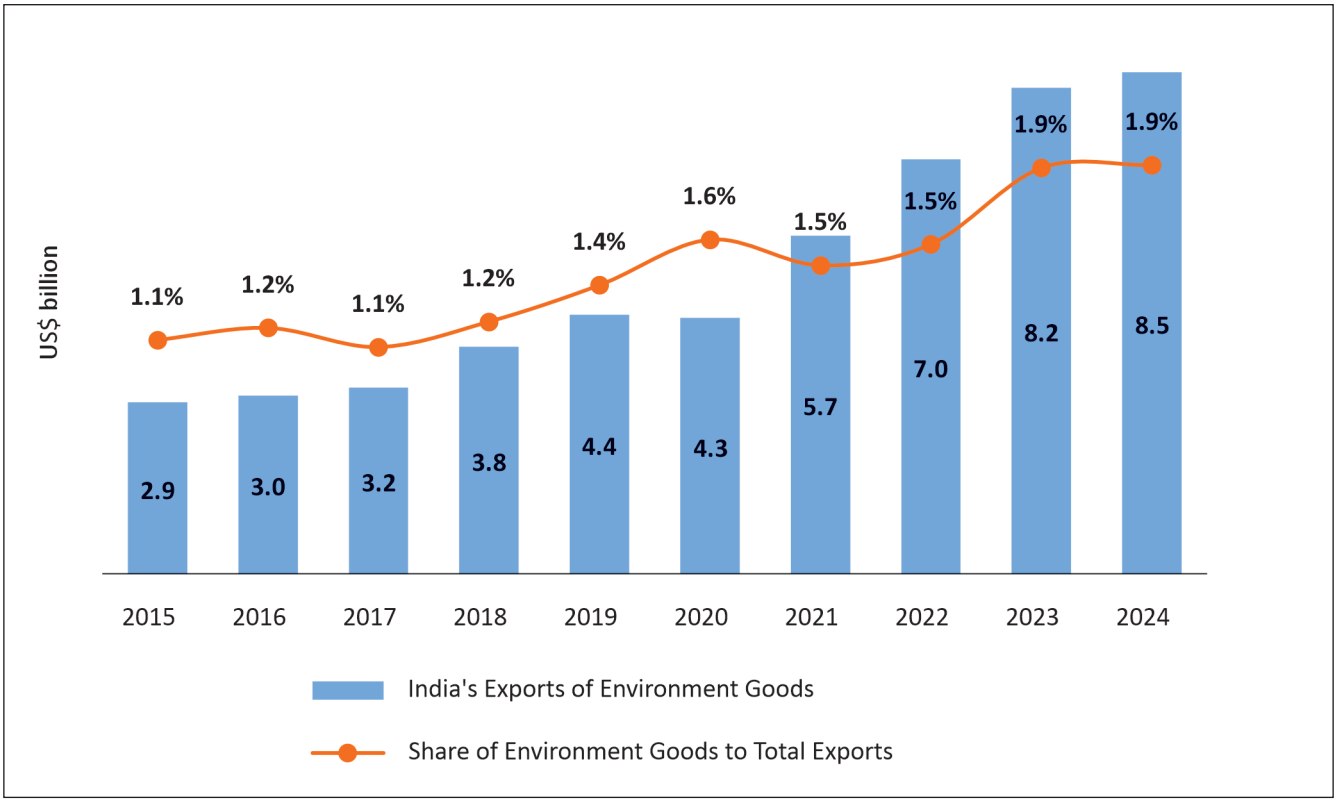
3.2 India's Trade in Environmental Goods

India ranks as the sixth-largest global market for environmental technologies exports[14]. Among major developing economies, India's share in global exports of EGs has gradually increased from 0.7% in 2015 to 1.6% in 2024. Apart from 2020, the value of EG exports in India has witnessed a general rising trend (**Chart 3.3**), increasing from US$ 2.9 billion in 2015 to US$ 8.5 billion in 2024, with the corresponding increase in share of EGs exports to total exports from 1.1% in 2015 to 1.9% in 2024.

[14] International Trade Administration, USA: India Country Commercial Guide (https://www.trade.gov/country-commercial-guides/india-environmental-technology)

The top export items in 2024 were goods primarily used for renewable energy production like photovoltaic cells, electric generators and parts of gas turbines. India has traditionally been among the largest consumers and importers of solar photovoltaic (PV) modules, and with the Indian government's push for domestic manufacturing, the volume of exports is also on the rise.

Chart 3.3: India's Environmental Goods Exports (US$ billion) (2015 - 2024)



Source: ITC Trademap and India Exim Bank Research

India's EG exports have expanded much faster than overall exports, with EG exports recording a CAGR of 12.7% between 2015 and 2024, compared with 5.9% for total exports. This indicates a gradual but clear shift in India's export structure towards greener and higher value-added products, aligned with the global demand for clean technologies and environmental solutions.

Newer green technologies are beginning to contribute materially to export growth. Once largely dependent on imports for its renewable energy generation needs, India is decisively reshaping that narrative, with the export value of PV modules from India increasing by more than 23 times in just two years between FY2022 and FY2024[15]. PV modules and panels (HS 854143) exports scaled up to over US$ 1.8 billion in 2023 and US$ 1.5 billion in 2024, indicating India's emerging role as a supplier in the solar value chain. Parts suitable for use with electric motors and generators (HS 850300) show robust growth, with exports rising from about US$ 278 million in 2015 to nearly US$ 1.3 billion in 2024, implying a CAGR of 18.6%. Strong performance is also visible in parts of electrical transformers and inductors (HS 850490), parts of machines and mechanical

[15] Solar PV export value from India surged 23 times between FY2022 and FY2024, Institute for Energy Economics and Financial Analysis (https://ieefa.org/articles/solar-pv-export-value-india-surged-23-times-between-fy2022-and-fy2024)

appliances (HS 847990), and machinery or equipment for treatment processes (HS 841989), each registering double digit growth (**Table 3.2**). This pattern suggests India is building niche strengths in intermediate and component manufacturing that feed into global value chains for clean energy, industrial efficiency, and pollution control equipment.

Further, high growth is also seen in parts of non-electrical engines and motors (HS 841290, CAGR 20.5%), parts of gas turbines (HS 841199, 19.9%), and precision measurement and control instruments (HS 902610, HS 903180, around 12% CAGRs), indicating growing sophistication in engineering and instrumentation.

To mention, wind-powered generating sets (HS 850231) grow from a very low base to over US$ 200 million by 2024, with an exceptionally high CAGR of more than 50%, reflecting project-driven and policy-led expansion.

Table 3.2 India's Top 20 Environmental Goods Exports (US$ million)

HS Code	Product label	Exported value in 2015	Exported value in 2019	Exported value in 2022	Exported value in 2023	Exported value in 2024	CAGR 2015 - 2024
TOTAL	**India's Total Exports**	**263,889.0**	**323,250.7**	**452,684.2**	**431,245.5**	**441,700.6**	**5.9%**
	India's Environmental Goods Exports	**2,900.7**	**4,386.4**	**7,013.4**	**8,230.3**	**8,487.6**	**12.7%**
854143	Photovoltaic cells assembled in modules or made up into panels	0	0	571.6	1,787.0	1,511.4	-**
850300	Parts suitable for use solely or principally with electric motors and generators	278.0	692.3	1,200.0	1,145.7	1,294.9	18.6%
847989	Machines and mechanical appliances, n.e.s.	305.1	377.0	551.3	533.1	599.5	7.8%
850490	Parts of electrical transformers and inductors, n.e.s.	186.6	281.9	417.2	449.3	498.6	11.5%
847990	Parts of machines and mechanical appliances, n.e.s.	123.5	214.3	239.2	305.2	357.8	12.5%
841989	Machinery, plant or laboratory equipment, whether or not electrically heated, for the treatment	118.1	181.1	227.8	283.7	303.9	11.1%
841290	Parts of non-electrical engines and motors, n.e.s.	52.6	96.4	395.5	219.1	282.0	20.5%
903289	Regulating or controlling instruments and apparatus (excl. hydraulic or pneumatic, manostats,	199.1	226.4	242.4	279.6	258.5	2.9%

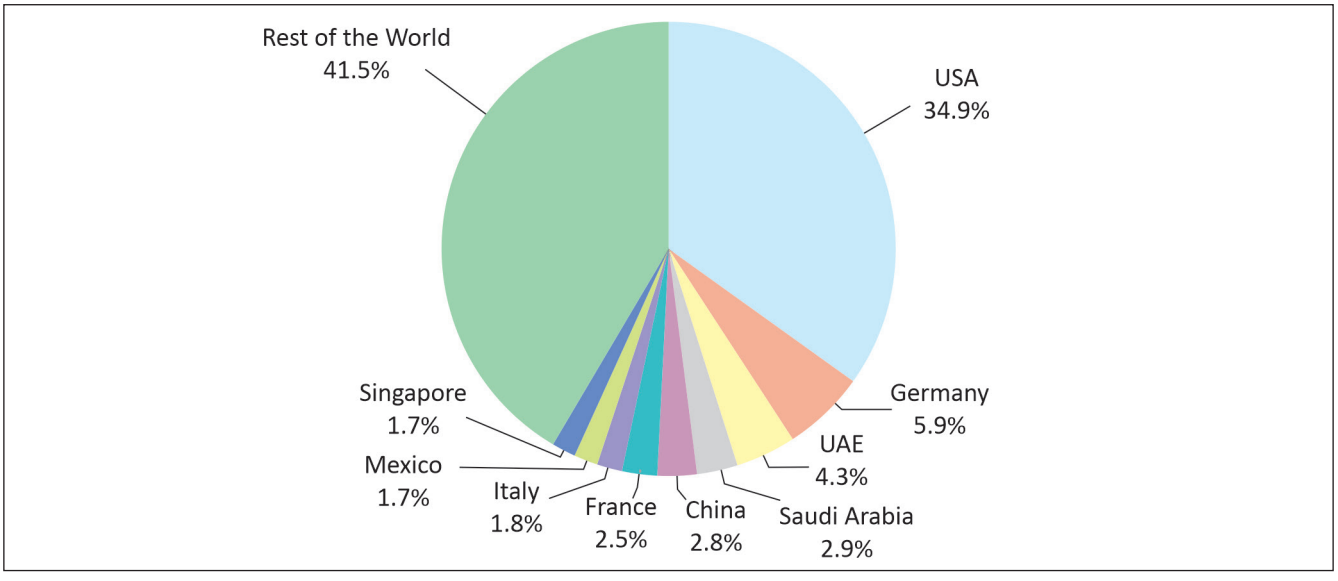
HS Code	Product label	Exported value in 2015	Exported value in 2019	Exported value in 2022	Exported value in 2023	Exported value in 2024	CAGR 2015 - 2024
842199	Parts of machinery and apparatus for filtering or purifying liquids or gases, n.e.s.	114.6	160.7	238.1	224.0	243.9	8.8%
842121	Machinery and apparatus for filtering or purifying water	101.4	153.6	179.3	167.8	225.3	9.3%
850231	Generating sets, wind-powered	4.7	42.3	367.0	202.0	218.9	53.4%
841199	Parts of gas turbines, n.e.s.	37.0	85.4	167.1	181.2	189.6	19.9%
903180	Instruments, appliances and machines for measuring or checking, not elsewhere specified	64.6	106.7	138.4	156.2	187.0	12.5%
901580	Instruments and appliances used in geodesy, topography, hydrography, oceanography, hydrology,	65.3	102.8	103.4	177.3	160.8	10.5%
850164	AC generators "alternators", of an output > 750 kVA (excl. photovoltaic generators)	57.1	71.8	78.2	104.0	152.6	11.5%
902610	Instruments and apparatus for measuring or checking the flow or level of liquids (excl. meters	46.7	87.2	115.8	106.0	130.0	12.0%
842139	Machinery and apparatus for filtering or purifying gases (excl. isotope separators and intake	117.0	129.8	149.9	134.8	129.1	1.1%
841990	Parts of machinery, plant and laboratory equipment, whether or not electrically heated	121.8	93.5	153.8	120.1	123.3	0.1%
842129	Machinery and apparatus for filtering or purifying liquids (excl. such machinery and apparatus	55.4	98.2	95.8	102.4	117.2	8.7%
847420	Crushing or grinding machines for solid mineral substances	56.8	137.6	106.3	121.9	109.9	7.6%

Source: ITC Trademap and India Exim Bank Research

Note: n.e.s.: not elsewhere specified

The largest export market for India's EG exports was the US **(Chart 3.4),** with the share of 34.9% in total EG exports of India, as it is one of the largest solar markets in the world. Even in 2010, India exported about "20% of the EG consisting of renewable energy plant group" to the USA[16]. Over the years, India has effectively capitalized on the strategic opportunities arising from current geopolitical tensions and the global shift embodied by the China+1 policy. Other export markets of India's EG exports include Germany (5.9%), UAE (4.3%), Saudi Arabia (2.9%) and China (2.8%), among others.

Chart 3.4: India's Environmental Goods - Export Destinations (% share)



Source: ITC Trademap and India Exim Bank Research

The domestic EG industry despite being highly fragmented with many players, has expanded rapidly due to the increasing environmental regulations shaping the world currently. The industry includes equipment suppliers, engineering procurement, construction contractors, consultants and service providers. Most of the top valued EG exports of India are apparatus required for production of renewable energy, including but not limited to parts of gas turbines, and generating sets for wind power. India has undertaken several initiatives to promote clean energy and these have helped in the capacity building to promote exports of EG. The National Solar Mission under the Ministry of New and Renewable Energy aims to "promote ecologically sustainable growth".

However, the growth in the share of EG in total exports exhibits fluctuations. This indicates that variations in environmental regulations and geopolitical conditions can influence the proportion of EG exported, which will be examined in greater detail in the subsequent chapter.

3.3 Environmental Goods Imports of India

Due to rapid growth, urbanisation and environmental challenges like air and water pollution, India's market for green technology is gaining the attention of major international players. According to the International

[16] CUTS Comments on Trade Sustainability Impact Assessment on the Environmental Goods Agreement, Centre for International Trade, Economics & Environment, 2016 (https://www.cuts-citee.org/pdf/CUTS_Comments_on_European_Union_Trade_Sustainability_Impact_Assessment_on_the_Environmental_Goods_Agreement.pdf).

Trade Administration of the US government[17], India's ongoing air and water pollution issues will fuel demand for environmental technologies and solutions. The Indian environmental technologies market, valued at around US$ 23 billion, is expected to grow at a CAGR of 7.5% from 2023 to 2028[18]. Water and wastewater management is the most promising sub-sector in India's environmental technology segment. According to Central Pollution Control Board (CPCB)'s report[19], India's has a low water treatment capacity and sewage treatment capacity of 27.3% and 18.6% respectively, hence demand for high-end technologies is constantly on the rise.

Further, India is the second largest market in the world for air pollution control technologies and municipal solid waste management, after China. According to GlobeNewswire market report, India's air pollution control systems market size was valued at US$ 10.4 billion in 2024 and is expected to reach over US$ 18 billion by 2030, at a CAGR of 9.4%[20]. In 2019, Ministry of Environment, Forests and Climate Change (MoEF&CC) launched the National Clean Air Program (NCAP) to reduce air pollution levels by 20% within five years in over 100 of the most polluted cities in India. Over 50% of India's installed power generation capacity is fuelled by coal-fired power plants. India has stringent emission standards for power plants, with a target of 60-80% reduction in particulate matter (PM), sulphur oxides (SOx), nitrogen oxides (NOx), and mercury emissions. These developments have also driven demand for these technologies and EGs, hence there is huge potential in these areas in forthcoming years.

India's EG import bill has risen sharply in recent years, with values increasing from about US$ 7.2 billion in 2015 to US$ 11.9 billion in 2022, and further to US$ 17.3 billion in 2023 and US$ 17.9 billion in 2024 (**Chart 3.5**). Over the same period, the share of EG imports in India's total imports has climbed from 1.7% in 2021 to 2.6% and 2.5% in 2023 and 2024 respectively, indicating a clear upward shift in the relative importance of EG in the country's import basket.

This pronounced increase since 2021 can be linked to India's accelerated policy push towards achieving net-zero emissions and meeting its updated NDCs, which has created substantial demand for clean energy and low-carbon technologies that domestic industry cannot yet fully supply. The growing domestic manufacturing capacities in key segments such as solar modules, storage solutions, and other cleantechnology components have therefore necessitated higher imports of environmental goods to support rapid deployment of renewable energy and related infrastructure.

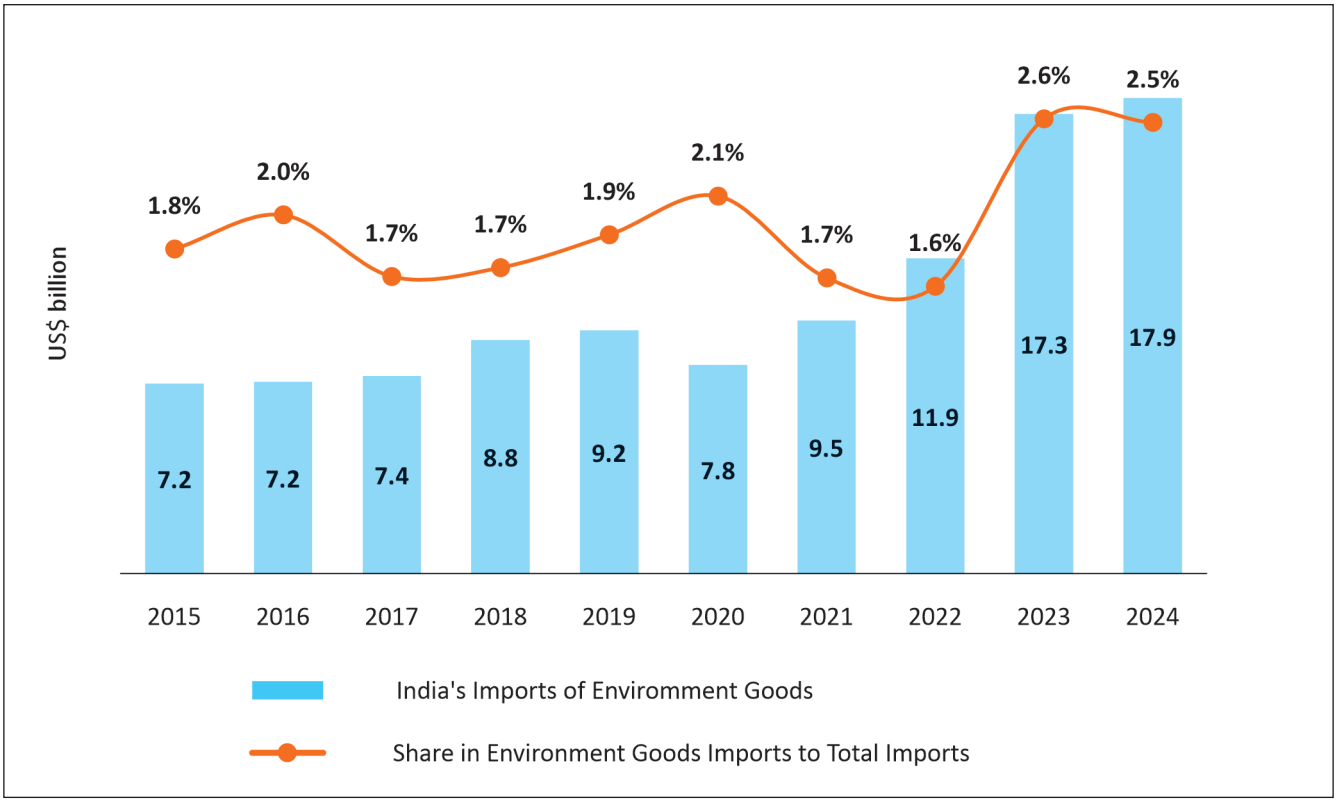
[17] International Trade Administration, USA: India Country Commercial Guide (https://www.trade.gov/country-commercial-guides/india-environmental-technology)

[18] International Trade Administration, USA: India Country Commercial Guide (https://www.trade.gov/country-commercial-guides/india-environmental-technology)

[19] Annual Report 2019 - 2020, CPCB (https://cpcb.nic.in/openpdffile.php?id=UmVwb3J0RmlsZXMvMTI0M18xNjE2NTYxOTAxX21lZGlhcGhvdG8xMTgzNi5wZGY=)

[20] India Air Pollution Control Systems Market Report 2024-2030, GlobeNewswire (https://www.globenewswire.com/news-release/2024/11/14/2980928/28124/en/India-Air-Pollution-Control-Systems-Market-Report-2024-2030-Clean-Air-Initiatives-Spurs-Investments-Surge-in-Regulatory-Mandates-Rising-Environmental-Awareness-Fueling-Developments.html)

Chart 3.5: India's Environmental Goods Imports (US$ billion) (2015 - 2024)



Source: ITC Trademap and India Exim Bank Research

While India's total imports increased at a compound annual growth rate (CAGR) of 6.7% between 2015 and 2024, EG imports expanded at 10.7% over the same period, more than one and a half times the pace of aggregate import growth. Within EGs, the composition of imports reveals a clear shift towards lowcarbon energy equipment, particularly solar value-chain products. PV cells and modules (HS 854143 and 854142) emerge as major items only from 2022 onwards, accounting for cumulative imports of around US$ 4.5 billion in 2024 **(Table 3.3)**, reflecting India's rapid scaling-up of solar generation capacity under its climate commitments. This is driven by policy initiatives such as enhanced renewable targets, production linked incentive schemes, and intensified project implementation that require substantial imported inputs. This pattern suggests that the country is actively building domestic capacity in these sectors. In this context, being a net importer need not be seen as a weakness. Rather, imports of green technologies and intermediate goods can play a constructive role in the early stages of capacity development, enabling technology transfer, and the creation of backward linkages that support domestic industry growth[21].

A second notable feature is the dominance of machinery, instruments, and parts used for measurement, control, and purification, which together form the bulk of the top 20 imported EGs. Items such as machines and mechanical appliances (HS 847989), measuring and checking instruments (HS 903180), regulating and controlling apparatus (HS 903289 and 903290), and various parts of transformers, motors, and filtration equipment (HS 850490, 850300, 842199, 842129) all show solid positive CAGRs. This indicates deepening

[21] CSEP article titled 'Understanding the Importance of Trade Integration for India's Green Transition: An Analysis of Trade in Green Goods',2025. (https://csep.org/blog/understanding-the-importance-of-trade-integration-for-indias-green-transition-an-analysis-of-trade-in-green-goods/)

investment in pollution control systems, process optimisation, and environmental monitoring across industry, power, and urban infrastructure, as firms respond to tightening domestic environmental regulations and global sustainability standards.

The import basket also highlights India's growing emphasis on advanced analytical and environmental monitoring capabilities. Chromatographs, electrophoresis instruments, UV/visible/IR analytical equipment, gas and smoke analysis apparatus, and related parts (HS 902710, 902720, 902750, 902789, 902790, 903190) exhibit some of the highest growth rates among the listed products, with certain categories recording CAGRs above 15%. This reflects increased regulatory and scientific demand for precise measurement of emissions, pollutants, and environmental quality, which is essential for implementing market-based instruments, ensuring compliance with global valuechain requirements, and supporting research and innovation in clean technologies.

Table 3.3 India's Top 20 Environmental Goods Imports (US$ million)

HS Code	Product label	Imported value in 2015	Imported value in 2019	Imported value in 2022	Imported value in 2023	Imported value in 2024	CAGR 2015 - 2024
TOTAL	**India's Total Imports**	**390,799.0**	**478,883.0**	**732,566.0**	**673,791.0**	**702,773.5.0**	**6.7%**
	India's Environmental Goods Imports	**7,153.7**	**9,151.2**	**11,863.9**	**17,290.2**	**17,885.7**	**10.7%**
854143	Photovoltaic cells assembled in modules or made up into panels	0	0	538.5	3,053.3	2,916.6	-*
847989	Machines and mechanical appliances, n.e.s.	734.8	1,251.9	1,205.4	1,553.1	2,009.7	11.8%
854142	Photovoltaic cells not assembled in modules or made up into panels	0	0	795.2	1,967.4	1,565.8	-*
903180	Instruments, appliances and machines for measuring or checking, not elsewhere specified	520.0	881.4	881.8	1,023.2	1,163.6	9.4%
850490	Parts of electrical transformers and inductors, n.e.s.	302.7	599.5	531.6	630.6	786.9	11.2%
903289	Regulating or controlling instruments and apparatus (excl. hydraulic or pneumatic, manostats	432.8	624.6	757.1	772.0	757.2	6.4%
850300	Parts suitable for use solely or principally with electric motors and generators, electric	464.1	589.9	749.4	666.9	698.7	4.6%

HS Code	Product label	Imported value in 2015	Imported value in 2019	Imported value in 2022	Imported value in 2023	Imported value in 2024	CAGR 2015 - 2024
847990	Parts of machines and mechanical appliances, n.e.s.	278.5	435.2	415.4	588.0	611.0	9.1%
842199	Parts of machinery and apparatus for filtering or purifying liquids or gases, n.e.s.	291.4	380.9	496.4	478.3	536.6	7.0%
902790	Microtomes; parts and accessories of instruments and apparatus for physical or chemical analysis	240.4	294.7	358.0	367.0	393.4	5.6%
902789	Instruments and apparatus for physical or chemical analysis, or for measuring or checking viscosity	0.0	0.0	268.0	374.5	359.5	-
842139	Machinery and apparatus for filtering or purifying gases (excl. isotope separators and intake	202.7	309.6	324.2	309.4	343.2	6.0%
903190	Parts and accessories for instruments, appliances and machines for measuring and checking	213.7	193.0	217.6	284.2	342.2	5.4%
902720	Chromatographs and electrophoresis instruments	179.6	214.6	250.6	295.8	330.6	7.0%
902750	Instruments and apparatus for physical or chemical analysis, using UV, visible or IR optical	79.3	166.1	261.9	310.7	312.4	16.5%
841989	Machinery, plant or laboratory equipment, whether or not electrically heated, for the treatment	324.9	288.2	270.2	393.4	301.6	-0.8%
902710	Gas or smoke analysis apparatus	64.8	126.7	204.8	292.5	268.5	17.1%
903290	Parts and accessories for regulating or controlling instruments and apparatus, n.e.s.	209.4	218.2	250.5	258.6	251.7	2.1%
842129	Machinery and apparatus for filtering or purifying liquids (excl. such machinery and apparatus	112.7	154.0	255.1	263.1	239.6	8.7%

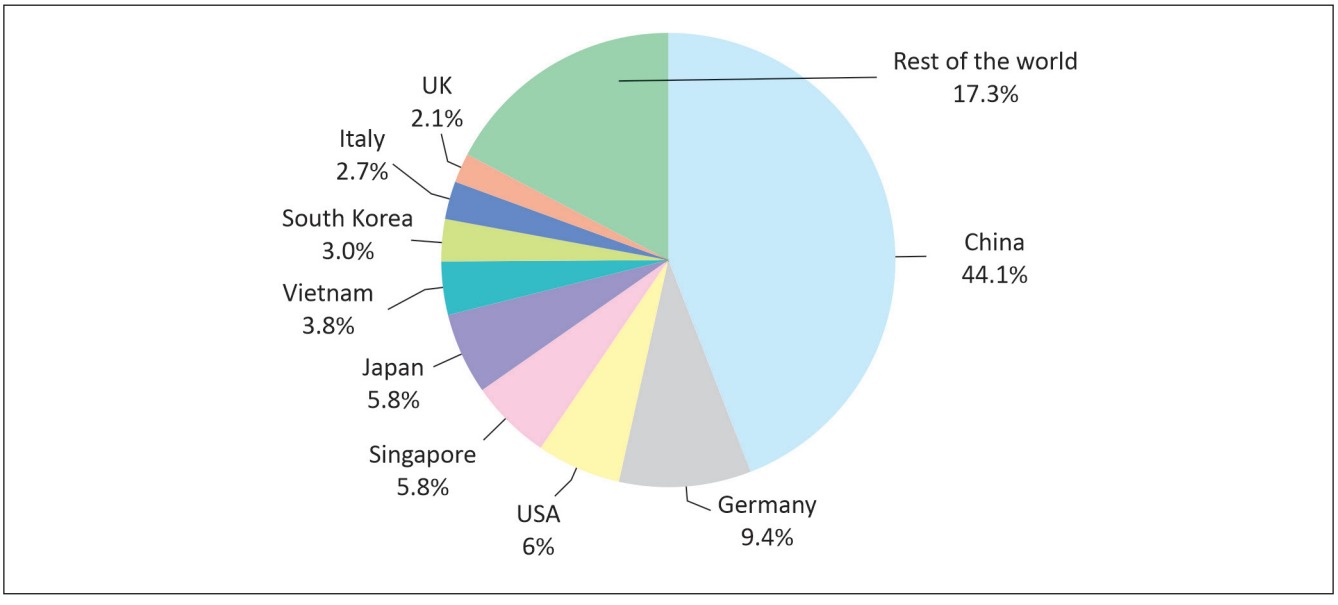
HS Code	Product label	Imported value in 2015	Imported value in 2019	Imported value in 2022	Imported value in 2023	Imported value in 2024	CAGR 2015 - 2024
841990	Parts of machinery, plant and laboratory equipment, whether or not electrically heated	112.0	143.9	190.6	218.2	221.3	7.9%

Source: ITC Trademap and India Exim Bank Research

Note: n.e.s.: not elsewhere specified

The **Chart 3.6** shows that India's EG imports are highly concentrated, with China alone accounting for 44.1% of total EG imports. This highlights India's substantial dependence on Chinese suppliers for critical green technologies and components, implying exposure to supply-chain disruptions, price volatility, and policy or geopolitical frictions emanating from a single dominant partner.

Chart 3.6: India's Environmental Goods- Import Sources (% share)



Source: ITC Trademap and India Exim Bank Research

Other major import sources of India's EG imports include Germany at 9.4% and the USA at 6%, pointing to reliance on advanced economy sources for high-spec equipment and precision instruments. Together with Singapore and Japan at 5.8% each, and Vietnam at 3.8% and South Korea at 3%, India's import profile is also firmly anchored in regional partners across Asia.

3.4 India's Revealed Comparative Advantage in Environmental Goods

Revealed Comparative Advantage (RCA) is a measure which have been used extensively to help assess a country's export potential/competitiveness. It helps in identifying categories of exports in which an economy has a comparative advantage by way of comparison of the country's trade scenario with the world scenario. It can also provide useful information about potential trade prospects with new partners. The basic assumption

underlying the concept of RCA is that the trade profile reflects the inter-country differences in terms of relative costs as well as non-price aspects.

As per Balassa's (1965) measure, RCA index for country I for commodity j is:

$$RCA_{ij} = (x_{ji}/X_i) / (x_{jw}/X_w)$$

Where,

xji : Exports of Commodity 'j' from Country 'i'

Xi : Total Exports from Country 'i'

xjw: Total Exports of Commodity 'j' from World

Xw: Total Exports from World

The RCA index ranges from 0 to infinity, with 1 as the break-even point.

RCA > 1: The country has a revealed comparative advantage in that commodity, meaning it exports more of that product relative to its total exports than the world average.

RCA < 1: The country has a comparative disadvantage in that commodity.

To corroborate the findings on India's share in global EG exports, RCA analysis was conducted. Revealed comparative advantage assessment reveals that India has comparative advantage in 34.4% of the total traded EG exports. Following are the 21 EG goods in which India holds revealed comparative advantage.

Table 3.4: List of Environmental Goods in which India holds Revealed Comparative Advantage

HS Code	Product Code	India's Global Export (US$ million)	Global Imports (US$ million)	RCA
854143	Photovoltaic cells assembled in modules or made up into panels	1511.4	48778.3	1.7
850300	Parts suitable for use solely or principally with electric motors and generators	1294.9	23869.0	3.0
850490	Parts of electrical transformers and inductors, n.e.s.	498.6	15164.3	1.8
841989	Machinery, plant or laboratory equipment, whether or not electrically heated	303.9	11558.8	1.4
841290	Parts of non-electrical engines and motors, n.e.s.	282.0	11200.3	1.4
842121	Machinery and apparatus for filtering or purifying water	225.3	12072.6	1.0
850231	Generating sets, wind-powered	218.9	6167.9	1.9
901580	Instruments and appliances used in geodesy, topography, hydrography, oceanography	160.8	5359.5	1.6

HS Code	Product Code	India's Global Export (US$ million)	Global Imports (US$ million)	RCA
850164	AC generators "alternators", of an output > 750 kVA (excl. photovoltaic generators)	152.6	3243.3	2.6
847420	Crushing or grinding machines for solid mineral substances	109.9	4268.7	1.4
903300	Parts and accessories for machines, appliances, instruments or other apparatus	94.9	3129.9	1.7
840690	Parts of steam and other vapour turbines, n.e.s.	87.7	2455.4	2.0
840290	Parts of vapour generating boilers and superheated water boilers, n.e.s.	68.4	1960.0	1.9
851490	Parts of electric industrial or laboratory furnaces and ovens	58.3	1749.3	1.8
841960	Machinery for liquefying air or other gases	53.6	1225.9	2.4
841790	Parts of industrial or laboratory furnaces, non-electric, incl. incinerators, n.e.s.	49.3	2669.4	1.0
851420	Furnaces and ovens functioning by induction or dielectric loss	42.0	850.0	2.7
840490	Parts of auxiliary plant of heading 8402 or 8403 and condensers for steam or other vapour power	26.6	465.5	3.1
840410	Auxiliary plant for use with boilers of heading 8402 or 8403, e.g. economizers, superheaters	11.5	542.9	1.2
840420	Condensers for steam or other vapour power units	9.4	218.5	2.4
841933	Lyophilisation apparatus, freeze drying units and spray dryers	7.6	360.6	1.2

Source: ITC Trademap and India Exim Bank Research

Note: n.e.s.: not elsewhere specified

Further revealed comparative advantage assessment reveals that India lacks a comparative advantage in 65.6% of total traded EG goods. Following are the 40 EG in which India holds comparative disadvantage.

Table 3.5: List of Environmental Goods in which India does not hold Revealed Comparative Advantage

HS Code	Product Code	India's Global Export (US$ million)	Global Imports (US$ million)	RCA
847989	Machines and mechanical appliances, n.e.s.	599.5	53566.2	0.61
847990	Parts of machines and mechanical appliances, n.e.s.	357.8	22486.9	0.87
903289	Regulating or controlling instruments and apparatus	258.5	25833.8	0.55
842199	Parts of machinery and apparatus for filtering or purifying liquids or gases, n.e.s.	243.9	18112.2	0.74
841199	Parts of gas turbines, n.e.s.	189.6	26541.3	0.39
903180	Instruments, appliances and machines for measuring or checking	187.0	31404.5	0.33
902610	Instruments and apparatus for measuring or checking the flow or level of liquids	130.0	7286.2	0.97
842139	Machinery and apparatus for filtering or purifying gases	129.1	20246.4	0.35

HS Code	Product Code	India's Global Export (US$ million)	Global Imports (US$ million)	RCA
841990	Parts of machinery, plant and laboratory equipment, whether or not electrically heated	123.3	8940.1	0.75
842129	Machinery and apparatus for filtering or purifying liquids (excl. such machinery and apparatus	117.2	13232.9	0.48
902690	Parts and accessories for instruments and apparatus	86.1	5582.8	0.84
902750	Instruments and apparatus for physical or chemical analysis, using UV	82.4	11018.2	0.41
902620	Instruments and apparatus for measuring or checking pressure of liquids or gases (excl. regulators)	81.3	12320.4	0.36
847982	Mixing, kneading, crushing, grinding, screening, sifting, homogenising	81.0	6967.8	0.64
903190	Parts and accessories for instruments, appliances and machines for measuring	72.3	11247.3	0.35
902790	Microtomes; parts and accessories of instruments and apparatus for physical or chemical analysis	51.4	14388.9	0.19
854390	Parts of electrical machines and apparatus, having individual functions, n.e.s.	48.0	9076.7	0.29
902789	Instruments and apparatus for physical or chemical analysis, or for measuring or checking viscosity	46.1	10877.0	0.23
903290	Parts and accessories for regulating or controlling instruments and apparatus, n.e.s.	45.2	4903.8	0.50
842132	Catalytic converters or particulate filters, whether or not combined	42.8	11223.2	0.21
841182	Gas turbines of a power > 5.000 kW (excl. turbojets and turbopropellers)	37.5	4978.3	0.41
854142	Photovoltaic cells not assembled in modules or made up into panels	35.4	5728.6	0.34
841939	Dryers (excl. lyophilisation apparatus, freeze drying units, spray dryers	33.6	2302.2	0.80
902710	Gas or smoke analysis apparatus	26.5	8404.1	0.17
902680	Instruments or apparatus for measuring or checking variables of liquids or gases, n.e.s.	22.0	4072.5	0.29
850239	Generating sets (excl. wind-powered and powered by spark-ignition internal combustion piston	17.7	3169.6	0.31
903149	Optical instruments, appliances and machines for measuring or checking	16.8	11224.9	0.08
902730	Spectrometers, spectrophotometers and spectrographs using optical radiations	15.8	4349.9	0.20
902720	Chromatographs and electrophoresis instruments	15.8	3021.0	0.28
851439	Electric industrial or laboratory furnaces and ovens	8.7	886.0	0.54

HS Code	Product Code	India's Global Export (US$ million)	Global Imports (US$ million)	RCA
841780	Industrial or laboratory furnaces and ovens, non-electric, incl. incinerators	5.6	1938.8	0.16
901390	Parts and accessories for lasers and other appliances and instruments	5.3	2695.1	0.11
851419	Industrial and laboratory furnaces and ovens, resistance heated	3.0	2442.8	0.07
901380	Optical appliances and instruments	2.7	3965.5	0.04
902781	Mass spectrometers	0.9	4185.6	0.01
851431	Electron beam furnaces	0.3	98.9	0.16
841912	Solar water heaters	0.1	280.7	0.03

Source: ITC Trademap and India Exim Bank Research

Note: n.e.s.: not elsewhere specified

4. Regional Benchmarking of India's Environmental Goods Trade

Global trade is undergoing a profound transformation as sustainability becomes a central pillar of economic policy and international commerce. The trade in EGs has gained momentum in response to climate change, resource scarcity, and international commitments under agreements like the Paris Accord. Countries are increasingly aligning trade strategies with environmental objectives, creating new opportunities and challenges for exporters and policymakers alike.

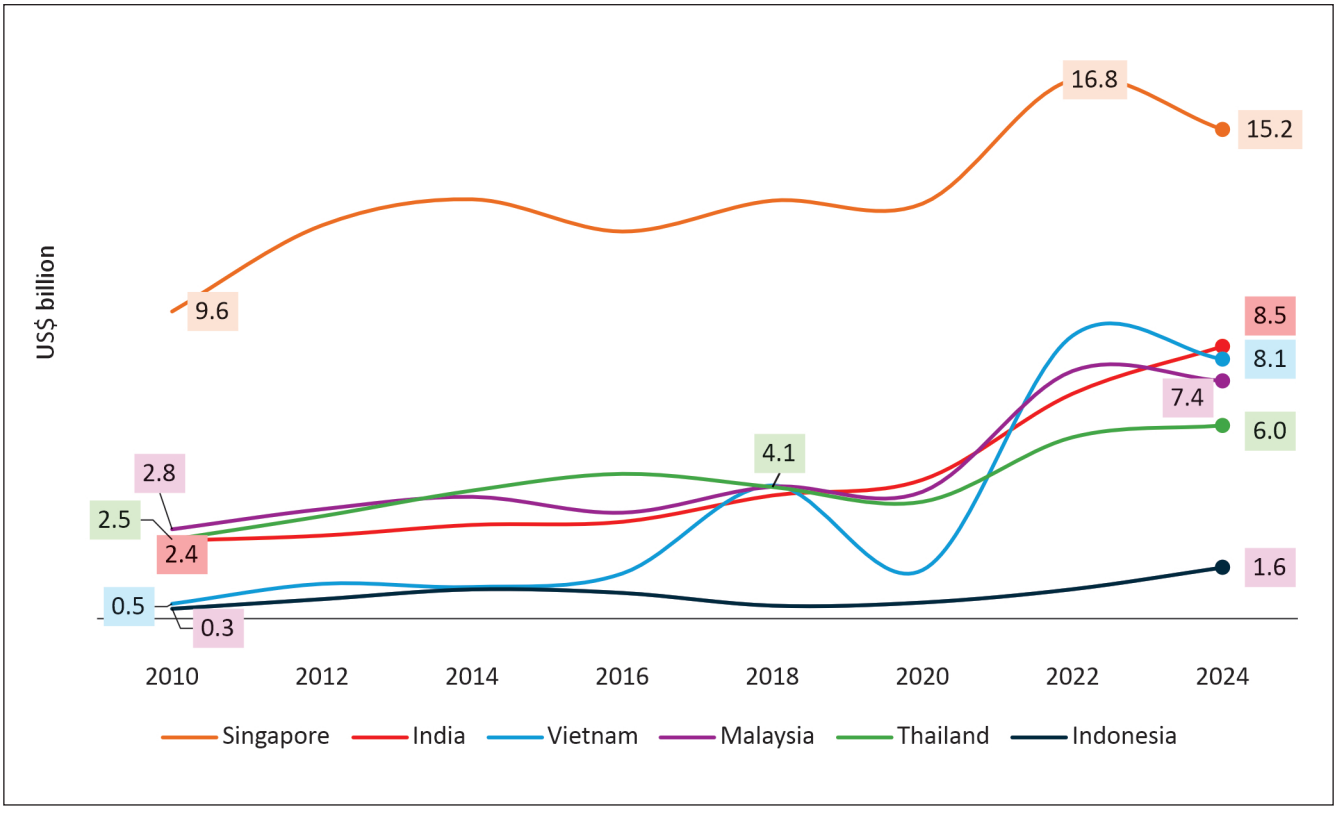
In Asia, the shift toward EGs is particularly significant due to the region's rapid industrialization, diverse economic structures, and growing role in global supply chains. Southeast Asian economies, alongside India, are striving to balance economic growth with environmental responsibility, leveraging green technologies and sustainable practices to remain competitive. This transition is not uniform; it reflects varying levels of technological advancement, regulatory frameworks, and resource endowments across nations.

Against this backdrop, understanding India's position relative to its Southeast Asian counterparts is critical. Comparative analysis offers insights into competitive advantages, policy gaps, and potential collaboration areas in green sectors such as renewable energy, low-carbon manufacturing, and climate-resilient exports. This chapter explores these dynamics, focusing on five strategically important countries viz., Singapore, Vietnam, Malaysia, Thailand, and Indonesia, within the context of green trade.

These nations vary in terms of economic development, trade specialization, and green export capabilities, making them ideal for a comparative analysis. Singapore leads in high-tech green services and regulatory frameworks. Vietnam and Malaysia are rapidly emerging green exporters in electronics and solar technologies. Thailand is transitioning towards low-emission mobility and renewable energy supply chains. Indonesia, while rich in resources, faces challenges in green trade integration, making it a valuable contrast case. India, as a regional powerhouse, plays a crucial role in global environmental goods trade and is a key player in discussions on Carbon Border Adjustment Mechanism (CBAM), green subsidies, and climate-resilient exports.

The **Chart 4.1** below presents global EG exports of select Asian countries. Across the six countries, aggregate EG exports expanded from US$ 18.1 billion in 2010 to US$ 46.8 billion in 2024, implying an approximate 6.5% CAGR over the period. While Singapore remained the leading exporter throughout, the composition of the group shifted meaningfully, with India and Vietnam emerging as powerful growth engines, particularly after 2018 and into the post-2020 phase. By 2024, the top three (Singapore, India, Vietnam) together accounted for approximately 68% of the regions exports for the select 5 economies along with India, underscoring a consolidation of scale among the leaders alongside steady growth among mid-tier economies.

Chart 4.1 Cross-Country Comparison of Environmental Goods Exports (US$ billion)



Source: ITC Trademap and India Exim Bank Research

4.1 Singapore

Singapore's EG exports increased from US$ 9.6 billion in 2010 to US$ 15.2 billion in 2024 recording CAGR of around 3.1%. The trajectory shows a firm step-up into 2014–2018, a slight easing in 2016, and a peak in 2022 (US$ 16.8 billion) before moderating in 2024. Despite this softening, Singapore remains a major player in EG exports in the region, indicating resilient competitiveness and entrenched ecosystem advantages, even as other regional players scale up.

Using its advantageous position and cutting-edge facilities, Singapore with a share of 2.8% in global EG exports, remains the 10th largest EG exporter across the globe in 2024. However, a good amount of its exports consists of re-exports or entrepôt[22] shipments. Singapore's exports of goods and services were 178.8% of GDP[23] in 2024, showing it is a highly trade-dependent economy driven by its role as a global logistics and services hub rather than large-scale domestic production.

Singapore's notable EG exports performance emerges from an effective alignment of national vision, regulatory frameworks, and industry incentives. The Green Plan 2030[24] establishes the foundational mandate, translating sustainability commitments into concrete targets for renewable energy expansion, emission reductions, and

[22] An entrepôt is a trading hub or port city where goods are imported, stored or lightly processed, and then re-exported—often without significant transformation.
[23] World Development Indicators, World Bank
[24] Green Plan, Government of Singapore (https://www.greenplan.gov.sg/)

green innovation. This top-down vision is reinforced by substantial financial incentives, including tax credits, Resource Efficiency Grants for Emissions (REG(E)), and the Enterprise Financing Scheme, which systematically reduce barriers to entry and scaling for companies developing and exporting environmental technologies. Compliance with international standards such as ISO 14000 and participation in Green Economy Agreements further enable market access and reduce non-tariff trade barriers, positioning Singaporean exporters competitively in markets like the EU and North America.

The success of Singapore's EGs sector is equally grounded in institutional coordination and public-private collaboration. Government agencies, including the Economic Development Board, Ministry of Trade and Industry, and Enterprise Singapore (a statutory board under the Ministry of Trade and Industry of the Government of Singapore), work cohesively to align incentives, build technical capabilities, and facilitate knowledge transfer. This institutional architecture ensures that SMEs and multinational enterprises alike have access to targeted support, financing, and market intelligence necessary to innovate and export competitively. The emphasis on inclusivity and capability-building has democratized access to green export opportunities, allowing a diverse portfolio of companies, from waste management to renewable energy to sustainable chemicals, to participate in and contribute to Singapore's export growth.

Singapore's advanced and diversified export base reflects decades of investment in R&D, human capital, and innovation ecosystems. Sustained commitment to research through initiatives like Research, Innovation and Enterprise 2025 (RIE2025), coupled with world-class institutions and a highly educated workforce, has enabled rapid commercialization of cutting-edge environmental technologies. EGs, spanning renewable energy machinery, advanced materials, eco-friendly chemicals, and circular economy solutions, now represent a meaningful share of Singapore's export portfolio, integrated alongside traditional strength sectors such as electronics and chemicals. This integration ensures resilience, as demand for EGs continues to accelerate globally amid the transition to net-zero emissions.

The international positioning and market access that Singapore enjoys amplifies its export competitiveness. As a hub of global trade and logistics, Singapore benefits from seamless connectivity to diverse markets and established networks with trading partners across ASEAN, Asia-Pacific, Europe, and beyond. Active participation in bilateral and regional sustainability initiatives, such as collaborations on green shipping corridors with India and green economy agreements with multiple partners, expands market opportunities and reinforces Singapore's brand as a trusted partner in the global green transition. This combination of strategic location, institutional support, and diplomatic engagement positions Singapore's EGs exporters to capitalize on rising global demand for sustainable solutions.

4.2 Vietnam

Vietnam registered the strongest longterm scaling in EG exports, jumping from US$ 0.5 billion in 2010 to US$ 8.1 billion in 2024, recording an impressive CAGR of around 20.4%. The path was volatile marked by a sharp rise into 2018 (US$ 4.1 billion), a correction by 2020 (US$ 1.5 billion), and an exceptional rebound by 2022 (US$ 8.8 billion). Even with a slight pullback in 2024, Vietnam captured 1.5% share in 2024 as compared to 0.2% in global EG exports in 2015, highlighting rapid integration into EG supply chains and an expanding manufacturing footprint, albeit with higher shortterm fluctuations than peers.

Vietnam's rapid scaleup in EG exports is underpinned by a deliberate shift in its industrial and trade strategy toward green and circular development. The newly approved National Program for Environmental Industry Development (2025–2030) aims to further modernize domestic environmental industry enterprises, enabling them to compete effectively and contribute to environmental protection at national, regional, and global levels. The private sector is positioned as the driving force, supported through favourable policies, green financing, and improved access to technology and markets, with a strong focus on nurturing leading private corporations in environmental technology[25].

By 2030, Vietnam aims for domestic technologies and equipment to meet most of its own environmental treatment needs, while simultaneously using this scale to build export-competitive product lines in EGs such as treatment equipment, waste-to-energy technologies, and monitoring devices. These strategic ambitions are strongly reinforced by the National Action Plan for Circular Economy (NAPCE) to 2035, which orients production and consumption toward resource efficiency, waste minimization, and industrial symbiosis. The NAPCE sets quantitative goals for renewable energy capacity, waste-to-energy expansion, and recycling rates, and mandates circular models in sectors such as agriculture, textiles, plastics, electronics, and waste management. By 2035, the policy targets include raising renewable energy to 47% of primary energy, reducing national energy consumption by 8-10%, ensuring 95% of urban and 80% of rural solid waste is collected and treated, cutting landfill disposal below 50% and expanding biomass & waste-based power capacity to 2,270 MW[26].

To operationalize these targets, Vietnam is promoting green industrial zones and circular industrial parks where waste streams from one industry become inputs to another, laying the physical and regulatory foundation for new EGs value chains in areas like recycling technology, biomass energy, eco-packaging, and e-waste treatment. As firms adapt to these circular requirements, they increasingly invest in eco-design, cleaner production, and circular business models, generating a growing range of EGs that can be scaled for export markets.

Policy and incentive frameworks embedded in NAPCE and the National Program for Environmental Industry Development directly support firms' ability to invest in and export EGs. These programmes anticipate the use of green finance instruments, including green bonds, preferential lending, and targeted tax incentives for circular economy and environmental technology projects, thereby improving capital access for EGs producers. In parallel, the government is preparing a more complete legal framework and a future decree on environmental industry development to clarify standards, strengthen certification, and streamline trade promotion for EGs sectors. This mix of financial and regulatory support reduces risk for both domestic and foreign investors, encourages technology transfer, and accelerates capacity building among Vietnamese SMEs and larger firms that participate in global green value chains.

Vietnam's structural and locational advantages further amplify the impact of these policies on EG export performance. The country's export oriented manufacturing base, strong participation in global value chains, and comprehensive network of trade agreements [including, Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), EU-Vietnam Free Trade Agreement (EVFTA), and Regional Comprehensive

[25] Ministry of Agriculture and Environment, Vietnam (https://en.mae.gov.vn/vietnams-environmental-industry-poised-to-drive-green-transition-9005.htm)
[26] Climate Policy Database (https://climatepolicydatabase.org/)

Economic Partnership (RCEP)] provide wide market access for EGs and related components. At the same time, rising environmental and carbon related trade measures in key destination markets are pushing Vietnamese exporters to upgrade toward greener technologies and higher environmental standards, exactly in line with the domestic policy push under the environmental industry program and NAPCE. Together, these frameworks and advantages have translated Vietnam's green policy orientation into tangible export outcomes in EGs, explaining both the sharp long-term scaling and the capacity for rapid rebounds after short-term shocks.

4.3 Malaysia

Malaysia's EG exports scaled from US$ 2.8 billion in 2010 to US$ 7.4 billion in 2024 with a CAGR of around 7.2%, with a clear step-up post 2020 (recording a growth of more than 85% from 2020 to 2024). Malaysia's performance in EG exports reflects a long-running green technology agenda combined with targeted fiscal incentives, industrial policy, and structural manufacturing strengths. The National Green Technology Policy (NGTP), launched in 2009, explicitly positions green technology as a driver of economic growth and guides interventions across energy, buildings, transport, water, waste management, manufacturing and ICT, creating sustained demand and scale for green equipment, components and services that are also exportable. Over time, Malaysia has developed competitive capabilities in segments such as PV products, water and waste water treatment equipment, air pollution control systems, waste management equipment and environmental monitoring instruments.

A key reason EG exports have been able to expand, is the depth and breadth of Malaysia's green incentives framework, which reduces investment risk and improves returns for firms producing EGs. The Green Technology Financing Scheme (GTFS), introduced in 2010 and subsequently expanded, provides soft loans and guarantees for both producers and users of green technology, lowering financing costs for projects in renewable energy, energy efficiency, waste management and green buildings that often rely on imported or locally manufactured environmental equipment[27]. Complementing this, Green Investment Tax Allowance (GITA) provides for companies that utilize green technology products certified with the MyHIJAU Mark[28] to be eligible for a 100% Green Investment Tax Allowance. According to the 2026 Budget announcement of Malaysia, these products must be sourced locally.

Malaysia's policy framework also leverages eco-labelling, standards and circular economy initiatives to strengthen the marketability of its EG exports. The MyHIJAU Mark serves as the official national green label, certifying products and services that meet government-endorsed environmental criteria and aligning them with international expectations, which in turn facilitates their uptake in both Government Green Procurement (GGP) and export markets seeking verified green products. In parallel, the Circular Economy Policy Framework under the Ministry of International Trade and Industry links New Industrial Master Plan 2030 (NIMP 2030) and the 12th Malaysia Plan (2021-2025), explicitly aiming to "catalyse green growth" in manufacturing by improving resource efficiency, increasing recycled content and secondary feedstock use, and enhancing the competitiveness and exportability of Malaysian products under tightening sustainability regulations abroad (e.g., EU product requirements). These policies push manufacturers, especially in electrical and electronics industry, plastics and materials, to integrate eco-design and circular principles, thereby increasing the embedded environmental value

[27] Malaysian Green Technology and Climate Change Corporation (https://www.gtfs.my/page/features-gtfs-40)
[28] MyHIJAU Mark & Directory is a Government of Malaysia initiative to promote the sourcing and purchasing of green products and services in Malaysia.

of their exports. As Malaysia advances toward its 2050 net-zero target, these strategies collectively strengthen the nation's commitment to a sustainable economy and establishes a robust policy foundation for expanding the production and export of EGs, positioning Malaysia as a key player in the region.

4.4 Thailand

Thailand advanced from recording US$ 2.5 billion exports of EGs in 2010 to US$ 6 billion in 2024, witnessing a CAGR of 6.5% during the same time period. The growth trajectory reflects early momentum into 2016, a mid-period dip, and a solid recovery to 2024. Together, these mid-tier exporters provide stability to the regional export base and diversify the group's supply capabilities.

Thailand's improved performance in EG exports is closely linked to its long running green industrial and energy transition agenda, which has created demand for environmental technologies at home and exportable capabilities for regional and global markets. The Alternative Energy Development Plan (AEDP) 2013-2037[29] and related power sector strategies have driven aggressive deployment of renewables, biofuels, and biogas, requiring significant volumes of solar equipment, biomass and biogas systems, grid components, and control technologies. These same product categories overlap with widely used EG lists, so the build out of domestic projects has helped Thai firms and foreign investors scale production, localize parts of the value chain, and then supply equipment and components to export markets across the globe. Thailand's established strengths in machinery, electronics, vehicle parts, plastics, and rubber products further reinforce this, because many EG sub-categories, such as efficient motors, power electronics, EV components, and environmental monitoring equipment, sit exactly at the intersection of these sectors.

A second pillar is Thailand's broader industrial upgrading strategy under "Thailand 4.0" and the Eastern Economic Corridor (EEC), which explicitly targets advanced, highervalue manufacturing with strong green and digital dimensions. Within Thailand 4.0, future industries like smart electronics, next generation automobiles (including EVs), biofuels and biochemicals, robotics and automation, and medical technologies are prioritized, all of which have sizeable EGs content (for example, EV batteries, charging infrastructure, light-weight and low emission components, and biobased inputs). The EEC offers fiscal and non-fiscal incentives, tax holidays, tariff exemptions, streamlined approvals, and infrastructure, designed to attract high-tech and low carbon FDI into these sectors. This combination of targeted industrial policy and placebased incentives has deepened Thailand's integration into global value chains for EGs over time.

Foreign direct investment has been a crucial enabler of Thailand's EGs export capacity, particularly through long standing participation of Japanese, US, and other Asian investors in automotive, electronics, and related supply chains. Early waves of FDI created scale in assembling vehicles, electronics, and machinery, and, as global producers shifted toward cleaner technologies, Thai plants increasingly began producing more efficient engines, emission control parts, ecocars, hybrid and EV components, and higher-efficiency appliances. The recent FDI inflow numbers for Thailand are striking. In the first three quarters of 2025, Thailand attracted a record-breaking THB 1.37 trillion (US$ 42.2 billion) in investment applications, a 94% increase year-on-year.

[29] Alternative Energy Development Plan 2018-2037, Thailand (https://climate-laws.org/document/alternative-energy-development-plan-2018-2037_c79f)

Foreign investors, predominantly from Singapore, China and Japan, accounted for 80% of this total. Digital infrastructure, advanced electronics and electric vehicles (EV) dominate the investment pipeline, signalling an important shift in Thailand's industrial composition[30].

Thailand's policy direction on green growth and climate also supports EG exports by aligning domestic producers with tightening global sustainability requirements. The government has announced ambitious net-zero and emission reduction targets and is working on climate and carbon pricing legislation, while sectoral initiatives target cleaner industry and more stringent environmental standards. In trade exposed sectors like automobiles, machinery, plastics, and chemicals, the rising importance of EU and US climate and ESG related rules (for example, product carbon footprints and supply chain transparency) is already pushing Thai exporters to upgrade technology, improve energy efficiency, and adopt cleaner inputs. These adjustments increase the performance of exported products and, in some cases, shift product portfolios toward explicitly green goods such as EVs, higher efficiency equipment, and more sustainable materials. While Thailand still faces challenges due to the carbon intensity of parts of its industrial base, the combination of green oriented energy and industrial policy, targeted investment incentives, deep FDI driven integration in GVCs, and active outward investment in renewables and infrastructure provides a strong foundation for its continued good performance in environmental goods exports.

4.5 Indonesia

Indonesia's EG exports grew at a moderate pace increasing from US$ 0.3 billion in 2010 to US$ 1.6 billion in 2024. After 2020 the EG exports have witnessed noticeable acceleration, suggesting scope for further scaling from a low base as capacity and product mixes evolve. Indonesia's EG export trajectory needs to be assessed against both its large structural potential and its actual export composition. While the country has notable strengths in critical minerals, biomass, and renewable energy resources, these advantages have so far translated more into upstream, resource-heavy exports than into diversified, high-value EGs.

A first structural driver of this outcome is the continued dominance of raw and semi-processed commodities in Indonesia's trade profile. Green industrial policy has primarily focused on resource nationalism in minerals, especially nickel ore export bans and mandatory domestic processing, as well as large biofuel and palm oil value chains. These measures have certainly increased exports of "greenrelated" intermediates such as battery grade nickel and biofuel feed-stocks but have not yet produced a broad base of sophisticated EGs like solar modules or advanced batteries. As a result, the value added, technology content, and product diversity of Indonesia's EG exports remain lower than in peers that specialize in finished green products rather than inputs.

Compounding this is Indonesia's slow and uneven renewable energy rollout, which fails to create a robust domestic market to anchor EG manufacturing and exports. The new RUPTL 2025-2034 outlines an increase of more than 40% in power generation from coal and gas from 2024 to 2034, with fossil power generation by 2030 about 10% higher than targeted in the previous RUPTL; the plan proposes adding 16.6 GW of new fossil power through 2034, signalling continued fossil reliance. Renewables targets have been downgraded from 20.9 GW in new clean power capacity by 2030 (under RUPTL 2021-2030) to 17 GW, falling even further

[30] ASEAN+3 Macroeconomic Research Office (http://amro-asia.org/thailands-transformation-two-part-series-part-2-leveraging-fdi-for-structural-transformation)

short of the Just Energy Transition Partnership's Comprehensive Investment and Policy Plan (JETP CIPP) from November 2023, which outlined 24.3 GW, including just 10.6 GW of solar and wind targeted in the new RUPTL, or merely 40% of JETP ambitions[31]. Coal lock-ins, long-term Power Purchase Agreements (PPAs), regulatory uncertainty, and grid constraints have thus slowed deployment of renewables hardware, reducing incentives for local production scale-up. Without a large, predictable domestic demand base for solar, wind and grid equipment, firms have weaker incentives to invest in local manufacturing at scale, in contrast to countries where rapid domestic deployment of renewables has underpinned globally competitive EGs industries.

In conclusion, India can draw on the best practices of these countries, particularly in fostering innovation, enhancing policy support for green industries, and encouraging public-private partnerships. By addressing infrastructure and institutional challenges, providing financing for green technology projects, and developing a comprehensive long-term green growth strategy, India can enhance its competitiveness in global green trade while advancing its sustainability objectives.

[31] Centre for Research on Energy and Clean Air (https://energyandcleanair.org/publication/indonesias-ruptl-outlines-faster-growth-in-fossil-fuel-use-downgrades-ambition-for-clean-energy/)

5. Adapting to Environmental Regulations

Global trade policy is rapidly evolving to integrate environmental and climate objectives, giving rise to environmental regulations that condition access in the international market on environmental performance and sustainability outcomes. The mandates in these regulations are grounded in the recognition that trade can and must be part of the policy framework to address climate change, biodiversity loss and pollution, and that environmental considerations can no longer be sidelined in trade governance. These regulatory instruments aim to level the playing field by internalising the environmental costs of production and preventing issues like carbon leakage, where emissions shift to jurisdictions with weaker regulations. As major economies adopt such measures, exporters worldwide face both opportunities and challenges: compliance with evolving regulations that can open markets for low-carbon goods and services while posing adjustment costs, particularly for producers in developing countries with limited capacity to meet stringent sustainability requirements.

5.1 Emergence of Trade as an Instrument for Climate Action

Trade accounts for approximately 20–30% of global emissions[32], largely driven by the direct and indirect emissions from manufacturing carbon intensive industrial goods such as steel and aluminium, as well as the fuels used in their cross-border transportation. While accession to the WTO and free trade agreements (FTAs) facilitated economic integration by reducing barriers and expanding market access, they have also resulted in increased emissions among trading partners by stimulating demand for carbon intensive primary commodities and downstream products like automobiles and aircraft. Reduced trade barriers, combined with greater capital mobility, have heightened the risk that manufacturing would migrate to jurisdictions with weaker climate regulations, an occurrence known as "carbon leakage[33,34]"

The Paris Agreement, adopted in December 2015, marked a turning point not only in global climate governance but also in the relationship between climate commitments and international trade. Since then, trade has evolved from a sector largely peripheral to climate negotiations into a direct instrument of climate policy. According to UNCTAD's Global Trade Update[35], trade policy tools are now being strategically integrated into national climate plans (Nationally Determined Contributions or NDCs) to drive the low-carbon transition,

[32] Trade and Climate Change, World Trade Organization, 2021 (https://www.wto.org/english/news_e/news21_e/clim_03nov21-4_e.pdf)
[33] Carbon leakage occurs when cheaper goods are sourced from a region with less regulation and less stringent policies or when EU companies shift abroad for more lenient climate standards.
[34] The risks and opportunities of the EU's green trade agenda, Brookings, 2025 (https://www.brookings.edu/articles/the-risks-and-opportunities-of-the-eus-green-trade-agenda/)
[35] UNCTAD calls for aligning markets and trade with the Paris Agreement to accelerate the low-carbon transition and finance climate action ahead of COP30, UNCTAD, 2025 (https://unctad.org/news/trade-powers-climate-ambition)

transforming trade from a consequence of climate action into an engine for it. UNCTAD data shows that climate-related regulations, though only a small share of total trade measures, are concentrated in major CO2-intensive sectors like automotives, impacting trade flows of around US$ 6.5 trillion amounting to over a quarter of global trade in 2022.[36]

The European Union (EU), by virtue of its market dominance and role as a key trading partner for many developing countries including India has leveraged this position to transmit its own policy priorities to the rest of the world, establishing global environmental standards without formal coercion. Regulatory scholars term this the "Brussels Effect," evident in domains such as the GDPR (General Data Protection Regulation), chemicals regulation under REACH (Registration, Evaluation, Authorization and Restriction of Chemicals), product standards such as USB-C Universal Charger Directive (2022) and various Ecodesign requirements. The mechanism operates in two ways: companies adopt EU standards voluntarily to secure market access, and countries progressively align their domestic legislation with EU frameworks either through regulatory competition or by viewing the EU as a model environmental leader. Recent EU regulations such as the CBAM, EUDR and ESPR, CSDDD demonstrate the Brussels Effect's continuing relevance, and the trading partners of EU are seen to be preparing themselves to the requirements of these regulations.

The regulatory architecture pioneered by the EU is spreading rapidly beyond European borders. The UK has announced plans to introduce its own CBAM by 2027[37]. Major economies including Canada, Australia, Japan, and China are also exploring similar frameworks. Indonesia and Vietnam have begun considering carbon pricing regimes. This diffusion operates through dual channels: regulatory competition, where countries adopt policies to maintain competitiveness in low-carbon markets, and ideational emulation, where the EU serves as a benchmark environmental leader.

For developing economies like India, this transformation presents an important strategic paradox. India has demonstrated substantial commitment to climate action pledging net-zero emissions by 2070, pushing circular economy agenda, including focus on circular design principles, emerging green hydrogen sector and pursuing aggressive renewable energy expansion. Building export competitiveness in EGs and low-carbon production, resource efficient processes positions India to benefit from expanding global markets for sustainable products. However, binding environmental (and social) requirements simultaneously creates significant burdens, particularly for the micro, small, and medium enterprises (MSMEs) that form the backbone of India's export ecosystem. Meeting these new requirements would be a gradual process and, in the interim, could place Indian exporters at a competitive disadvantage because of higher compliance costs.

5.2 Adaptation to Environmental Regulations is Critical for India's Trade Competitiveness

Adaptation to the emerging environmental regulations that are reshaping international trade is extremely important as the risks extend beyond immediate export price competitiveness to encompass longer-term supply chain reconfiguration and sectoral transformation dynamics. A key risk category involves the progressive narrowing of access to economically significant markets such as the EU, as India seeks to

[36] Trade regulations for climate action: New insights from the global non-tariff measures database, UNCTAD, (https://unctad.org/publication/trade-regulations-climate-action-new-insights-global-non-tariff-measures-database)

[37] UK Border Carbon Adjustment Mechanism (CBAM) Factsheet, UK Government, 2025, (https://www.gov.uk/government/publications/factsheet-carbon-border-adjustment-mechanism-cbam/factsheet-carbon-border-adjustment-mechanism)

position itself as a global manufacturing hub. The expanding regulatory trade barriers including CBAM, EUDR, ESPR and under that the Digital Product Passport (DPP) requirements, CSDDD, and traceability mandates, create compounding compliance burdens that could systematically exclude non-compliant suppliers from high-valued markets.

The second risk involves the changing geographies of trade flows, with global supply chains relocating production to avoid CBAM costs. They could move to lower-cost EU locations or to countries with established sustainability infrastructure, including decarbonization investments, circular economy systems, sustainable sourcing frameworks, and carbon pricing that allows them to offset CBAM duties through cross-border credits. Countries demonstrating ESG compliance from deforestation-free supply chains to product circularity would gain significant competitive advantages.

The third risk relates to Indian manufacturers shifting investment and production capacity to cater to jurisdictions outside the EU and other developed markets regulatory scope, potentially limiting access to higher-value market segments and constraining long-term growth opportunities as sustainability regulations proliferate globally across multiple jurisdictions.

Counter-balancing these risks are substantial market opportunities: green and sustainable products command measurable price premiums in global markets, and early adaptation creates first-mover advantages in accessing these premium segments. The global market for green premium products is expanding at an accelerating pace. Market research has projected that the global green premium products market size was valued at US$ 180.1 billion in 2024 and is expected to reach US$ 204.5 billion by 2025 and US$ 665.0 billion by 2034, exhibiting a CAGR of 14% during 2025–2034.[38] This expansion is not a speculative projection but reflects demonstrated consumer and commercial preferences. Global consumer research[39] documents that consumers are willing to spend an average of 9.7% more on sustainably produced or sourced goods, with certain categories commanding substantially higher premiums. For instance, real estate buyers demonstrate an 8-18% willingness to pay for green-certified buildings with Building Research Establishment Environmental Assessment Method (BREEAM) or National Australian Built Environment Rating System (NABERS) ratings. Within India specifically, research reveals that 60% of Indian consumers express willingness to pay a premium for sustainable products, though actual purchase conversion remains constrained by availability, pricing, and credibility challenges, a gap that represents precisely the opportunity for first-moving Indian producers[40].

When Indian companies implement green supply chain methodologies including life cycle assessment (LCA), cleaner production technologies, eco-design principles, reverse logistics, and product carbon footprint analysis, the combined effect is two-fold. There could be immediate cost reductions through identification of hotspots to improve energy and resource efficiency, and enhanced brand reputation that supports both price realization and access to institutional investors increasingly incorporating ESG criteria into procurement decisions.

[38] Market Research Report, Polaris Market Research, 2025, (https://www.polarismarketresearch.com/industry-analysis/green-premium-products-market)

[39] Consumers willing to pay 9.7% sustainability premium, even as cost-of-living and inflationary concerns weigh: PwC 2024 Voice of the Consumer Survey, PwC, 2024, (https://www.pwc.com/gx/en/news-room/press-releases/2024/pwc-2024-voice-of-consumer-survey.html)

[40] 60 pc in India Willing to Pay a Premium for Sustainable Products, Indian Retailer Bureau, 2022 (https://www.indianretailer.com/article/whats-hot/retail-trends/60-pc-in-india-willing-to-pay-a-premium-for-sustainability-products.a7988)

Adaptation also brings in opportunities for technology transfer and capability acquisition flow through development cooperation, trade capacity-building, and bilateral investment frameworks. Firms that demonstrate early adoption of sustainability standards gain access to technical assistance, capacity building support, and technology transfer opportunities that later moving competitors must pay for commercially.

5.3 Overview of Key Environmental Regulations Reshaping International Trade

Compliance with the evolving environmental regulations is becoming critical not only for environmental stewardship but also for maintaining global market access and competitiveness. As highlighted in earlier sections, the EU has emerged as the principal architect of binding environmental regulations, constructing a multi-layered regulatory architecture that transforms environmental compliance from a voluntary commitment into a mandatory condition for market access. At the core of this architecture lie four inter-connected regulations.

Carbon Border Adjustment Mechanism (CBAM)

Starting October 2023, the European Union introduced a new regulation that directly impacts how exporters do business with Europe. CBAM initially targets six carbon-intensive sectors at highest risk of carbon leakage, viz. cement, iron and steel, aluminium, fertilizers, hydrogen, and electricity. The EU selected these sectors because they face the most intense carbon pricing pressure domestically and are most vulnerable to being undercut by imports from countries without equivalent carbon costs. In terms of its structure, CBAM is not a tariff in the traditional sense, but is a carbon cost that ensures imported goods carry the same climate burden as products made within the EU. CBAM's core intent is simple but far-reaching, to prevent carbon leakage. This occurs when European manufacturers, facing high carbon costs under the EU's Emissions Trading System (ETS)[41], relocate production to countries with weaker climate rules or when the EU buyers simply import cheaper, carbon-intensive goods from abroad. By putting a carbon price on imports equivalent to what the EU producers pay, CBAM levels the playing field and reinforces the EU's ambition to achieve climate neutrality by 2050. Exporters to the EU will need to measure, report, and eventually pay for the embedded emissions[42] in their products. Thus, CBAM operates alongside the EU ETS and extends carbon pricing to imports.

The Transitional Period (October 1, 2023 – December 31, 2025) for CBAM is over where, the EU importers (called "CBAM declarants") collected and reported emissions data quarterly, but no financial payment was required or done. This was essentially a data gathering exercise where importers declared quantities imported, embedded emissions, and any carbon price already paid in the country of origin. The goal was to refine the system and help supply chains prepare. Indian exporters have already been witnessing asks on emissions data from EU buyers[43]. Ability to provide actual verified information on specific embedded emissions of the goods could decide whether importers would continue working with the Indian exporters.

[41] Under the ETS, EU manufacturers must buy allowances for every tonne of CO_2 they emit.

[42] These are the carbon footprints built into your goods during production, and CBAM splits them into two categories. Direct emissions are the CO_2 equivalent released during the actual production process itself, including emissions from producing the heating and cooling used in production, regardless of where that energy comes from. Indirect emissions are the CO_2 equivalent from generating the electricity consumed in your production process, no matter where that electricity was generated.

[43] Interactions with different industries has highlighted this.

The recently started Definitive Period (January 1, 2026, onwards) mandates that the CBAM declarants must purchase CBAM certificates from the CBAM registry operated by the competent authority of the EU Member State, matching the embedded emissions in their imports. However, the actual obligation to purchase certificates will commence from 2027. The certificate price is tied to the weekly average auction price of EU ETS allowances, currently fluctuating between €60-90 per tonne of CO_2.

One of CBAM's most significant risks for Indian MSMEs emerged in recent EU guidance notes that if the enterprises cannot provide verified emissions data, importers must use "default values"[44] set at the level of the worst-performing 10% of EU installations in that sector. This is not a theoretical concern but becomes a commercial threat, as these inflated default values directly translate into significantly higher CBAM certificate costs, making goods uncompetitive compared to suppliers who can document their actual (likely lower) emissions.

Verification requirements for the reported data are also tightening in the Definitive Phase as opposed to the transitional phase that allowed some flexibility such as allowing importers to use estimates or supplier declarations without full verification. From 2026 onward, the EU is likely to require third-party verification of emissions data, similar to how EU installations under the ETS are audited. This means Indian facilities may need to engage accredited verifiers (auditors recognized under EU ETS) to verify their emissions calculations, which would add additional cost for the operator (Indian exporters).

EU Deforestation Regulation (EUDR)

Deforestation is a main driver of the climate and biodiversity crises, and the EU contributes to it by consuming a significant share of products associated with deforestation. The Intergovernmental Panel on Climate Change (IPCC) has found that halting deforestation and restoring ecosystems is one of the most efficient ways to reduce CO_2 levels and thus fighting climate change. EUDR, adopted in 2023 aims to ensure that a set of key products traded and consumed in the EU and globally no longer contribute to deforestation and forest degradation. The regulation applies to operators who either place on the EU market or export from it, a specific set of commodities or products viz. palm oil, cattle, soy, coffee, cocoa, timber and rubber, as well as derived products such as beef, furniture, and chocolate listed in Annex 1 of the Regulation[45]. It is relevant for both domestically produced and imported goods. It was supposed to come into force starting December 30, 2024, for large companies but the start was initially postponed by one year. Further, the latest amendment[46] approved by the EU notes that large operators[47] will need to comply with the law from

[44] Default values are intentionally punitive. They are unrelated to actual emissions or production efficiency. For example, if a steel plant is relatively clean but lacks proper documentation, the exports from the plant will be penalized in a way as if it's among the highest emitted producers in Europe. The EU hasn't fully clarified who determines which installations are worst performing, for non-EU countries, adding uncertainty. More importantly, these inflated default values translate directly into higher CBAM certificate costs, making goods uncompetitive compared to suppliers who can document their actual (likely lower) emissions.

[45] Regulation (Eu) 2023/1115 Of the European Parliament and of the Council, EU Parliament, 2024, (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02023R1115-20241226)

[46] Deforestation: Council signs off targeted revision to simplify and postpone the regulation, EU Council, 2025, (https://www.consilium.europa.eu/en/press/press-releases/2025/12/18/deforestation-council-signs-off-targeted-revision-to-simplify-and-postpone-the-regulation/)

[47] An "operator" is defined in the EUDR as any natural or legal person who places on the EU market or exports from its relevant commodities or products in the course of a commercial activity. Here, placing on the market means the first making available of a relevant product on the EU market.

December 31, 2026, and, micro and smaller operators from mid-2027. European Commission will also be conducting a simplification review of the regulation by April 30, 2026, , opening space for further delays and rollbacks.

To meet the requirements of the regulation, companies placing or exporting the affected products in or from the EU market will have to conduct due diligence to confirm that the products have not been sourced from land which was deforested or degraded after December 31, 2020. Companies will also have to verify that these products are compliant with relevant legislation of the country of production, including respect for human rights, and the rights of affected indigenous people

Eco-design for Sustainable Products Regulation (ESPR)

The EU's ESPR represents a foundational shift toward making sustainable, circular products the norm within the European market. It establishes mandatory (over a phased time period) environmental requirements for most goods, aiming to reduce environmental impact across their entire lifecycle, from raw material extraction to end-of-life management.

The central objective of ESPR is to enhance product durability, repairability, recyclability, and energy efficiency while eliminating hazardous substances. This directly affects Indian exporters across priority product groups including textiles & apparel, furniture, iron & steel, aluminium, tyres, chemicals (e.g., paints, detergents), electronics, and information and communication technology (ICT) products. Compliance hinges on two pillars: Mandatory Performance Requirements (e.g., minimum wash cycles for textiles, seam strength for furniture) and comprehensive Information Requirements, primarily fulfilled through the Digital Product Passport (DPP).

Digital Product Passport (DPP) Implementation

The DPP, the operational component of ESPR, with initial requirements beginning in 2026, would be a digital record accessible via QR code. The implementation follows a phased approach spanning five years, with the first wave targeting batteries and energy-intensive industrial products in 2026-2027. The rollout would progressively expand to include electronics, textiles, furniture, and vehicles during 2028-2029, culminating in a fully integrated DPP system by 2030 when all product categories sold in the EU must carry a digital passport. Businesses face significant uncertainty as the delegated acts, which will detail exactly what information must be included in DPPs and how, remain unpublished, making it difficult to prepare structured compliance strategies.

Product-Specific DPP Data Requirements

The illustrative DPP requirements tailored to each product category include:

i. Batteries & EVs: Requires data on chemistry, carbon footprint, critical raw material (e.g., cobalt, lithium) sourcing regions, and due-diligence indicators, supporting the existing EU Battery Regulation.

ii. Textiles & Apparel: Focuses on detailed fibre composition (including blends), origin of materials, care/ repair instructions, and environmental indicators like water footprint.

iii. Electronics: Emphasizes repairability (spare part availability, manuals), hazardous substance disclosure, and component traceability, aligning with WEEE and RoHS directives.

iv. Construction Materials: Centres on declared performance (strength, fire behaviour), detailed material composition, and product-level carbon footprint to inform sustainable building.

v. Metals (e.g., Steel/Iron): Highlights raw material origin, recycled content share, production pathway, and batch-specific carbon footprint, supporting the Critical Raw Materials Act.

Exporter Responsibilities

Indian exporters to the EU bear the legal responsibility to ensure placed products comply, maintain technical documentation for a decade, verify manufacturer conformity, and cooperate with EU market surveillance, including product recalls, if needed. ESPR mandates the immediate elimination of hazardous substances like carcinogenic, mutagenic, and reprotoxic (CMR) chemicals, persistent, bioaccumulative & toxic (PBT) substances, and specific flame retardants or heavy metals. This necessitates deep supply chain engagement. Exporters must ensure their suppliers (of raw materials and components) meet these eco-design standards and must document full traceability, providing compliance information to authorities, if requested.

6. Impact of Environmental Regulations on India’s Trade

Global environmental regulations are creating differentiated impacts across India's key export sectors, with varying degrees of readiness and vulnerability. Energy-intensive industries such as steel, aluminium, and cement face immediate cost pressures under carbon pricing mechanisms like CBAM, while labour intensive sectors including textiles, leather, and footwear must navigate complex supply chain transparency and circularity mandates. Agricultural exports confront deforestation-free sourcing requirements, and the chemical industry grapples with restrictions on hazardous substances and extended producer responsibility. The automotive and electronics sectors, deeply embedded in global value chains, face mounting pressure to demonstrate carbon footprint reductions and adopt circular design principles. Understanding these sector-specific challenges and opportunities is critical for designing targeted policy responses that protect India's export competitiveness while advancing sustainability objectives.

6.1 Sectoral Impact Analysis

6.1.1 High-Exposure Sectors under CBAM

Industries characterized by high energy intensity and process emissions face direct financial and operational impacts from CBAM. The iron and steel sector, primarily classified under HS Chapters 72 and 73, stands as the most exposed, given the EU's status as a leading destination for Indian exports. The regulation's scope is comprehensive, targeting basic forms like ingots and rolled products, with a clear intent to broaden into downstream articles to prevent circumvention. Similarly, the aluminium industry (HS Chapter 76, covering products from unwrought metal to plates and structures) is within the mechanism's ambit, with trade data already indicating market adjustments in anticipation of compliance costs. The cement sector (HS 2523) and key fertilizer products, especially carbon-intensive nitrogen-based variants and their precursors such as ammonia (HS 2814) and urea (HS 3102), are also covered. It is important to note that the HS codes and chapters referenced here are indicative; exporters must refer the CBAM Regulation EU 2023/956, EU 2025/2083 and annexes to the proposal for a regulation of the European Parliament and of the Council amending Regulation (EU) 2023/956 amended in December 2025 to verify the full list of obligated products.

6.1.2 High-Exposure Sectors under EUDR

The EUDR imposes a different kind of challenge, built around supply chain transparency and proof of sustainable sourcing for commodities linked to deforestation. India’s leather exports, specifically raw and tanned bovine hides and skins (HS 4101, 4104, 4107), are directly regulated, placing a significant due diligence burden on a traditionally strong export segment. Natural rubber and manufactured articles like tires (HS 4001, 4011) are included due to the association of rubber cultivation with forest conversion. Major agricultural exports such as coffee (HS 0901), cocoa (HS 1801), and soybeans, oil, and meal (HS 1201, 1507, 2304) are core regulated commodities. Exporters must now provide geolocation data and verifiable evidence that their

products are deforestation-free. Furthermore, the timber and wood products sector, spanning from raw logs to finished furniture and paper (HS 44, 94), is covered. Compliance necessitates robust traceability systems back to the plot of land, impacting countless smallholders and processors within these supply chains.

6.1.3 Sectors with Differentiated or Emerging Risk

The regulatory impact is not uniform. The textiles sector (HS Chapters 52, 61, 62), despite its export volume to the EU, currently remains outside the direct scope of both CBAM and EUDR, as finished goods and cotton are not listed. However, the risk of future sector-specific sustainability mandates persists. Palm oil (HS 1511) is a high-priority commodity under EUDR, though India's direct exposure is limited as a net importer. A notable emerging concern is maize (HS 1005), which is under formal review for addition to the EUDR, representing a potential future compliance hurdle for exports[48].

The exposure of Indian sectors to these regulations is significant and evolving. For industries under CBAM, such as steel, aluminium, cement, and fertilizers, compliance is already urgent, and the future outlook points toward expansion into more finished goods, increasing both cost and complexity. Under the EUDR, future expansions are likely to include commodities such as maize.

Looking ahead, these environmental regulations are expected to broaden in scope and be adopted by other major markets. Exporters should treat compliance not as a one-time obligation, but as an ongoing strategic priority vital for long-term resilience and market access.

6.2. Practical Issues and Challenges Exporters Face in Sectors[49]

Across multiple export-oriented sectors, environmental regulations are increasingly perceived not as isolated compliance requirements, but as structural shifts in market access conditions. Exporters consistently highlighted that the transition from traditional quality and price-based competition to data-driven environmental and social compliance is creating significant operational, financial, and organizational challenges.

Awareness and Interpretation Gaps

A dominant issue across sectors is low awareness and limited clarity regarding upcoming regulations such as CBAM, EUDR, DPP, extended[50] chemical compliance regimes, and traceability obligations. Many exporters, especially MSMEs and Tier-II/Tier-III suppliers, remain uncertain which regulations apply to their products, markets, and HS codes, and whether requirements apply directly or indirectly. In several cases, exporters only became aware of new obligations when their shipments were delayed, cancelled, or subjected to additional documentation requests, indicating a reactive rather than proactive compliance culture.

Lack of Verified Emissions and Sustainability Data

A critical cross-sectoral bottleneck is the absence of credible, verifiable datasets for carbon emissions, energy use, water consumption, chemical inputs, and land-use impacts. Exporters reported difficulty obtaining

[48] The European Union's Deforestation Regulation (EUDR -Regl. (EU) 2023/1115), 2023 (https://unece.org/sites/default/files/2023-12/FORESTA2023-COFFI-81-EFC-42-item-04-c-02-forest-economics-and-markets-policies-europe-wall.pdf)

[49] This section draws insights from discussions and feedback received during stakeholders' interaction sessions with exporter.

[50] The term "extended" reflects the trend of these compliance regimes expanding in terms of substances covered, sectors affected, supply chain depth required, and reporting granularity.

upstream data (Scope 3 emissions, raw material footprints, farm-level traceability), particularly where supply chains are fragmented or informal. Many suppliers continue to rely on self-declarations and undertakings, which are increasingly viewed as insufficient under the EU and the US regulations requiring third-party verification. Sectoral benchmarks or national databases for emissions factors are largely unavailable, forcing exporters to depend on consultants or foreign datasets at high cost.

Fragmented and Opaque Supply Chains

Sectors such as textiles, leather, rubber, agri-commodities, and engineering goods face deep supply chain fragmentation, often spanning multiple states, intermediaries, and small producers. Traceability requirements under deforestation, circularity, and DPP rules are difficult to meet when farmers, small processors, recyclers, and sub-contractors lack digital systems or sustainability awareness. Exporters highlighted resistance from suppliers to share supplier-level information, driven by confidentiality concerns, fear of audits, or lack of documentation.

Cost of Certification and Compliance

The financial burden of compliance emerged as one of the most consistently cited barriers. Costs include life-cycle assessments, Environmental Product Declarations (EPDs), chemical testing, sustainability audits, product certifications, digital traceability tools, and recurring renewal fees. For MSMEs, compliance costs can be disproportionate to order size, making small export consignments commercially unviable. Hidden and ancillary costs, such as registration fees, consultant charges, data management, and internal manpower, often exceed headline certification costs. While financing schemes and incentives exist, exporters reported limited awareness, complex access procedures, and lack of handholding, reducing uptake. Cluster-based infrastructure (common treatment plants, shared testing labs, collective data platforms) exists in some regions but is uneven and not universally accessible.

Recognition and Acceptance of Standards

Exporters across sectors reported challenges related to recognition of Indian test results and certifications in regulated markets. Buyers frequently insist on testing or certification from specific international agencies, even when equivalent domestic facilities exist. This duplication increases cost and time and challenges confidence in domestic conformity assessment systems. Inconsistent or evolving buyer interpretations of regulations further complicate compliance planning.

Digitalisation and Documentation Burden

Emerging regulations increasingly rely on continuous digital reporting, creating new pressures on exporters. Requirements for DPPs traceability platforms, and carbon reporting systems demand structured data collection over multiple years. MSMEs highlighted limited internal capacity for digital data management and lack of trained sustainability personnel. Exporters anticipate a sharp rise in documentation, audits, and administrative scrutiny, raising concerns about delays and compliance fatigue.

A FEPS-NIPFP[51] study emphasizes that CBAM compliance, which requires detailed quarterly reporting of direct and indirect emissions data, methodologies, and verification documentation, imposes compliance costs that disproportionately burden smaller firms unable to absorb these administrative and technical expenses. Indian firms report that maintaining dual pricing structures, one for CBAM-compliant EU shipments, another for non-EU markets, creates operational complexity that advantaged larger competitors better absorb.

Uneven Pressure Across Value Chains

Regulatory pressure is currently unevenly distributed. Large exporters, OEM-linked suppliers, and firms selling directly majorly to Europe are under immediate scrutiny. Lower-tier suppliers and domestic-focused firms remain relatively insulated, delaying preparedness and risking sudden disruption when requirements cascade downstream. This asymmetry creates coordination challenges, as compliant exporters struggle to source from unprepared suppliers. There is also resulting of a tiered competitiveness landscape where only firms with capital to invest in emissions accounting systems, carbon pricing infrastructure, and certification mechanisms can maintain access to premium export markets.

Low Technological Maturity

Many low-carbon solutions are still in developmental stages or lack large-scale deployment experience in the Indian context. This uncertainty makes industries hesitant to adopt innovative technologies without proven efficacy and reliability. Additionally, high upfront capital costs, challenges in access to green financing, and inconsistent policy incentives further slowdown early adoption. The absence of localized data and performance benchmarks often undermines investor confidence. Strengthening demonstration projects and public–private partnerships could help bridge this trust gap and accelerate commercialization.

6.3 Sectoral Case Examples

Case 1: Carbon and Product Data as Market Gatekeepers

Exporters of engineering, metal, and industrial goods, supplying to regulated markets reported that absence of product-level environmental data increasingly leads to lost orders. In one instance, failure to provide an EPD within required timelines resulted in cancellation of a confirmed export order, despite long-standing buyer relationships. This highlighted that compliance delays now translate directly into commercial losses, not just reputational risk.

Case 2: Deforestation and Traceability in Agri-Based Exports

Agri-commodity processors sourcing from multiple regions reported uncertainty in meeting deforestation-free requirements due to diffuse farm sourcing and lack of land-use records. While awareness of regulations exists, exporters expressed concern about how to practically demonstrate compliance when raw materials originate from hundreds of smallholders. Some exporters are reconsidering EU market focus, redirecting exports to less regulated destinations until clearer guidance and systems emerge.

[51] Evaluating the impact of CBAM on developing countries, Foundation for European Progressive Studies, 2024, (https://feps-europe.eu/publication/evaluating-the-impact-of-cbam-on-developing-countries/)

Case 3: Leather and Rubber Supply Chains under Pressure

Exporters in leather and rubber-based sectors noted increasing buyer scrutiny on raw material origin, chemical use, and traceability. Small exporters highlighted that testing and certification costs for chemical compliance cannot be absorbed for low-volume orders, leading to pricing pressure and margin erosion. Larger players with certified inputs and established systems are better positioned, highlighting a growing compliance divide within the sector.

Case 4: MSMEs and Market Exit Risks

Several MSME exporters across food, chemicals, gems and jewellery, and consumer goods sectors indicated that regulatory complexity, payment delays, certification costs, and loss of incentives are cumulatively discouraging exports. In some cases, firms with established export capabilities are pivoting toward domestic markets due to faster payments and lower compliance burden, leading to under utilisation of export infrastructure.

6.4 Overall Impact on Trade and GDP

The quantitative impact of the environmental regulations on India's macro-economic performance presents a paradoxical picture. While the aggregate GDP impact appears modest in isolation, the concentrated sectoral exposure reveals substantial underlying disruption if mitigation measures are not implemented.

The Baseline Negative Impact Scenario, modelled through Computable General Equilibrium (CGE) utilizing an economy-wide model calibrated to India's 2022-2023 input-output structure, projects that without domestic carbon pricing mechanisms, as per the Centre for Social and Economic Progress (CSEP) report, India's GDP could decline by 0.02 to 0.03% between 2026 and 2030 due to the carbon revenue outflows to the EU from CBAM compliance[52]. This modelling emphasizes that while CBAM-covered exports represent only 0.2% of India's total GDP, the concentration of these exports within carbon-intensive sectors, particularly iron and steel, which constitutes 90%of CBAM-exposed shipments, creates disproportionate sectoral vulnerability despite minimal aggregate GDP metrics. There is concern that imposing carbon tariffs could erode India’s export competitiveness and increase production costs in key industries. The study[53] also takes an alternative scenario termed PCARBON, under which, if India implements its own carbon tax aligned with but lower than the EU's carbon price, the government could generate carbon tax revenue of ₹ 2,93,000 crore in 2026 and ₹ 3,61,100 crore in 2030, that is approximately 1% of GDP in carbon tax revenue and this revenue could be recycled domestically to offset household and industry losses. Under the PCARBON + CBAM scenario combining domestic carbon pricing with EU compliance, India's GDP impact reverses to a small positive gain (0.01%) in later years as the retained domestic carbon revenue enables compensatory transfers and productivity-enhancing investments.

[52] Assessing the Distributional Implications of the EU’s CBAM on India: A CGE Analysis, Centre for Social and Economic Progress, 2025 (https://csep.org/working-paper/assessing-the-distributional-implications-of-the-eus-cbam-on-india-a-cge-analysis/).

[53] Assessing the Distributional Implications of the EU’s CBAM on India: A CGE Analysis, Centre for Social and Economic Progress, 2025 (https://csep.org/working-paper/assessing-the-distributional-implications-of-the-eus-cbam-on-india-a-cge-analysis/).

A study by Council on Energy, Environment and Water (CEEW) projects that India will face export losses of US$ 771 million corresponding to a 0.72% decline in output destined for the EU across CBAM-affected products[54]. When contextualized within the UNCTAD global assessment, developing countries are collectively expected to face up to US$ 16 billion in additional import charges under CBAM, with India, Brazil, and South Africa identified as the most exposed economies amongst the developing countries.

Additional regulations including EUDR, ESPR, and due diligence requirements can create cumulative tariff equivalent barriers that compound the headline CBAM impact.

6.5 Sectoral Output Losses and Trade Exposure: The Concentration Problem

While aggregate GDP impact appears manageable, sectoral vulnerabilities are clearly visible. A recent GTRI report[55] documents that the CBAM mechanism is already causing measurable economic damage even before full implementation, with Indian exporters facing a cascading series of compliance burdens, cost pressures, and market access restrictions. India's steel and aluminium exports to the EU have plunged dramatically, declining 24.4% from US$ 7.7 billion in FY 2024 to US$ 5.8 billion in FY 2025. The reporting mandate alone, which began in October 2023, has caused many small and mid-sized exporters to suspend shipments. Iron and steel exports have been hit hardest, declining 35.1% to US$ 3.1 billion, while aluminium exports fell 9.8% and articles of iron and steel declined 6.8%. The report notes that even after India's forthcoming Carbon Credit Trading Scheme (CCTS) becomes operational, Indian carbon prices are expected to remain below US$ 10 per tonne, far below the EU ETS price of approximately €65/US$ 71 per tonne. This means exporters will still need to pay the difference, roughly US$ 61/tCO_2 as CBAM liability, creating a substantial additional cost burden.

EUDR creates exposure across agricultural and forestry-dependent sectors. Approximately 479 product categories worth US$ 1.3 billion annually representing 23.6% of India's global exports in these categories fall within EUDR's regulatory scope[56]. The coffee sector of India exports over 70% of its coffee with nearly 60% heading to the EU exemplifies this challenge. Only 20% of the coffee production has achieved EUDR-ready certification through mechanisms like Rainforest Alliance verification, and the remaining 80% faces potential market exclusion unless certification is rapidly scaled. The leather, paper, and wooden furniture industries similarly confront significant supply chain restructuring requirements to achieve deforestation-free sourcing and geolocation-based traceability compliance.

Sustainability rules for the textile sector require ethical sourcing, safe working conditions and pollution control traceability, stricter chemical restrictions, raising fixed compliance costs (audits, certifications, data systems, process upgrades), which are particularly challenging for India’s fragmented MSME dominated textile clusters and could weaken price competitiveness against more consolidated supplier countries. Suppliers unable to comply with these requirements, may be phased out of high-value orders even if their unit cost are lower. New EPR and circularity requirements in the EU imply that brands will prefer suppliers that can help them

[54] EU Carbon Border Adjustment Mechanism, CEEW, 2025 (https://www.ceew.in/sites/default/files/facet-eu-carbon-border-adjustment-mechanism-report.pdf).

[55] Countdown to CBAM: EU will start collecting tax from Jan 1, 2026, (https://gtri.co.in/DisplayFlagshipReports.aspx?ID=122#:~:text=for%20all%20countries.,%E2%80%A2,%E2%80%A2).

[56] EU’s deforestation regulation set to affect exports of 479 agriculture items from India, says research report, 2023, (https://www.thehindubusinessline.com/economy/eus-deforestation-regulation-set-to-affect-exports-of-479-agriculture-items-from-india-says-research-report/article66866948.ece).

design for recyclability, reduce waste and provide composition data, potentially diverting orders away from conventional Indian producers that still rely on mixed fibres, hazardous chemicals or informal waste handling. Restrictions on waste exports and tougher rules on synthetic microfibres also threaten low-value, fast-fashion-oriented export segments. CBAM is not yet applied to textiles, but policy analyses flag the risk that the mechanism or similar carbon-pricing tools could be extended to high-emitting textile value chains, exposing coal-reliant wet-processing and spinning operations in India to future carbon cost pass-through. This would disadvantage exporters that do not invest in energy efficiency and cleaner energy relative to competitors with lower embedded emissions.

Regional concentration magnifies the employment dislocation. Odisha, historically the foundation of India's iron and steel industrial base, hosts major integrated steel producers and mining operations. The sector employs about 2.8 million people directly and indirectly but is dominated by small-scale units with low productivity due to outdated technology, unskilled workers, and informal employment. The sector also has significantly higher GHG emission intensity compared to the global average[57]. A reduction in EU-destined steel exports could impact workers in the State. Chhattisgarh, the second-largest steel production centre, faces similar potential implications. These regions, characterized by limited economic diversification and significant dependence on commodity extraction and heavy manufacturing, lack the institutional capacity for rapid workforce transition and retraining.

6.6 Sectoral Output and Competitiveness Recovery: From Loss to Premium Positioning

Beyond aggregate employment and GDP metrics, adaptation to the environmental regulations enables sectoral competitiveness recovery through premium market positioning rather than commodity price competition. This strategic repositioning fundamentally can alter the trade dynamics underlying CBAM impact.

In steel, while low-cost commodity export markets will be difficult to maintain under CBAM carbon costs, green steel produced through renewable-powered EAF, hydrogen Direct Reduced Iron (DRI,) or blast furnace with integrated carbon capture commands premium prices in developed-country markets. A modelling exercise finds that green steel prices trade at a premium to conventional steel in EU, UK, and North American procurement systems, specifically because major OEMs and construction companies have net-zero commitments requiring sustainable supply chains[58]. Steelmakers investing early in emissions measurement, green technology deployment, and transparent supply chain reporting position themselves to capture these premium segments, generating higher profit margins that offset volume losses from CBAM competitiveness erosion.

In coffee and specialty exports, EUDR compliance becomes a market-access prerequisite that, when achieved early, provides competitive differentiation and premium pricing. Indian coffee exporters with EUDR-ready certification can access specialty coffee markets in Europe where sustainable sourcing commands 20%-40% price premiums over commodity coffee. One of the coffee producers from Karnataka in May 2024 became the first Indian farm verified by Rainforest Alliance to ship EUDR ready coffee beans into Europe and it exemplifies

[57] Just Transition in Odisha for Green Growth and Green Jobs. International Forum for Environment , Sustainability and Technology (Iforest), 2024. (https://iforest.global/wp-content/uploads/2025/10/Just-Energy-Transition-Odisha-Report.pdf)

[58] Unlocking green steel demand, EY Parthenon, 2025, (https://www.ey.com/content/dam/ey-unified-site/ey-com/en-in/insights/mining-metals/doucments/ey-unlocking-green-steel-demand-digital.pdf).

how certification converts compliance from a cost centre into a market-opening asset[59]. It presents a case of how EUDR certification, rather than representing a cost burden, becomes a market-opening asset enabling entry into premium segments previously inaccessible without sustainability credentials.

In textiles, green and sustainable textile production creates entry points into premium segments (athleisure, technical fabrics, luxury sustainable fashion) where global brand OEMs increasingly concentrate procurement to meet net-zero commitments. India's textile sector aspiration of reaching US$ 350 billion in value by 2030 (with US$ 100 billion in exports)[60] explicitly targets green textile positioning, with government support through the PLI scheme for technical and sustainable textiles (₹ 10,683 crore allocation)[61] and the InTex India programme supporting SME cluster transitions[62]. This represents not merely compliance with ESPR and EUDR requirements but proactive market positioning to capture growing demand for sustainable textiles in developed-country markets.

6.7 Policy Implications and Synergies with India's Macroeconomic Aspirations

The impact assessment demonstrates that adaptation to the emerging global environmental regulations is not merely a compliance burden to minimize, but a strategic opportunity to advance India's broader macroeconomic aspiration of achieving a US$ 5 trillion economy while positioning as a responsible and reliable trading partner in developed-country value chains. The synergies are multiple.

First, green technology adoption enhances industrial efficiency and profitability independent of CBAM. Renewable energy costs in India are among the lowest globally (US$ 30-40 per megawatt-hour for solar, US$ 40-50 for wind), substantially below fossil fuel alternatives. Steel mills powered by renewable electricity reduce operational energy costs by 15 to 25%, while simultaneously achieving CBAM compliance, creating a “twin benefit” of cost competitiveness and environmental performance.

Second, green exports open opportunities to access premium priced global markets increasingly reserved for sustainability compliant suppliers. As developed-country companies implement net-zero commitments and ESG procurement requirements, suppliers lacking green certifications face de facto market exclusion from large institutional buyers. Early Indian adoption of green production and supply chain practices captures first-mover advantages in premium market segments where price competition is minimal, and brand loyalty supports sustained price realization.

Third, alignment with emerging global environmental regulations positions India as a key player in Global South leadership. India's climate justice advocacy emphasizing “common but differentiated responsibilities” (CBDR) is credible only if India itself demonstrates comprehensive domestic climate action and investment. By proactively implementing green transitions across export sectors, India strengthens its diplomatic position in the Global South.

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[59] First EUDR-Ready Coffee Verified by the Rainforest Alliance Bound for Europe, Rainforest Alliance, 2024, (https://www.rainforest-alliance.org/press-releases/first-eudr-ready-coffee-bound-for-europe/)

[60] India’s textile industry expected to grow to US$350 bn by 2030 and add 3.5 crore jobs: Shri Giriraj Singh, Ministry of Textiles, 2025 (https://www.pib.gov.in/PressReleasePage.aspx?PRID=2051849&reg=3&lang=2).

[61] Government has approved Production Linked Incentive (PLI) Scheme for Textiles. With this, India is poised to regain its dominance in Global Textiles Trade, PIB Delhi, 2021 (https://www.pib.gov.in/PressReleasePage.aspx?PRID=1753118&reg=3&lang=2).

[62] InTex India Project supports Small and Medium-sized Enterprises (SMEs) in adopting circular business models and life cycle approaches through capacity-building workshops and policy support, in key textile hubs, including Surat, Karur, Salem, Dindigul, and Perundura.

7. Adaptation and Mitigation Strategies to Comply with Environmental Regulations

7.1 Renewable Energy Expansion

India under its rapid renewable energy expansion efforts is targeting 500 GW non-fossil fuel capacity by 2030. Efficient technologies are critical enablers for compliance with trade regulations like CBAM, slashing Scope 2 emissions in energy-intensive exports. A report from a think tank notes that to fully decarbonise their electricity use and remain competitive in the global market, India's heavy industries require 120 GW of dedicated renewable energy capacity by 2030[63]. The report further highlights that renewables could avoid 17% of heavy industry emissions by 2030, while stimulating clean manufacturing and multi-billion dollar investments amid global carbon tariffs. It further emphasizes that green electrification offers a pathway for industries to meet increasing national and international emission regulations. The declining costs of electricity sourced from renewables present economic advantages in India. Industries stand to gain from primary energy savings and protection from volatile fuel prices. Further, the rising demand for renewables in industrial decarbonisation can attract large-scale investments in renewable energy projects, creating new jobs and invigorating India's renewable energy ecosystem by integrating hydrogen into the energy mix.

7.2 Skills Development and Workforce Transition

This represents both an employment opportunity and an essential investment. The Skill Council for Green Jobs (SCGJ), established under India's Ministry of Skill Development, targets training more than 150,000 workers annually in green energy, green building, sustainable agriculture, and circular economy roles. Academic institutions including IIT Delhi, National Institute of Fashion Technology (NIFT), and National Institute of Design (NID) are introducing specialized curricula in green engineering, sustainable design, and environmental management, creating institutional capacity for sustained workforce transition. Industrial Training Institutes (ITIs) must urgently integrate green skilling into core curricula covering emissions accounting, EAF operations, EUDR geo-location mapping, and renewable energy maintenance to equip the workforce to participate in the green transitions. ITIs should scale NSQF-aligned courses on key required trades such as solar kiln integration and blockchain traceability, ensuring SMEs access certified workers for low-carbon transitions. By offering a comprehensive curriculum, specialized labs, and industry support, the academic and training institutes can equip students with hands-on skills and certifications, enhancing their employability and positioning them to lead in a sustainable, innovation-driven future.

[63] Navigating CBAM: Renewables can cut 17% of India's heavy industry emissions by 2030, Ember, 2024 (https://ember-energy.org/latest-updates/navigating-cbam-renewables-can-cut-17-of-indias-heavy-industry-emissions-by-2030/).

7.3 Certifications

For Indian exporters, the critical pathway to capturing these premium markets is through sustainability certifications that serve as market passports by documenting attributes of sustainability. As highlighted earlier the case of the coffee producer from Karnataka that became the first Indian farm verified by Rainforest Alliance to ship EUDR ready coffee beans into Europe in 2024 exemplifies how certification converts compliance from a cost centre into a market-opening asset[64].

The Indian chemical sector provides another instructive case study. Many companies have adopted internationally recognized certifications including ISCC PLUS (for renewable feedstock traceability) and Responsible Care, enabling them to access higher-value contracts in sensitive developed-country markets. It helps the exporters boost credibility, reduce regulatory risks, and future-proof their market presence in an era where sustainability defines competitive advantage.

The Directorate General of Commercial Intelligence and Statistics (DGCI&S) June 2025 data reveals that specialty and green-certified chemical exports to the United States now represent 18 to 20% of India's US$ 5.3 billion chemical export portfolio, commanding premium pricing that reflects buyer willingness to pay for verified sustainability credentials.

The Global Organic Textile Standard (GOTS) certification demonstrates how sustainability standards have benefitted Indian exporters. India now accounts for more than 50% of global organic cotton production, largely due to GOTS certification providing verified credentials that meet international standards. This has opened premium market access in the EU and North America, with GOTS-certified Indian cotton products commanding price premiums of over 10% over conventional alternatives. Beyond trade benefits, GOTS has driven genuine sustainability improvements, eliminating harmful chemicals, conserving water, ensuring fair labour practices, and creating full supply chain traceability from farm to finished product. The GOTS experience proves that third-party certification could simultaneously validate sustainability claims, simplify compliance for international buyers, and create competitive differentiation, though its success relied heavily on industry collaboration, government support, and stable certification standards, lessons that will be critical for Indian MSMEs navigating CBAM and EUDR requirements.

7.4 Sustainable Finance Opportunities

Sustainable finance unlocks premium market advantages for Indian MSMEs meeting CBAM/EUDR standards by providing concessional capital for compliance and transitions[65]. India ranks as the fourth-largest emerging market source of aligned Green, Social, Sustainable and Other Labelled (GSS+) Bonds debt globally following China, South Korea, and Chile with cumulative issuance reaching US$ 55.9 billion by December 2024, up 186% from US$ 21.4 billion in 2021[66]. This is driven by SEBI's enhanced BRSR Core requirements, the RBI Green

[64] First EUDR-Ready Coffee Verified by the Rainforest Alliance Bound for Europe, Rainforest Alliance, 2024 (https://www.rainforest-alliance.org/press-releases/first-eudr-ready-coffee-bound-for-europe/).

[65] Sustainable finance incorporates ESG principles into business decisions and investment strategies, covering issues from climate change to labor practices.

[66] India's sustainable debt market tops US$ 55.9 billion – new MUFG-CBI report maps rapid growth and pathways to 2030, Climate Bonds Initiative, 2025 (https://www.climatebonds.net/news-events/press-room/press-releases/indias-sustainable-debt-market-tops-usd-55-9-billion-new-mufg-cbi-report-maps-rapid-growth-pathways-2030).

Deposit Framework, IFSCA sustainable finance guidance and a forthcoming national climate taxonomy which are standardising disclosures and boosting investor confidence. Certified exporters can access green loans at lower rates, longer tenors, and blended finance guarantees reducing equity needs. In emerging markets excluding China, ESG investments have surged to approximately 18% of foreign financing, quadrupling from recent-year averages and positioning ESG-compliant MSMEs to benefit from reduced capital costs[67].

7.5 Compliance Accounting Infrastructure

Targeted support for CBAM compliance and emissions accounting infrastructure is critical. While larger firms are establishing internal emissions reporting capabilities, small and medium enterprises lack resources for Scope 1 and Scope 2[68] emissions data collection, quarterly reporting, and verification and require subsidized technical assistance. The India CBAM Registry launched in January 2026 by EEPC India/FIEO under Ministry of Commerce and Industry (MOCI) offers a centralized portal for emissions data standardization, supplier verification, and EU importer access, reducing individual SME costs. Training for MSMEs on emissions monitoring, with local consultant pools and technology transfer for clean practices could play a key role[69]. The approach to providing support to MSMEs for CBAM should parallel India's successful approach to GST implementation, where the government provided transitional support and compliance infrastructure rather than imposing unilateral obligations[70].

India's demonstrated excellence in digital public goods (UPI as global real-time payments leader, Aadhaar as world's largest biometric ID and CoWIN for COVID vaccination platform serving 1 billion doses) provides a template for establishing national level supply chain traceability platforms integrating satellite geolocation, blockchain verification, and real-time emissions tracking. Such infrastructure would enable small producers to achieve geolocation based EUDR compliance without establishing individual proprietary systems, reducing compliance costs dramatically while ensuring data integrity. In 2025, the Rubber Board of India launched the Bharat Sustainable Natural Rubber (BSNR) initiative[71]: a bold, government-led response to the EUDR. Built in partnership with sustainability technology firm TRST01, the BSNR program is now regarded as one of the most ambitious traceability efforts in the global rubber sector. The platform enables inclusive compliance at scale, protects market access, and sets a precedent for how agricultural traceability systems can work in practice. For stakeholders across the supply chain, this means one thing: a future-ready path to trade resilience, environmental credibility, and digital empowerment. In January 2025, Agricultural and Processed

[67] Sustainable Finance in Emerging Markets is Enjoying Rapid Growth, But May Bring Risks, International Monetary Fund, 2022 (https://www.imf.org/en/blogs/articles/2022/03/01/sustainable-finance-in-emerging-markets-is-enjoying-rapid-growth-but-may-bring-risks)

[68] Scope 1 Emissions: Covers Direct Greenhouse Gases (GHG) emissions from sources owned or controlled by a company (e.g., burning fuel, industrial processes).
Scope 2 Emissions: Covers indirect emissions from the generation of purchased electricity, steam, heat, or cooling consumed by the company.

[69] Implications of global climate regulations on Indian MSMEs, UK Government, 2025 (https://www.sameeeksha.org/pdf/publications/Global%20climate%20regulations%20-Implications%20for%20Indian%20SMEs_final-190825.pdf).

[70] India's GST implementation succeeded for SMEs through transitional support rather than unilateral mandates: a Composition Scheme offered flat 1–6% taxes and quarterly filing for firms under INR 1.5 crore turnover; GSTN provided free digital tools integrated with Aadhaar/UPI; nationwide training camps reached 10 million+ enterprises; and threshold exemptions formalized 13 million unregistered SMEs with minimal closures (5–7% vs. predicted 20%). This infrastructure-first model ensured 65% of SMEs r eported improved compliance efficiency.

[71] How India is Building the World's Largest Rubber Traceability System for EUDR Compliance, Bharat Sustainable Natural Rubber, 2025 (https://bsnr.rubberboard.org.in/New%20Blog%20Page%20isnr.html).

Food Products Export Development Authority (APEDA) at the Ministry of Commerce launched the TraceNet 2.0, upgraded blockchain/IoT-based traceability for organic agri-exports, integrating geolocation and real-time monitoring for regulatory oversight and market access[72].

7.6 State Level Interventions

At the state level, adaptation requires recognition that green trade compliance creates opportunities for competitive state-level positioning. States hosting major export-oriented steel, aluminium, chemical, or agricultural sectors should establish state-level green transition roadmaps that:

First, attract green manufacturing investments through location-specific incentives for firms establishing zero-deforestation sourcing networks, renewable energy-powered production facilities, and certified supply chain infrastructure. States should compete not on lowest tax rates but on provision of green production ecosystem advantages (reliable renewable energy supply, institutional support for certifications, labour training programs).

Second, establish dedicated green export promotion agencies with mandates to support sectoral green certification and market access in premium global markets. These agencies should function as one-stop-shop service providers offering support across emissions accounting, certification navigation, supply chain transparency documentation, and green financing access.

Third, develop sectoral green competitiveness clusters. States hosting coffee, leather, agricultural, or forest product industries should establish integrated support systems for smallholder producer collectives to achieve EUDR compliance. Models should include government-provided geolocation mapping, shared supply chain documentation systems, and cooperative certification arrangements that reduce per-unit compliance costs. Learning could be drawn from the Central Government's scheme on promoting organic farming through the Paramparagat Krishi Vikas Yojana (PKVY), a component of Pradhan Mantri- Rashtriya Krishi Vikas Yojana (PM-RKVY). The PKVY scheme provides end-to-end support to organic farmers i.e. from production to processing, certification and marketing in cluster-based approach.

7.7 Sectoral Handholding by Industry Bodies

Industry bodies must guide and provide tailored support to high-exposure commodities. These bodies should prioritize rapid compliance with EU regulations like EUDR and CBAM while helping to unlock premium pricing for sustainable products.

Priority Commodities include:

Coffee: EUDR compliance certification could be deployed through small-holder cooperatives using the Coffee Board's example, which is actively engaging exporters and smallholders through its mobile app for grower registration, plantation geolocation mapping, and verification by extension officers, ensuring transparent, low-

[72] Union Minister of Commerce & Industry Shri Piyush Goyal launches 8th edition of National Programme for Organic Production, Ministry of Commerce & Industry, 2025 (https://www.pib.gov.in/PressReleseDetailm.aspx?PRID=2091601&reg=3&lang=2).

cost EUDR data sharing without external consultants[73]. This has supported US$ 1.8 billion in exports (FY 2025), positioning India as a low-risk supplier despite global challenges. grower registration app for geolocation mapping. Certified organic and regenerative coffee could be positioned for EU premiums, as 90% of India's producers operate on small plots.

Leather: Council for Leather Exports (CLE) could lead the rollout of blockchain-based traceability platforms linking cattle sourcing to tanneries, addressing EUDR requirements for CN codes 4101 (raw hides and skins), 4104 (tanned/crust hides), and 4107 (leather further prepared). Additionally, the adoption of vegetable tanning and chemical-reduced processes in Leather Working Group (LWG) certified facilities in Kolkata and Chennai could be accelerated to enhance both EUDR compliance and environmental sustainability.

Agro-processed products: Industry associations such as the Solvent Extractors' Association of India (SEA) and the Indian Oilseeds and Produce Export Promotion Council could facilitate supply chain mapping for deforestation-free soy, palm oil, and derivatives by promoting regenerative agriculture programs. Leveraging successful models like Organic India's agroforestry and composting practices, these bodies could help farmers and processors secure organic certifications while ensuring EUDR compliance and potential exemptions for sustainably sourced commodities.

Steel: Industry bodies like the Indian Steel Association (ISA) could play a catalytic role by collectively negotiating capital subsidies for Electric Arc Furnace (EAF) conversions and green hydrogen pilot projects. Additionally, these associations could broker preferential renewable electricity tariffs with power utilities, enabling steel manufacturers to leverage India's expanding renewable energy capacity for cost-competitive decarbonization.

Commodity Boards could spearhead proactive compliance strategies for emerging sustainability regulations like EUDR and CBAM, following the Coffee Board's model. Other product Boards and Sectoral Councils of Exports should replicate this support to build sectoral resilience.

7.8 Learning from Existing Models and Pilots

India possesses, demonstrated models and operational pilots that showcase viable pathways for integrating sustainability compliance into manufacturing ecosystems without imposing unaffordable burdens on MSMEs. These initiatives ranging from foundry cluster infrastructure to sectoral compliance platforms reveal actionable design principles for scaling compliance support across vulnerable regions and sectors. Case Study of Rajkot Foundry Cluster depicts the impact of building collective compliance infrastructure[74].

Small foundries in the Rajkot cluster faced significant structural barriers to regulatory compliance and market access. Individual firms incurred prohibitively high costs for energy audits, quality testing, and Bureau of Indian Standards (BIS) certification, with each operation bearing duplicative expenses, energy assessments and laboratory services alone cost several lakhs of rupees annually per unit. Certification timelines extended

[73] Coffee Board engaging with local exporters to ensure compliance with EU's Deforestation Regulation, CNBC TV 18, 2025 (https://www.cnbctv18.com/business/coffee-board-engaging-with-local-exporters-to-ensure-compliance-with-eus-deforestation-regulation-19623877.htm).

[74] India's Dilemma: Navigating CBAM in a Changing Climate Economy, Global Governance Initiative, 2025 (https://www.councilonsustainabledevelopment.org/post/the-cbam-challenge-india-s-trade-climate-balance).

up to 45 days for BIS approval, creating bottlenecks in export processing. More critically, foundries lacked the technical capacity and measurement, reporting, and verification (MRV) infrastructure required to prepare for carbon-pricing mechanisms such as CBAM, leaving them exposed to future compliance risks and market exclusion. A Common Facility Centre (CFC) intervention, implemented collaboratively by The Energy and Resources Institute (TERI), the Rajkot Engineering Association, and Swiss development partners, addressed these structural gaps through centralized technical services. The project consolidated energy audits, materials testing, BIS certification support, and MRV data analytics into shared infrastructure, eliminating per-unit service duplication and dramatically reducing individual firm costs. Total project investment of ₹ 7.2 crore was structured as blended finance: industry contributed 10%, the Central Government 53%, and the State Government 34%, demonstrating how risk-sharing across stakeholders makes large-scale infrastructure viable for MSME clusters. The outcomes were measurable and economically significant. Energy retrofitting initiatives including installation of high-efficiency motors and pumps reduced electricity consumption by 12 to 15% across participating foundries, lowering per-tonne CO_2 emissions by approximately 0.2 tonnes. MRV pooling directly reduced CBAM compliance costs by 35% per firm, translating to savings of roughly ₹ 300,000 per quarter, with benefits compounding as carbon tariffs increase. BIS certification timelines contracted from 45 days to 15 days, eliminating export delays and improving market responsiveness.

The Rajkot model offers generalizable lessons for replication across India's manufacturing clusters. Blended funding structures distributing investment across industry, central, and state governments make capital-intensive technical infrastructure financially feasible for resource-constrained SME regions. Shared facility models dramatically lower barriers to expensive compliance services, creating economies of scale that individual firms cannot achieve independently. Early-stage investments in energy efficiency and MRV frameworks position clusters to meet emerging carbon-pricing and sustainability requirements without disruption, transforming regulatory compliance from a competitive disadvantage into a source of operational resilience and export competitiveness.

8. Policy Recommendations and Way forward

In the evolving landscape of global trade, environmental sustainability has become a central priority shaping policies, regulations, and economic strategies worldwide. Trade in environmental goods is increasingly recognized not merely as a niche market but as a vital component of climate diplomacy, sustainable development, and economic competitiveness. As countries adopt stricter environmental regulations and pursue green growth agendas, there is an urgent need for coherent policy frameworks and institutional structures that can guide and support businesses in navigating complex international environmental trade dynamics. The following policy recommendations outline a strategic pathway for India to strengthen its leadership and resilience in the global EGs trade ecosystem and become prepared towards the emerging global green norms.

8.1 Need for a Centralised Environment Trade Body

In today's rapidly evolving global trade landscape, environmental goods have become critical to both sustainability goals and regulatory compliance. This encompasses a broad spectrum from technologies explicitly designed for environmental protection, such as renewable energy systems, environmental monitoring instruments, and water management infrastructure, to carbon-intensive and deforestation-linked products now facing stringent trade regulations under mechanisms like the EU's CBAM and the EUDR.

As these environmental regulations reshape international commerce, understanding and navigating the environmental dimensions of traded goods has transitioned from a peripheral consideration to a central strategic imperative for businesses and policymakers alike.

Exporters are under compliance pressures. Notwithstanding the significant strides taken in renewable energy production incentives, there exists a need for a dedicated body that could govern the EG trade framework. The responsibilities are currently fragmented among different bodies under the government- the Ministry of Environment, Forest and Climate Change (MoEFCC) handles environmental clearance for hazardous substances and other environmental approvals if the goods involve pollutants or industrial impacts, while the Ministry of Commerce and Industry manages export regulations via the Directorate General of Foreign Trade (DGFT), though sector specific to EG trade is currently lacking, and the Ministry of New and Renewable Energy concerns itself with the promotion of domestic growth in green industries, but does not extend to global trade of these products.

The US government has a dedicated body “The Office of Energy and Environmental Industries (OEEI)”, which leverages in-depth sector expertise to coordinate public-private responses. Recently, a comprehensive list of US Government export assistance programs to help expand energy and environmental technologies business was developed. Environmental Technologies include technologies that prevent or mitigate pollution, ensure regulatory compliance, and promote environmental protection and resource efficiency. This includes a list of

annual export data for 126 10-digit Harmonized System (HS) Schedule B codes and annual import data for 67 6-digit HS import codes, which serve as a proxy for the environmental technologies sector as a whole. This helps businesses, researchers, and policy makers obtain insights on trade data for environmental goods and services.

An inter-departmental body under the Ministry of Commerce and Industry, comprising experts from the MNRE, the MoEF&CC, the BIS, and the DGFT, could be established to specialise in the global trade of environmental goods. This body could monitor international environmental trade regulations, publish sector-specific reports, and highlight high-potential goods with strong environmental relevance. This research would help in analysing the vulnerable sectors to environmental regulations and help in informed policy making, and a periodically revised list of EGs could be published based on which export incentives and fast-clearance initiatives could be implemented. By doing so, it would promote strategic growth in this emerging sector and help position India as a global leader in sustainable and green trade. The action plan could be as follows:

- **Develop a Comprehensive List of Environmental Goods and Technologies Mapped to HS Codes:** Create an officially recognised list of environmental goods and technologies aligned with Harmonized System (HS) codes. This will provide regulatory clarity, help exporters identify eligible products, and serve as the foundation for targeted trade and compliance strategies.

- **Launch Targeted Export Promotion Scheme based on the Environmental Goods List:** Use the curated list to design export incentives, streamline documentation processes, and promote high-potential EG sectors such as solar components, water treatment systems, and clean mobility solutions. Export promotion councils and trade missions could align their focus to support these categories.

- **Conduct Vulnerability Assessments and Strategic Planning for Key Sectors:** Identify domestic sectors most likely to be impacted by international environmental trade regulations such as CBAM or EUDR. Develop risk mitigation strategies, including decarbonisation roadmaps, capacity building, and compliance support mechanisms to enhance long-term export competitiveness.

8.2 Mutual Recognition Agreements to Promote Environmental Goods Trade

Divergent regulatory standards for EGs pose significant barriers to trade between India and its trading partners. To overcome these challenges, India can pursue Mutual Recognition Arrangements (MRAs) with key countries to harmonize technical standards and certification requirements for environmental products. For effective implementation, India could collaborate with relevant standardization bodies of partner countries to form dedicated technical working groups focused on the alignment of product-specific regulations, testing protocols, and certification processes. Engagement with international standard-setting organizations will facilitate convergence with global best practices, reducing technical barriers and compliance costs for exporters and importers alike. By systematically mapping regulatory requirements and fostering mutual recognition, India can promote smoother cross-border trade in EGs, enhance market access, and strengthen its position in the global green economy.

Further, the EU-Korea Green Partnership serves as a strong example of bilateral cooperation focused on sharing best practices in climate action, clean energy transition, and environmental protection. Similarly, the EU-Morocco Green Partnership, which is the first of its kind, was established to support developing countries

in implementing effective climate and environmental policies. It focuses on three thematic areas: climate and energy, marine and environmental issues, and the green economy. These frameworks highlight the European Union's commitment to international green cooperation and present a compelling case for extending such a partnership to India. As a large developing economy with ambitious climate goals, India is well positioned to benefit from structured collaboration with the partner economy that supports policy alignment, capacity building, and sustainable investment.

8.3 AI Inclusion for Enhanced Deployment of Renewable Energy

India has emerged as one of the global leaders in wind energy, with an installed capacity of over 50 GW as of 2025. According to data from the Ministry of New and Renewable Energy and PIB, India now ranks as the 4th largest installed wind power capacity in the world, with significant contributions from states such as Gujarat, Tamil Nadu, Maharashtra, and Karnataka. Wind energy witnessed sustained progress during the year, with 4.15 GW of new capacity added, compared to 3.25 GW in FY 2023–24, reflecting strong momentum in clean energy expansion[75]. With vast onshore and offshore wind potential and an active project pipeline, India is in a strong position to incorporate advanced digital technologies that can improve efficiency and long-term performance in the sector.

Denmark offers a compelling example of how artificial intelligence can transform wind energy management. The country has implemented AI-driven systems that combine weather forecasting, turbine performance metrics, and real-time grid demand data to optimize turbine operations. These predictive algorithms help operators anticipate wind conditions, reduce maintenance costs, and increase energy output. A study show that such systems have improved energy efficiency by up to 20% and reduced unplanned maintenance by nearly 40%[76]. Denmark's approach has created a more reliable, cost-effective, and responsive renewable energy ecosystem, driven by data and automation.

India can adapt Denmark's AI-based strategy to its own wind sector. With a large and geographically distributed wind power base, AI can help improve forecasting, optimize turbine use, and enable better integration of renewable power into the grid. Smart grid management tools that apply machine learning can also support dynamic energy balancing, reducing the dependence on large-scale storage systems. This shift would not only enhance system efficiency but also open up new opportunities for exporting AI-enabled energy solutions. In line with the goals of the International Solar Alliance and India's national clean energy commitments, integrating artificial intelligence into wind energy operations represents a natural step toward building a smarter and more sustainable energy future.

8.4 Export Promotion Zones

The establishment of dedicated export promotion zones for renewable energy technologies presents an important opportunity for India to enhance its position in global clean technology markets. Through schemes such as the Export Promotion Capital Goods (EPCG) program and the Production Linked Incentive (PLI), India

[75] India's Renewable Energy Capacity Achieves Historic Growth in FY 2024-25, Ministry of New and Renewable Energy, 2025 (https://www.pib.gov.in/PressReleasePage.aspx?PRID=2120729&reg=3&lang=2#:~:text=Wind%20energy%20also%20witnessed%20sustained,in%20India's%20renewable%20energy%20mix).

[76] Optimizing Energy Infrastructure with AI Technology: A Literature Review, Open Journal of Applied Sciences, 2024 (https://www.scirp.org/journal/paperinformation?paperid=138124).

is promoting domestic manufacturing of solar modules, wind turbine components, and green hydrogen equipment. By focusing these efforts within specialized zones, supported by infrastructure, logistics, and regulatory facilitation, India can develop hubs that support both export growth and technology development. These zones can also serve as platforms for attracting foreign investment and supporting innovation in renewable energy solutions.

A successful example in India would be the Dhirubhai Ambani Green Energy Giga Complex in Gujarat, which aims to integrate the production of solar modules, batteries, green hydrogen equipment, and electrolysers. This large-scale investment has the potential to make India a global supplier of renewable energy technologies while strengthening local supply chains and manufacturing capacity. With adequate policy support and export-oriented incentives, similar clusters can be replicated across other renewable-rich states to meet global demand and climate commitments.

Globally, countries such as the United Arab Emirates and Morocco have demonstrated how export-focused clean energy manufacturing zones can drive trade and energy diplomacy. The Noor Solar Complex in Morocco, supported by public-private collaboration and international finance, is now one of the world's largest solar power-production sites and contributes to green exports in the region. The UAE's Masdar City is another example where renewable technology development, capacity building, and export readiness converge in a single ecosystem. India can adopt similar models by designing zones that support both technology production and service delivery, combining export incentives with training programs, research support, and certification alignment for global standards.

8.5 Green Energy Corridor

Green energy corridors are transmission networks designed to carry electricity generated from renewable sources like solar and wind to the places where it is most needed. They are especially important today because many renewable energy projects are located far from major population or industrial centers. These corridors help reduce power losses, improve grid reliability, and allow clean energy to be traded across regions or even countries. As more countries aim for cleaner and more secure energy systems, building dedicated infrastructure for renewables has become a key part of long-term energy planning.

A strong example is the Caspian–Black Sea Green Energy Corridor, a regional initiative led by Azerbaijan, Georgia, Romania, and Hungary. The project involves laying a 1,100-kilometer high-voltage cable under the Black Sea to transmit green electricity from wind and solar farms in Caspian region to the European grid. It is backed by the European Union as part of its clean energy and connectivity goals. This corridor is being built specifically for renewable electricity and is part of a wider effort to strengthen cooperation on climate action and clean power trade between regions.

India can take valuable lessons from this model. The country has already started building its own green energy corridors to connect renewable-rich states with demand centres. Now, it can look beyond national borders. With strong solar and wind potential and its leadership role in initiatives like the International Solar Alliance and One Sun One World One Grid, India is in a good position to become a hub for clean energy trade in South Asia. Extending green energy corridors to neighbouring partner countries would not only support regional energy needs but also help India build lasting partnerships around sustainable development.

8.6 Beyond Environmental Compliance: Building Inclusive, Traceable Green Trade Value Chains

Green trade measures must extend beyond environmental compliance to encompass social standards, labour rights, and resilient supply chain governance. This integrated approach will lead to fair wages, worker empowerment, and ethical sourcing and would build sustainable value chains that address emerging global demands while promoting inclusive development for exporters. The EU CSDDD exemplifies this integration of social standards by requiring companies to identify, prevent, and mitigate environmental and human rights impacts throughout their value chains, including upstream suppliers and downstream operations. Advanced traceability systems enable real-time visibility into material origins, manufacturing processes, and labour conditions, reducing Scope 3[77] emissions, which account for approximately 90% of total CO_2 emissions, while simultaneously identifying labour rights violations.

Labour standards represent a crucial dimension of these human rights protections within sustainable trade measures. Industry evidence demonstrates that embedding labour rights protections, including fair wage commitments, reduced working hours, and skill development programmes directly correlates with improved worker welfare and operational outcomes. Studies highlight the importance of adopting a multi-dimensional perspective of labour standards which depend on the indicator used and different industries and supply chain stages are identified as relevant areas for efforts to enhance worker rights[78]. The garment and agricultural sectors, which employ millions globally, increasingly face regulatory pressure through frameworks like the EU CSDDD and UK Modern Slavery Act, making labour standards integration not merely ethical but commercially imperative. Beyond compliance, integrating labour protections strengthens both worker dignity and operational efficiency, creating competitive advantages in export markets demanding verified ethical sourcing.

Collaborative Standards Framework such as the International Chamber of Commerce (ICC's) updated framework for guiding businesses toward sustainable trade practices[79] provide consensus guidelines assessing sustainability across environmental and socio-economic dimensions, enabling banks, corporates, and investors to channel capital toward inclusive trade finance while mitigating greenwashing risks.

By prioritizing these interconnected pillars on environmental stewardship, labour protection, supply chain transparency, and stakeholder collaboration, India could position itself as a leader in comprehensive green trade frameworks, capturing premium market segments and driving resilient, equitable growth across industrial sectors.

[77] Scope 3 Emissions: are all indirect greenhouse gas (GHG) emissions, excluding Scope 2, that occur in the value chain of a reporting company, including both upstream and downstream emissions.

[78] Mapping efforts to protect worker rights in supply chains (EN),OECD, 2024 (https://www.oecd.org/content/dam/oecd/en/publications/reports/2025/02/mapping-efforts-to-protect-worker-rights-in-supply-chains_8e192c6e/f4eacea7-en.pdf)

[79] ICC Principles for Sustainable Trade and Trade Finance - ICC - International Chamber of Commerce, 2025 (https://iccwbo.org/news-publications/policies-reports/icc-principles-for-sustainable-trade/)

Annexure

Annexure A: CBAM Applicability Assessment and Regulatory Overview

1. CBAM Impact on Indian Exporters

Though CBAM is an EU regulation, its implications extend deeply to Indian manufacturing. While, EU importers do not produce the goods, they need actual verified emissions data from their suppliers to comply with the regulation, creating a cascading effect throughout the supply chain.

EU importers (CBAM Declarants) must report the following information:

- **Product details:** Quantities, CN (Combined Nomenclature) codes, and product types
- **Production information:** Installation name, address, UN location code (UNLOCODE), production routes and technologies used.
- **Emissions data:** Specific embedded emissions (tonnes of CO_2 equivalent per tonne of product or per MWh for electricity), broken down into direct and indirect components.
- **Calculation methodology:** Whether emissions were measured or calculated, inclusion of any default values if actual data were unavailable.
- **Carbon pricing:** Details of any carbon price already paid (taxes, levies, ETS participation), including amounts, legal basis, and proof of payment.

To fulfil these obligations, the EU importers push requirements back to the Indian manufacturer. Exporters need to provide goods-specific emissions in formats aligned with EU methodologies, not rough estimates, but calculations according to CBAM's technical rules. This data must be circulated using the CBAM communication template, in addition to complying with new amendments in the form of Implementing acts on calculation methodology released in December 2025. The Implementing acts lay down rules for the application of Regulation (EU) 2023/956 of the European Parliament as regards the methods for calculating of emissions embedded in goods.

2. Identifying CBAM Obligations

Before diving into compliance actions, exporters must determine whether CBAM applies to their products. This is a straightforward process, but it requires precision:

Step 1: Check the product's CN code

Every product exported to the EU is classified under a Combined Nomenclature (CN) code, an 8-digit classification system. Exporters likely already know this code from their customs documentation and invoices. If not, they could check their shipping bills, export declarations, or consult their customs broker.

Step 2: Cross-reference with Annex I of the Regulation (EU) 2023/956 and subsequent amended Annexes to the Regulation (EU) 2023/956 as regards the extension of its scope to downstream goods

The EU has published a list of CN codes covered under CBAM in Annex I of the regulation and subsequent amendment. Exporters should compare their product's CN code against this list. If it appears there, the product falls under CBAM reporting requirements.

Step 3: Check raw materials (Precursors)

This step is critical for manufacturers who don't export directly to the EU but supply inputs to other exporters. CBAM doesn't just cover final products; it also includes precursors, the carbon-intensive raw materials used to make those products. If a manufacturer produces materials like cement clinker, pig iron, ferro-alloys, even when selling them domestically to another Indian manufacturer who then exports the finished product, they are indirectly part of the CBAM supply chain.

Why Precursors matter: When an exporter exports the final CBAM product (such as, cement or steel) to the EU, they must account for the embedded emissions not just from their own production, but also from the precursors they purchased from their supplier. This means they will demand emissions data from their suppliers. If suppliers cannot provide it, customers either use default values (making their product uncompetitive and potentially affecting future orders) or find alternative suppliers who can provide the data. Manufacturers should not assume CBAM doesn't apply just because they don't export directly. They should check both their final products and any intermediate goods they produce that might feed into CBAM-covered supply chains. Downloading Annex I[80] of the Regulation (EU) 2023/956 and subsequent amended Annex[81] to the Regulation (EU) 2023/956 as regards the extension of its scope to downstream goods added in December 2025. Then, identifying relevant CN codes and determining obligation levels, whether as a direct exporter or as a precursor supplier within the chain – are essential steps.

Example Calculation (Based on default values)

Here's how the CBAM cost calculation works:

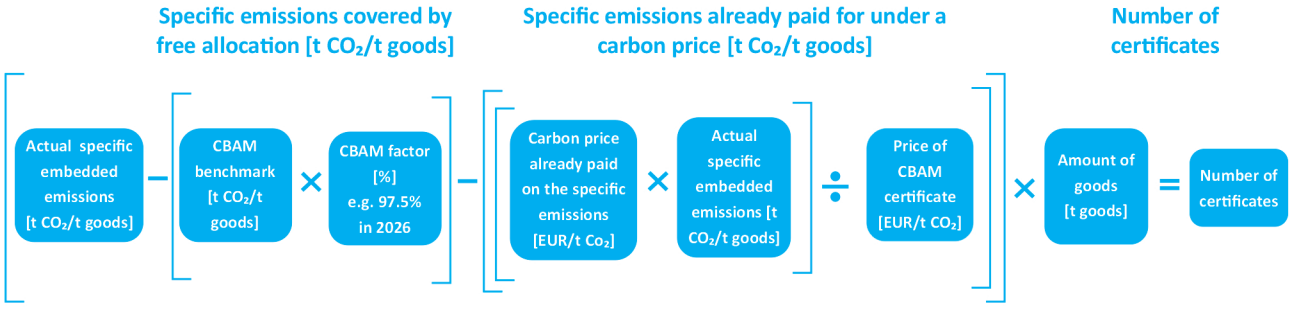
- **Given:** Export of Iron or Steel products under the CN Code - 73181900, Country of Origin – India, Emission intensity – 4.697 tCO2e/t, Benchmark – 1.364, Tonnage – 100 tonne for a given calendar year 2026, CBAM factor in 2026 – 97.5 %

[80] Regulation (Eu) 2023/956 of the European Parliament and of the Council of 10 May 2023 Establishing a Carbon Border Adjustment Mechanism, EU, 2023 (chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023R0956).

[81] Proposal for a Regulation of the European Parliament and of the Council amending Regulation (EU) 2023/956 as regards the extension of its scope to downstream goods and anti-circumvention measures, EU, 2025 (chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://eur-lex.europa.eu/resource.html?uri=cellar:a837cf93-db4d-11f0-8da2-01aa75ed71a1.0001.02/DOC_2&format=PDF).

- **Assumptions:** Price of CBAM Certificate in 2026 – EUR 80/t CO2

- **Formula:**

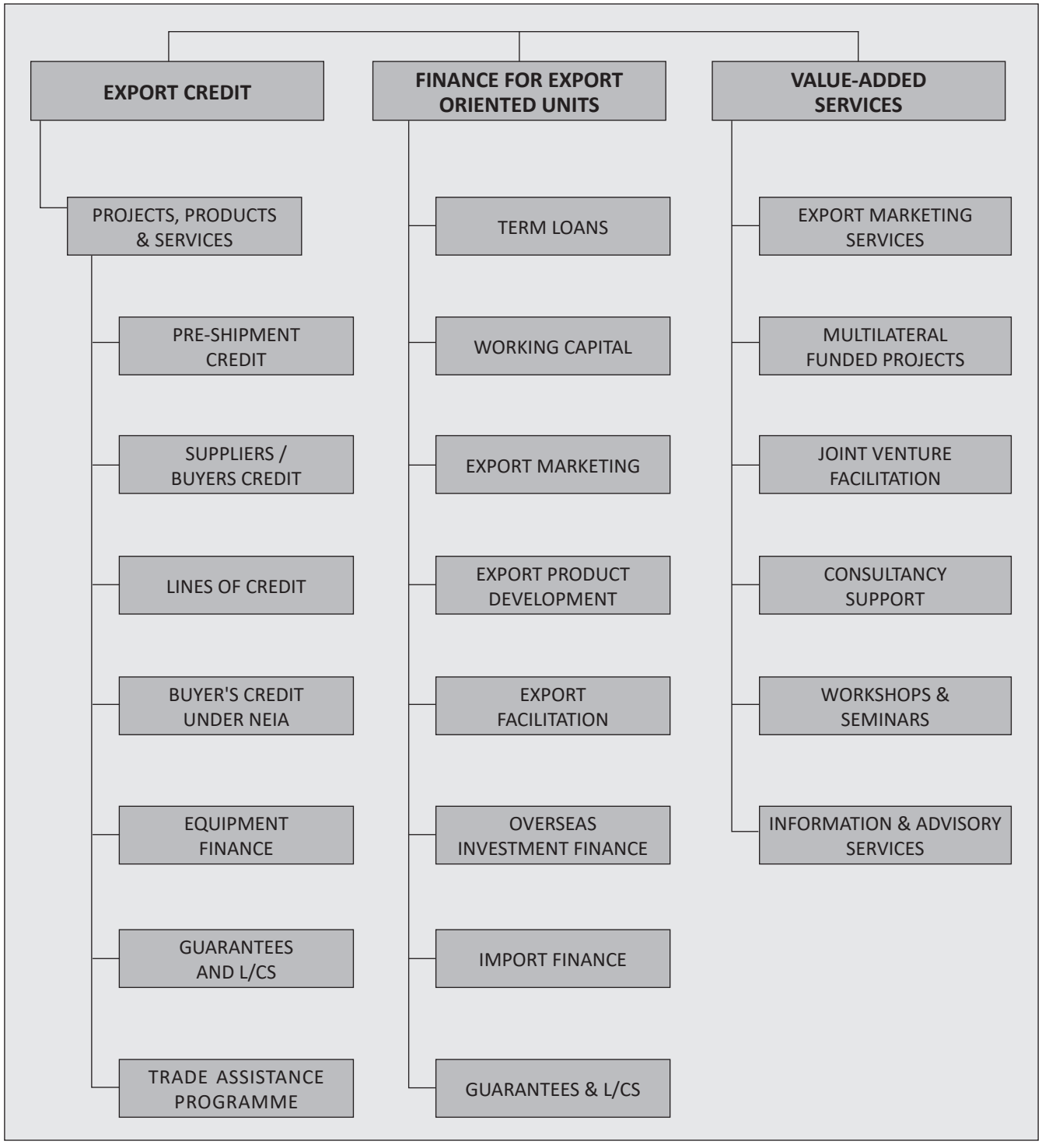


- **Calculation:**

CBAM Cost per ton in 2026 – EUR 269.37, Total CBAM Cost for 100 tonnes export – EUR 26,936.80, Total CBAM Certificates for 2026 – 337.

INDIA EXIM BANK'S MAJOR PROGRAMMES

Bank's Major Programmes



EXPORT-IMPORT BANK OF INDIA

HEAD OFFICE

Centre One Building, 21st Floor, World Trade Centre Complex, Cuffe Parade, Mumbai 400 005.
Phone: (91 22) 22172600 ● Fax : (91 22) 22182572
E-mail : ccg@eximbankindia.in ● Website: www.eximbankindia.in

LONDON BRANCH

5th Floor, 35 King Street, London EC2V 888 United Kingdom
Phone : (0044) 20 77969040 ● Fax : (0044) 20 76000936 ● E-Mail : eximlondon@eximbankindia.in

DOMESTIC OFFICES

Ahmedabad

Sakar II, 1st Floor,
Next to Ellisbridge Shopping Centre,
Ellisbridge P. O., Ahmedabad 380 006
Phone : (91 79) 26576843
Fax : (91 79) 26577696
E-mail : eximahro@eximbankindia.in

Bengaluru

Ramanashree Arcade, 4th Floor,
18, M. G. Road, Bengaluru 560 001
Phone : (91 80) 25585755
Fax : (91 80) 25589107
E-mail : eximbro@eximbankindia.in

Chandigarh

C- 213, Elante offices, Plot No. 178-178A,
Industrial Area phase 1,
Chandigarh 160 002
Phone : (91 172) 4629171
Fax : (91 172) 4629175
E-mail : eximcro@eximbankindia.in

Chennai

Overseas Towers, 4th and 5th Floor,
756-L, Anna Salai, Chennai 600 002
Phone : (91 44) 28522830/31
Fax : (91 44) 28522832
E-mail : eximchro@eximbankindia.in

Guwahati

NEDFi House, 4th Floor, GS Road,
Dispur, Guwahati 781 006
Phone : (91 361) 2237607 /609
Fax : (91 361) 2237701
E-mail : eximgro@eximbankindia.in

Hyderabad

Golden Edifice, 2nd Floor,
6-3-639/640, Raj Bhavan Road,
Khairatabad Circle, Hyderabad 500 004
Phone : (91 40) 23307816
Fax : (91 40) 23317843
E-mail : eximhro@eximbankindia.in

Indore

Unit No. 800-802, 8th floor,
Maloo 01, Plot No 26,
Scheme No 94 C,
Ring Road, Indore 452010
Email: eximiro@eximbankindia.in

Kolkata

Vanijya Bhawan, 4th Floor,
(International Trade Facilitation Centre),
1/1 Wood Street, Kolkata 700 016
Phone : (91 33) 68261301
Fax : (91 33) 68261302
E-mail : eximkro@eximbankindia.in

Lucknow

Unit No. 101, 102 and 103, 1st Floor,
Shalimar Iridium Vibhuti Khand,
Gomti Nagar, Lucknow 226010
Phone: (91 522) 6188035
Email: lro@eximbankindia.in

Mumbai

8th Floor, Maker Chamber IV,
Nariman Point, Mumbai 400 021
Phone : (91 22) 22861300
Fax : (91 22) 22182572
E-mail : eximmro@eximbankindia.in

New Delhi

Office Block, Tower 1, 7th Floor,
Adjacent Ring Road, Kidwai Nagar (E)
New Delhi 110 023
Phone : (91 11) 61242600 / 24607700
Fax : (91 11) 20815029
E-mail : eximndo@eximbankindia.in

Pune

No. 402 & 402(B), 4th floor,
Signature Building, Bhamburda,
Bhandarkar Rd., Shivajinagar,
Pune 411 004
Phone : (91 20) 26403000
Fax : (91 20) 25648846
E-mail : eximpro@eximbankindia.in

OVERSEAS OFFICES

Abidjan

5th Floor, Azur Building,
18-Docteur Crozet Road,
Plateau, Abidjan, Côte d'Ivoire
Phone : (225) 2720242951
Fax : (225) 2720242950
Email : eximabidjan@eximbankindia.in

Dhaka

Madhumita Plaza, 12th Floor,
Plot No. 11, Road No. 11, Block G,
Banani, Dhaka, Bangladesh - 1213.
Phone : (88) 01708520444
E-mail : eximdhaka@eximbankindia.in

Dubai

Level 5, Tenancy lB,
Gate Precinct Building No. 3,
Dubai International Financial Centre,
PO Box No. 506541, Dubai, UAE.
Phone : (971) 43637462
Fax : (971) 43637461
E-mail : eximdubai@eximbankindia.in

Johannesburg

2nd Floor, Sandton City Twin Towers East,
Sandhurst Ext. 3, Sandton 2196,
Johannesburg,
South Africa.
Phone : (27) 113265103
Fax : (27) 117844511
E-mail : eximjro@eximbankindia.in

Nairobi

Unit 1.3, The Oval, Jalaram Road,
Westlands,
Nairobi, Kenya
Phone : (254) 741757567
E-mail : eximnairobi@eximbankindia.in

São Paulo

Unit - 1603, World Trade Center
Avenida das Nações Unidas 12.551
São Paulo 04578-903,
Brazil
Phone: +55 (11) 3080 7561
Email: eximsaopaulo@eximbankindia.in

Singapore

20, Collyer Quay, #10-02,
Tung Centre,
Singapore 049319.
Phone : (65) 65326464
Fax : (65) 65352131
E-mail : eximsingapore@eximbankindia.in

Washington D.C.

1750 Pennsylvania Avenue NW,
Suite 1202,
Washington D.C. 20006,
United States of America.
Phone : (1) 2022233238
Fax : (1) 2027858487
E-mail : eximwashington@eximbankindia.in

India Exim Bank

Centre One Building, 21st Floor, World Trade Centre Complex, Cuffe Parade,
Mumbai - 400005 | Ph.: (91 22) 22172600
E-mail: info@eximbankindia.in | Website: www.eximbankindia.in
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