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The Role of Trade in Asia and the Pacific's Net Zero Pathways: Overview and Policy Implications

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KEY POINTS

- Trade-related actions will be instrumental in moving the world toward net zero emissions. Trade offers many solutions via facilitating exchange of environmental goods and services, technology transfer, and investment in green sectors and low-carbon technologies.
- Mainstream trade and trade policy into Nationally Determined Contributions. Governments in Asia and the Pacific must devise and implement ambitious, creative, and effective strategies, from carbon pricing and regulation to financing the green transition.
- Reduce tariffs and trade restrictions on environmental goods and services to promote efficient allocation of resources to more carbon-efficient production and investment.
- Accelerate trade facilitation and logistics reforms to reduce delays at borders and remove bottlenecks along the supply chain.
- Develop national carbon-pricing strategies and strengthen regional carbon market cooperation.
- Strengthen international cooperation to maximize effectiveness and minimize costs of green transition.

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INTRODUCTION

Countries in Asia and the Pacific play critical roles in the battle against climate change. They generate about half of global greenhouse gases annually and are highly vulnerable to its effects. ADB (2023a) calculates that failure to tackle climate change would result in a staggering $210 trillion in economic losses to the region over 2020–2100,[1] far more than any other, with developing Asia losing 24% of its gross domestic product (GDP) by 2100.[2]

Decisive policy actions are needed, with no less than the future of the region, and the world, at stake. Countries jointly producing 80% of the emissions of Asia and the Pacific have announced or are considering targets for net zero emissions (ADB 2023a), but so far only a few have either included them in development plans, framed initiatives to implement, codified them in law, or analyzed their implications (ADB 2023a). The magnitude of necessary changes means that extensive preparation is needed before charting a specific net zero pathway, supported by solid and innovative scientific, economic, financial, and social research. Since climate change transcends borders, meeting this common challenge

Note: In this publication, $ refers to United States dollars.

1 On a purchasing power parity basis at net present value, not including the Republic of Korea (ROK) and the Pacific. ADB (2023a, 8).

2 ADB (2023a, 10).

also requires unprecedented cooperation. National, regional, and international planning, dialogue, and cooperation are time-consuming. However, extreme weather events are becoming more frequent and severe, and climate-related disasters are increasing, whereas research supports the proposition that the costs of emissions mitigation are lower—and potential benefits higher—when action is taken earlier.[3]

Trade and trade policy can play a vital role in the transition to net zero. Economies in Asia and the Pacific are among the most open in the world, with trade in goods reaching almost 100% of GDP for the Association of Southeast Asian Nations (ASEAN) economies.[4] Asia and the Pacific accounted for 37% of world trade in 2021, up from 32% a decade earlier.[5] It is clear that international trade will continue to be a critical source of regional growth and poverty reduction. However, international trade poses both challenges and solutions for the green transition given the importance of carbon emissions associated with trade-related economic activities. Trade-related actions among Asia and the Pacific economies will be instrumental in moving the world toward net zero.

Besides taking stock of the problem, this brief aims to highlight the role of trade in the net zero transition and evaluate various modelling scenarios that reach net zero by 2050 in the extant literature. The next section provides an overview of the global and regional climate situation since 1995 and underscores the importance of trade in climate change mitigation from theoretical and empirical perspectives, with a focus on developments in Asia and the Pacific and future policy challenges. In the following section, the role of carbon markets in the transition is discussed. Even as coordinated carbon pricing can be an effective tool to meet climate goals, global cooperation continues to be lacking, while individual carbon-pricing programs are less effective and can create undesirable effects. The brief then evaluates the implications of the European Union (EU) Carbon Border Adjustment Mechanism (CBAM) for Asia and the Pacific as a regional case study. It also looks at some influential quantitative studies modelling scenarios that estimate the implications of pathways toward net zero, and trade and climate change scenarios. The final section provides trade-related policy recommendations for regional governments.

THE POLICY CHALLENGE FOR CLIMATE AMBITIONS

It comes as no surprise that the rapid increase in Asian economic growth is associated with an increase in its global carbon footprint. This increase, both in absolute terms and relative to the rest of the world, is a concern for all. Understanding the mechanism will start with an overview of the changing and essential role of Asia in realizing global climate ambitions, the climate change risks facing the region, and the role of international trade in mitigating their effects.

Situating Asia in Global Carbon Emissions

Figure 1 shows the rise in global carbon dioxide (CO_2) emissions from production, broken down into Asia and non-Asia, from 1995 to 2018. Overall, regional emissions in production rose from 21.4 billion tons to 33.6 billion tons per annum. This 57% increase testifies to difficulties associated with global efforts to rein in greenhouse gases. For instance, 1995 was the year of the first Conference of the Parties (COP) of the United Nations Framework Convention on Climate Change (UNFCCC) and an important milestone in elevating climate change mitigation as a policy priority. Asia's role became far more prominent thereafter; its share of global emissions increased from less than one-third to one-half.[6] Asian pathways to net zero will be key to realizing the 2015 Paris Agreement's central aim of keeping average global temperature to less than 2 degrees Celsius (°C) above pre-industrial levels and to pursue efforts to keep it below 1.5°C.

Production-based emissions are concentrated among a few economies (Table 1). The People's Republic of China (PRC), the United States, and India together account for over half of the total, with Japan, the Republic of Korea (ROK), and Indonesia appearing in the top 10 emitters. Among ASEAN members, only Indonesia is among the top 20 emitters, but the other ASEAN economies including Viet Nam are in the top 30. Table 1 shows that there is a high, positive correlation between production-based emissions and emissions embodied in exports.

The structure of production-based emissions across different industries in Asia matches the rest of the world. Manufacturing and utilities dominate at almost two-thirds of the global total and more than three-quarters of the Asian total, followed (distantly) by transportation services and domestic household emissions (Figure 2). The utilities sector accounts for the largest share of CO_2 emissions in all Asian subregions (Figure 3), followed by manufacturing, save for Central Asia where domestic household emissions are slightly higher than manufacture emissions. With Asia's rapid industrialization and central role in global value chains, CO_2 emissions embodied in production and consumption increased almost threefold from 1995 to 2018, with growth in production emissions expanding faster than those attributable to consumption (Figure 4).

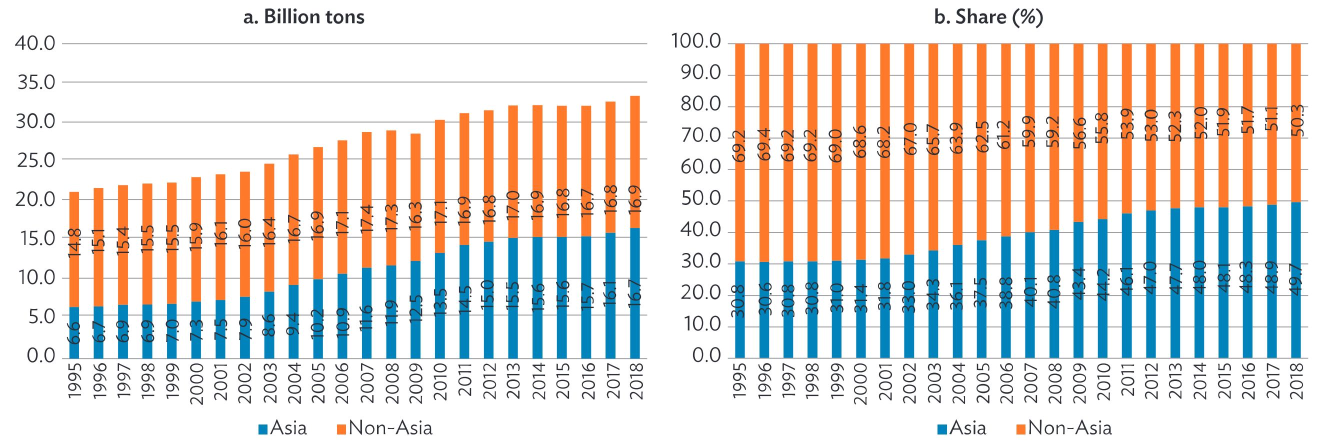
[3] The 2018 Report of the Global Commission on the Economy and Climate. Unlocking the Inclusive Growth Story of the 21st Century: Accelerating Climate Action in Urgent Times.

[4] World Bank. Trade as a % of GDP. https://data.worldbank.org/indicator/NE.TRD.GNFS.ZS (accessed September 2023); and the ASEAN Secretariat. ASEAN Statistical Highlights 2022. https://www.aseanstats.org/wp-content/uploads/2022/12/ASEAN-Highlights-2022-02.pdf (accessed September 2023).

[5] UNCTAD. 2022. Handbook of Statistics 2022. Trade Structure by Partner. https://hbs.unctad.org/trade-structure-by-partner/ (accessed 28 September 2023).

[6] Mitigation was only made a universal responsibility with the adoption of the Paris Agreement (COP21). Before that, mitigation was an issue for industrialized countries only. Before the Bali COP (COP13), there was a clear distinction between Annex I (industrialized countries) and non-Annex I countries. This distinction was progressively diluted until, at Paris, all parties agreed to support mitigation efforts according to their national abilities and circumstances (this is the reason there are NDCs).

Figure 1: Asia's Production-Based Carbon Dioxide Emissions



Source: OECD TeCO_2 database.

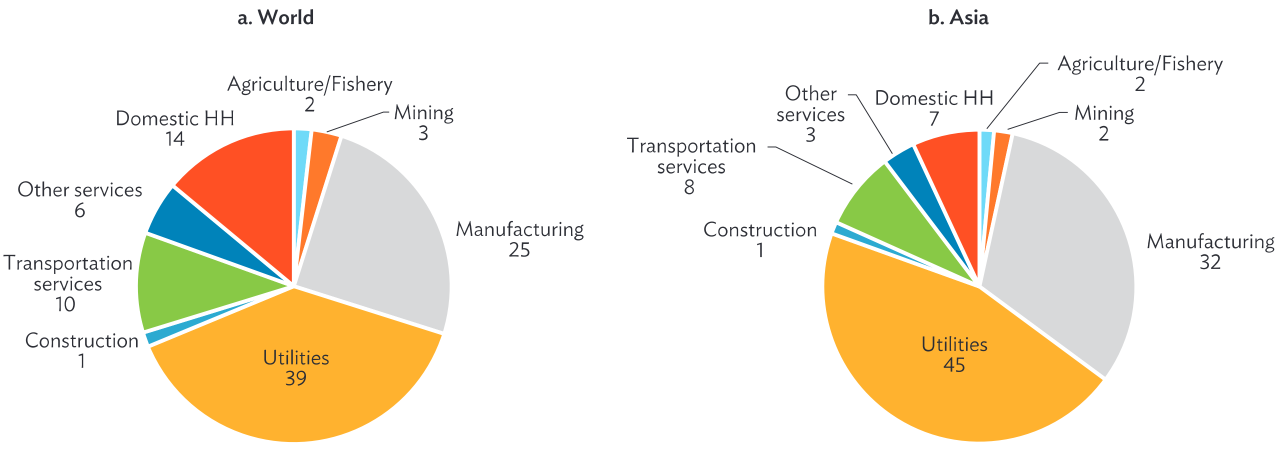
Table 1: Top 30 Carbon Dioxide Emitting Economies—Production and Exports, 2018

Economy	Production-Based CO_2 Emissions			Embodied CO_2 Emissions in Exports		
	Million ton	Share (% world)	Rank	Million ton	Share (% world)	Rank
People's Republic of China	9,916	29.5	1	1,948	20.1	1
United States	4,989	14.8	2	608	6.3	2
India	2,320	6.9	3	480	5.0	4
Russian Federation	1,626	4.8	4	507	5.2	3
Japan	1,151	3.4	5	305	3.1	7
Germany	739	2.2	6	400	4.1	5
ROK	648	1.9	7	366	3.8	6
Canada	589	1.8	8	281	2.9	8
Indonesia	561	1.7	9	124	1.3	24
Saudi Arabia	503	1.5	10	95	1.0	26
South Africa	433	1.3	11	172	1.8	14
Mexico	429	1.3	12	207	2.1	11
Brazil	419	1.2	13	116	1.2	25
United Kingdom	402	1.2	14	138	1.4	19
Australia	400	1.2	15	127	1.3	23
Türkiye	398	1.2	16	133	1.4	21
Italy	345	1.0	17	155	1.6	16
France	332	1.0	18	169	1.7	15
Poland	307	0.9	19	131	1.4	22
Taipei,China	284	0.8	20	232	2.4	10
Thailand	265	0.8	21	198	2.0	13
Spain	265	0.8	22	135	1.4	20
Viet Nam	247	0.7	23	204	2.1	12
Malaysia	237	0.7	24	143	1.5	17
Kazakhstan	209	0.6	25	61	0.6	31
Netherlands	176	0.5	26	139	1.4	18
Argentina	174	0.5	27	31	0.3	44
Singapore	154	0.5	28	241	2.5	9
Philippines	136	0.4	29	39	0.4	40
Belgium	101	0.3	30	84	0.9	27

CO_2 = carbon dioxide, ROK = Republic of Korea.

Source: OECD TeCO_2 database.

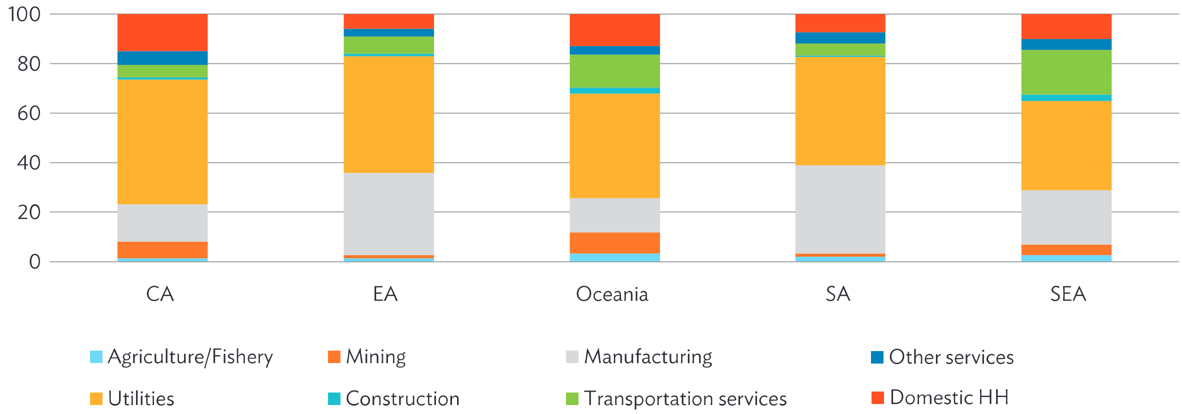
Figure 2: Production-Based Carbon Dioxide Emissions by Industry, 2018
(%, share)



CO_2 = carbon dioxide, HH = household.

Source: OECD TeCO_2 database.

Figure 3: Production-Based Carbon Dioxide Emissions by Industry and Subregion, Asia in 2018
(%, share)



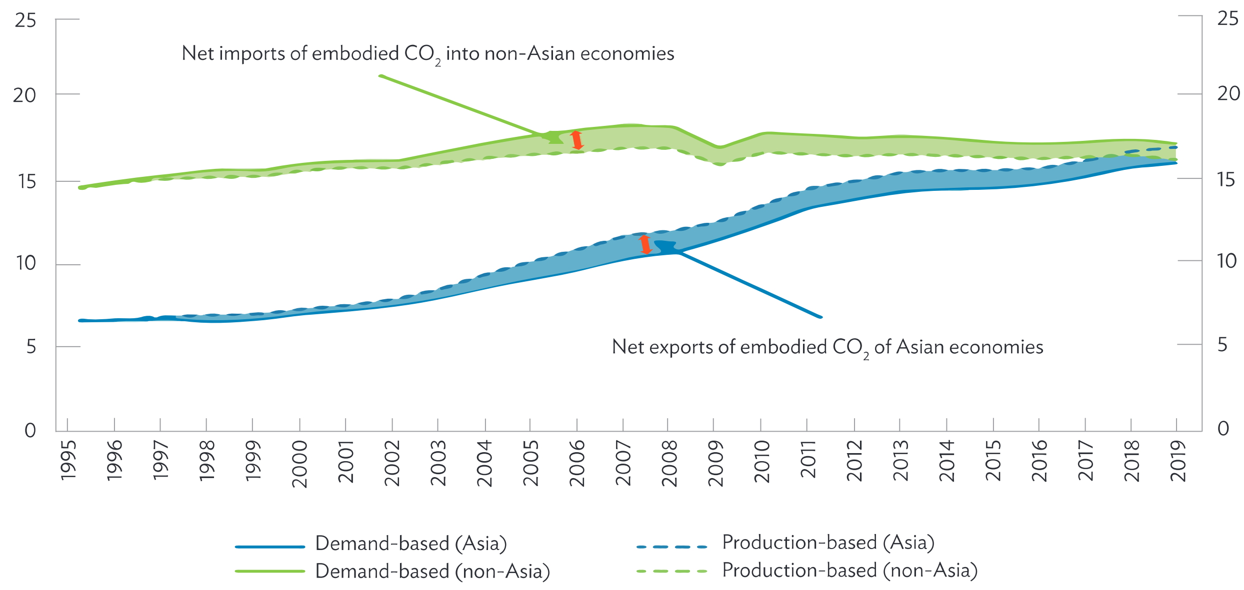
CA = Central Asia, CO_2 = carbon dioxide, EA = East Asia, HH = household, SA = South Asia, SEA = Southeast Asia.

Source: OECD TeCO_2 database.

With rising temperatures and forecasts of increasing weather volatility, Asia and the Pacific has experienced major climate-related disasters. ADB (2023b) underscores that extreme weather events in 2021 have directly affected over 48 million people in the region and led to the loss of 4,000 lives. Asia and the Pacific accounted for 39% of disasters worldwide over 2000–2021, with Southeast Asia the most affected subregion.[7] Economic forecasts vary, but it is commonly agreed that that losses in Asia from climate change are expected to be larger than the world average (ADB 2023b) (ILO 2019).

[7] ADB (2023a, 193).

Figure 4: Production- and Demand-Based Carbon Emissions—Asia versus Non-Asia
(giga tons CO_2)



CO_2 = carbon dioxide.

Note: The shaded areas in the graph represent the absolute difference between production-based (CO_2 emissions based on production, i.e., emitted by economies) and demand-based (CO_2 emissions embodied in domestic final demand, i.e., consumed economies) CO_2 emissions.

Source: ADB. 2023. *Asian Economic Integration Report 2023: Trade, Investment, and Climate Change in Asia and the Pacific.* Manila; using data from OECD TeCO2 data set.

Trade and Climate Change: Theoretical Considerations

Trade is essential in the success of Asia's economic development. Governments in the region have recognized the international marketplace as an engine of growth and a weapon against poverty, particularly over the past 4 decades. The chronology, extent, and speed of adopting outward-oriented reforms vary, but virtually all the region's governments have accepted an outward-oriented approach to development. Multiple channels connect trade to growth and poverty reduction (Petri and Plummer 2016). Trade allows countries to exploit their comparative advantage, improve the productivity of domestic resources, and tap into international markets. It raises incomes, spurs consumption and investment, and reduces the risks associated with shocks to domestic production and markets. Trade enables access to greater varieties of goods, services, and intermediate inputs, and helps local firms to use or acquire improved technologies (OECD 2011). It creates better jobs and provides incentives for learning and helps attract foreign direct investment (FDI). Recent research suggests that trade liberalization increases economic growth by 1.0 percentage point to 1.5 percentage points.[8]

That said, the environmental implications of trade are complicated. Modern trade theory suggests that gains from trade result from a more efficient division of labor across economies and that comparative advantage dictates trade patterns. Comparative advantage itself is determined by many factors and changes with a country's economic trajectory relative to its partners and global market trends. In neoclassical trade theory, for example, comparative advantage is determined by the relative endowments of labor and capital. If global production follows comparative advantage, a country's carbon footprint will be in part a function of the carbon-intensity of the products it specializes in making. If more advanced economies specialize in capital-intensive industries that also are more carbon-intensive, they would be expected to have a larger carbon footprint. However, the "pollution haven hypothesis" suggests that trade liberalization will lead to carbon-intensive industries moving to countries where carbon regulations are least stringent (WTO 2022).

Trade profiles can also be influenced by institutional considerations and externalities. The capital and labor costs pertinent to comparative advantage do not account for the negative global

[8] World Bank. Overview: Trade. https://www.worldbank.org/en/topic/trade/overview.

environmental effects of production, given that social costs will exceed the private costs where carbon emissions are not correctly priced or regulated. Without global agreement, firms in countries where carbon emissions are priced and/or regulated will be at a competitive disadvantage. That would lead to inefficient allocation of global production and potential for carbon leakage, where firms move production to countries with less stringent environmental policies. An "unlevel carbon playing field" could lead to trade conflict and "regulatory chill" where carbon-price differences undermines the political momentum for net zero in green-focused countries. Moreover, trade barriers tend to be lower in carbon-intensive products and these are traded more (WTO 2022). The literature on how climate change affects comparative advantage of countries is large, particularly in agriculture (Costinot et al. 2014), but much smaller on how it affects comparative advantage more generally.

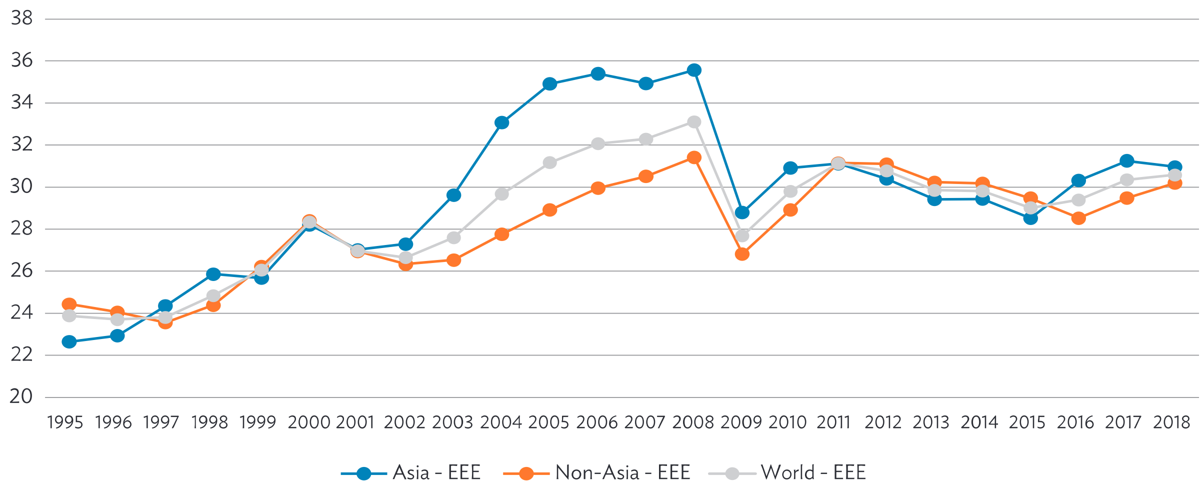
WTO (2022) surveys the relationship between trade and the environment, while ADB (2023b) offers a useful framework to evaluate how trade-induced production increases emissions, trade-generated structural change affects the carbon-intensity of production, and trade integration and FDI lead to cleaner technologies and other inputs that lower the carbon intensity of production. Consumption is also important: a CO_2 "balance" will result from the difference between production-based emissions and consumption-based emissions, which in turn are a function of comparative advantage, carbon leakage, and demand patterns.

ADB (2023a) finds that since 2011 the ratio of carbon emissions per production unit, called carbon intensity, is decreasing, likely through technology enhancement, environmental regulation, and deepening environmental consciousness. This regional decrease in carbon-emissions intensity in production holds also for trade, with emissions intensity for imports and exports falling by over half since 2000.

Mapping out Trade and Climate Change

In Asia (and globally), exports account for about 30% of total production-based CO_2 emissions, significantly up from 1995 but on par with its share a decade ago. Figure 5 shows trends in CO_2 emissions embedded in exports as a percentage of total production-based emissions over 1995 to 2018. The global export share grew significantly until the global financial crisis of 2008–2009, which is consistent with the trade boom where trade as a percentage of GDP grew from 43% in 1995 to a 61% peak in 2008.[9] The share of exports in total production-based emissions for Asia grew faster than the world average, especially between 2001 and the financial crisis, and rose over one-third from about 23% to 31% from 1995 to 2018. By subregion, East Asia's emissions embodied in exports significantly increased, representing its global share, from 18% in 1995 to 30% in 2018 (Figure 6). During the same period, Southeast Asia and South Asia also saw increases in their global share by 3.6 percentage points and 3.3 percentage points, respectively. Emissions embodied in Asian manufactured exports account for three-fourths of the total, followed by transportation and other services (Figure 7).

Figure 5: Asia's CO_2 Emissions Embodied in Exports (% production-based)

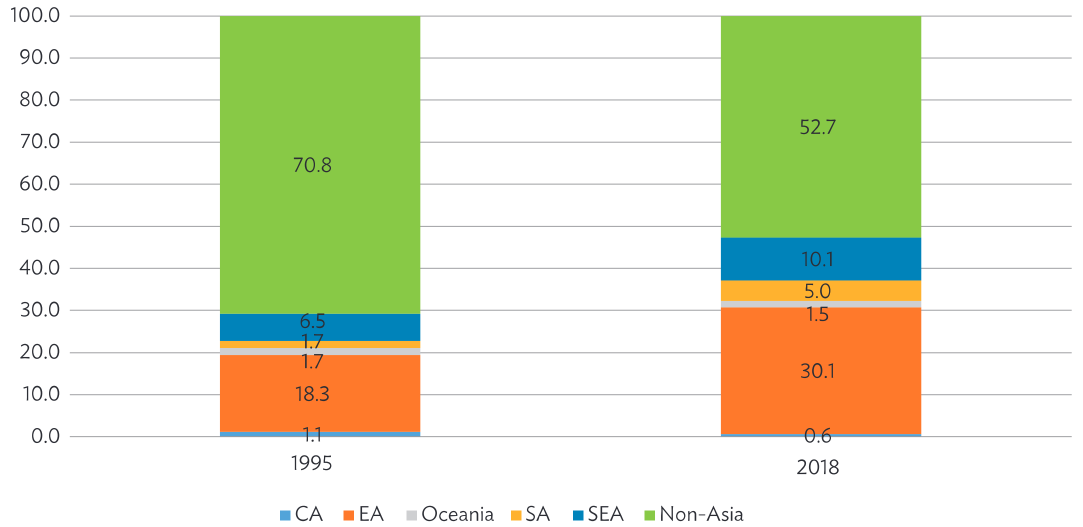


CO_2 = carbon dioxide, EEE = emissions embodied in exports.

Source: OECD TeCO$_2$ database.

9 Our World in Data. Trade as Share of GDP, 1960 to 2021. https://ourworldindata.org/grapher/trade-as-share-of-gdp (accessed 3 October 2023).

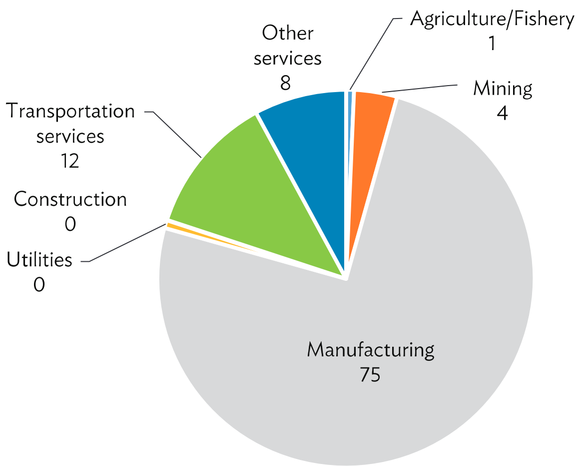
Figure 6: Asia CO_2 Emissions Embodied in Exports by Subregion
(%, global share)



CO_2 = carbon dioxide, CA = Central Asia, EA = East Asia, SA = South Asia, SEA = Southeast Asia.

Source: OECD TeCO_2 database.

Figure 7: Asia Emissions Embodied in Exports by Industry
(%, global share)



Source: OECD TeCO_2 database.

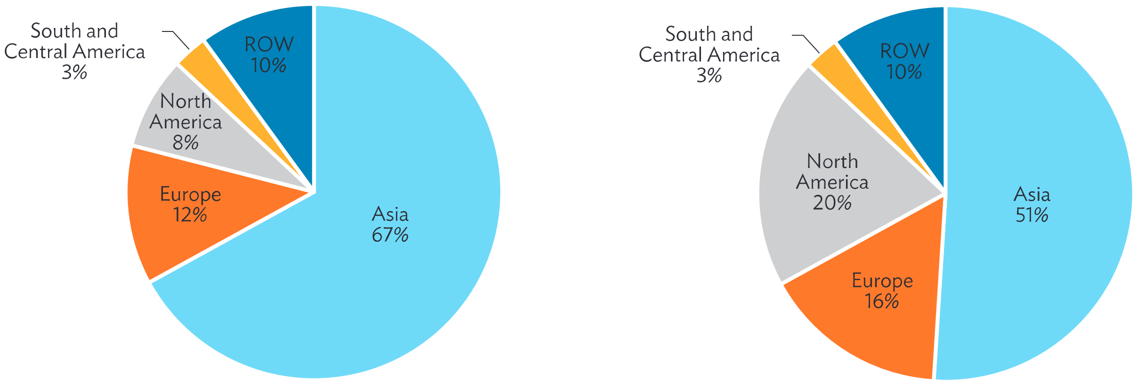
Intraregional trade has risen significantly in Asia since 1995 thanks to factors including faster liberalization efforts than any other region and regional markets expanding at a faster pace than the global average. Intraregional trade makes a significant contribution to Asia's carbon footprint as well, given the deepening of regional value chains. Figure 8 shows that two-thirds of emissions embodied in Asian imports and half of its exports are from intraregional sources. This underscores the key potential role of initiatives like the Regional Comprehensive Economic Partnership and regional value chains in reducing Asia's carbon footprint.

Carbon Balance and Carbon Leakage

As noted, the potential for carbon leakage is important. It makes little sense to price carbon in a socially optimal manner on domestic production if this leads to relocation to markets where the carbon externality is not internalized. It would create unfair conditions and reduce political support for climate action at home. Hence, concerted policy action to reduce carbon leakage makes sense.

It is also the case that comparative-advantage industries in some countries will be more carbon-intensive than in others. The "industrial structure effect," even if there were a global carbon price, would suggest that the carbon intensity of the exports of some economies will be greater than others even when conditions are fair. This effect has been called "weak carbon leakage" and has been described by Peters and Hertwich (2007) as production in developing countries to meet consumption in the developed countries.

Figure 8: Asia's CO_2 Emissions Embodied in Imports by Origin (left), Exports by Destination (right)



CO_2 = carbon dioxide ROW = rest of the world.

Source: OECD TeCO_2 database.

Figure 9 shows the carbon balance for the net exports of Asia and Asia excluding the PRC over 1995–2018 (panel a) and by economy over 2010–2018 (panel b). For the region, the balance is strongly positive: production emissions exceed those related to consumption, peaking just before the global financial crisis. Without the PRC there is much more balance. This underscores the role of the PRC as a center of regional production networks and manufacturing. Other economies with high positive balances are India; Taipei,China; Singapore; and the ROK. ASEAN is actually split: Singapore, Malaysia, Thailand, Viet Nam, and (marginally) Brunei Darussalam have positive balances, whereas the Philippines, Indonesia, Cambodia, and (marginally) Lao People's Democratic Republic have negative balances.

Another approach would be to estimate carbon leakage directly, through movement of carbon-intensive production to exploit lower regulatory standards and/or carbon prices. Felbermayr and Peterson (2020) and a few other studies have identified this as empirically discernible. Yet, lack of a global database or an accepted methodology makes it difficult to estimate the complete carbon leakage effect (World Bank 2015). Among the few studies to have estimated carbon leakage by country, Misch and Wingender (2021) consider a carbon-leakage rate that measures the degree to which domestic carbon emissions in production are offset by higher emissions abroad in meeting domestic demand. Their estimates for 38 economies, including 6 in Asia and the Pacific (Australia, the PRC, India, Japan, ROK, and New Zealand), are presented in Figure 10. The measure equals 1.0 when domestic reductions of emissions are fully offset by emissions abroad, leaving global emissions unchanged. By this measure, only ROK receives an above average score (0.25); the other Asian economies are at the low end of the spectrum, with only the United States scoring lower.

In sum, exploring the relationship between carbon balance and carbon policy stringency is complicated. It would be difficult to develop an ideal approach to capture empirically the role of policy. Even so, many attempts have been made to develop metrics, scorecards, and dashboards.[10]

CARBON PRICING: CASE STUDY OF THE EU CARBON BORDER ADJUSTMENT MECHANISM

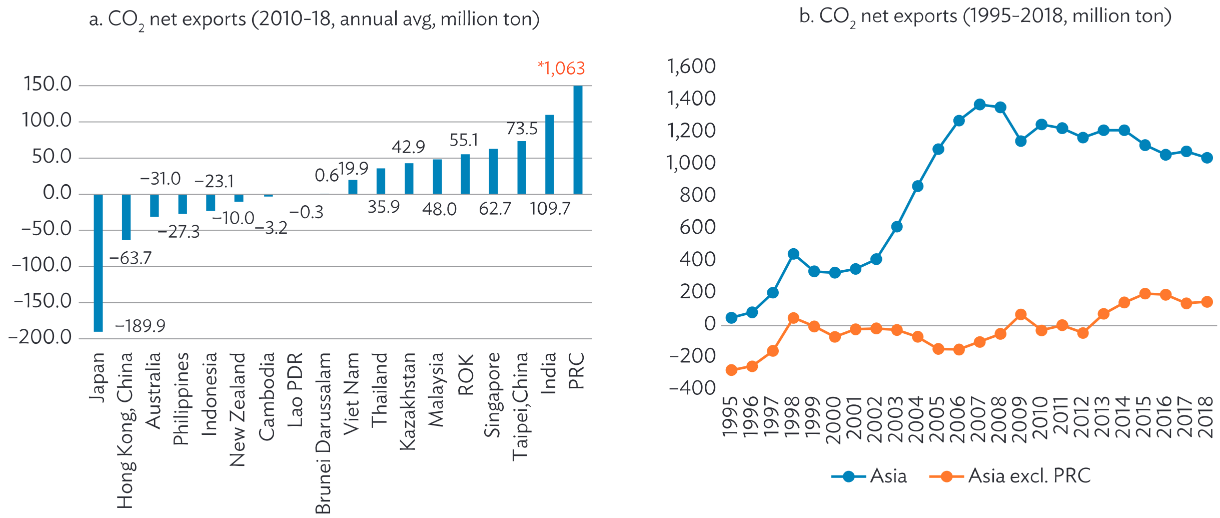
Reductions in carbon emissions in trade-related economic activities can generally be achieved either through regulatory requirements or through carbon pricing.[11] Placing an explicit price on emissions is becoming an increasingly popular way to meet climate targets, as well as a source of funding for the net zero transition. According to the World Bank, carbon prices now cover almost one-fourth of all global emissions.[12] Approaches include the application of a carbon tax directly on greenhouse gases, emissions trading systems (such as "cap and trade"), and various types of crediting mechanisms.

[10] Examples include the Climate Change Performance Index, Climate Action Tracker, World Bank's Regulatory Indicators for Sustainable Energy, Environmental Performance Index, and the Carbon Pricing Dashboard.

[11] I. Parry. 2021. Five Things to Know About Carbon Pricing. *International Monetary Fund.* September. https://www.imf.org/en/Publications/fandd/issues/2021/09/five-things-to-know-about-carbon-pricing-parry.

[12] World Bank data cited by *The Economist,* 1 October 2023. https://www.economist.com/finance-and-economics/2023/10/01/how-carbon-prices-are-taking-over-the-world.

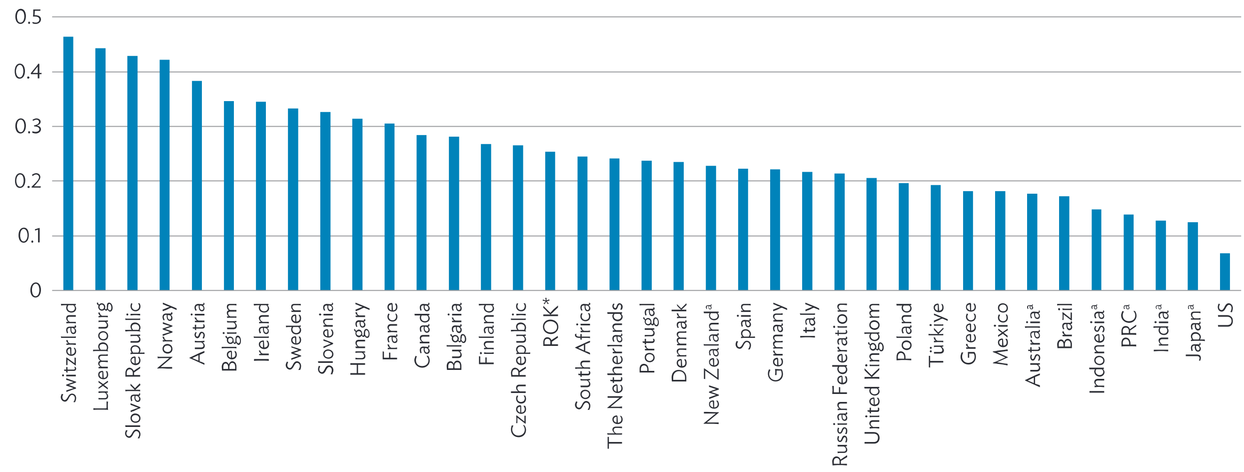
Figure 9: Carbon Balance
(CO_2 emissions, production versus final demand)



CO_2 = carbon dioxide, PRC = People's Republic of China, Lao PDR = Lao People's Democratic Republic, ROK = Republic of Korea.

Source: OECD TeCO_2 database.

Figure 10: Carbon Leakage Rate



PRC = People's Republic of China, ROK = Republic of Korea, US = United States.

[a] A country in Asia.

Note: carbon leakage represents the extent to which domestic carbon emissions reductions are offset by higher emission abroad; it equals one when domestic reductions of emissions are fully offset by emissions abroad, leaving global emissions unchanged.

Source: Misch and Wingender (2021).

The EU has developed one of the most ambitious climate action plans. The region aims to become the first climate-neutral continent by 2050. In 2021, the EU strengthened its commitment by adopting the "Fit for 55" package with the target of reducing net greenhouse gas emissions by at least 55% by 2030, compared with 1990 emissions.

Climate ambition in a vacuum comes with the risk of carbon leakage. The CBAM, one component of the EU Green Deal, aims to prevent this. The CBAM imposes a levy on carbon-intensive products in six sectors that are imported into the EU: iron and steel, cement, fertilizers, aluminum, electricity, and hydrogen. These items were selected due to their high susceptibility to carbon leakage, magnitude of carbon emissions, and administrative feasibility (Simões 2023). The CBAM is an important landmark to prevent carbon leakage by putting an established price on carbon emissions generated during production of identified goods that are imported into the EU market (European Commission n.d.). This new regulation will encourage the EU's trading partners to establish carbon pricing strategies of their own.

The CBAM entered into force on 16 May 2023. During the transitional phase from 1 October 2023, EU importers of CBAM goods are required to submit quarterly reports indicating (i) the quantities of CBAM goods imported during the quarter, by country of origin and production site; (ii) embedded direct and, if applicable, indirect emissions; and (iii) the carbon price due in the country of origin, if applicable. CBAM regulation takes full effect on 1 January 2026. Importers will then need to (i) obtain an authorization to import CBAM goods; (ii) declare on a yearly basis the quantity of CBAM goods imported in the preceding year and their embedded emissions; and (iii) surrender CBAM certificates to cover the declared emissions (Deloitte 2023).

The CBAM should help the EU meet its Fit for 55 climate goals and its net zero plan to 2050, raising funds to support the transition, preventing carbon leakage, and ensuring a "level playing field" for its firms. However, it is unclear how the CBAM will affect other regions, particularly in the developing world, where domestic carbon pricing might be low or zero. Other concerns relate to equity, as the proposed tariff may adversely impact trade, especially exports from developing countries.

Given that economies in Asia and the Pacific depend on international markets for growth and development, the implications of the CBAM are potentially significant, particularly since other markets may follow with their own versions.

Figures 11 and 12 show the exposure of ADB developing member countries (DMCs) to CBAM through shares of their exports to the EU and the World Bank's Aggregate Relative CBAM Exposure Index.[13] Figure 11 presents the CBAM exposure index, which is computed by multiplying the export share of each country by the embodied carbon payment per dollar of export to the EU. Figure 12 presents a relative exposure index. This is calculated by multiplying the same export share by the difference between the exporter's emission intensity and the EU average emission intensity for the CBAM product, scaled by the assumed CBAM price of $100 per ton (World Bank 2023). A positive relative exposure index indicates that a country has higher carbon-emission intensity than the EU average, and so will likely have higher costs under CBAM.

Georgia has the greatest CBAM product exports to the EU relative to its global exports at 35%. Cambodia and India follow, each with 19%, with Tajikistan at 18%, and Azerbaijan at 16%. Not surprisingly, Georgia also has the highest aggregate relative CBAM exposure with an index score of 0.0464. India comes next with 0.0303, followed by Kazakhstan (0.0051), Viet Nam (0.0043), and the PRC (0.0024). Countries with the lowest index scores are Cambodia with -0.0010 and Sri Lanka and Tajikistan with 0.0001. Some countries are more exposed than others at the sector level. For example, India's iron and steel industry, Georgia's fertilizer, and Kazakhstan's aluminum are exposed to the risks of CBAM.

So far, the evidence on CBAM exposure suggests that the effect on most sectors and countries may not be large. However, risks could increase, particularly if the EU increases the coverage of CBAM sectors or other major markets follow the EU approach, or both. After all, the EU market share of a country's exports was key to the determination of the exposure index: the EU is a relatively small market for most of the countries involved. Should major trading partners impose their own version of CBAM, the situation could be different. Legislation, for example, is already being considered in the United States to calculate sector-specific emissions intensity that could lead to its own version of CBAM (Dumain 2023).

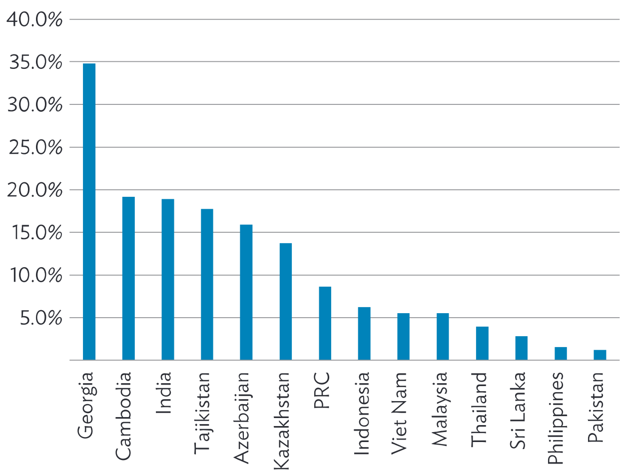
Conforming with CBAM requirements will also be costly (Columbia Center on Sustainable Investment 2021). During the CBAM transitional period that concludes at the end of 2025, importers of CBAM goods are obliged to report total embedded emissions. These are defined as direct emissions released during the production of goods and indirect emissions from the production of electricity that is consumed during production. Hence, EU importers are already preparing for the "hard" CBAM to come in 2026. Some importers may gradually seek more competitive exporters, with price competitiveness now inclusive of a CBAM tax. This could lead to a search for new suppliers and potentially shift value chains to inside the EU or to other markets with equivalent domestic carbon prices.

The European Commission published an impact assessment report on CBAM in 2021.[14] This found the effects to be limited, most importantly because the covered sectors constitute a small part of the EU economy even as they contribute a large share of emissions. The report estimated that its real GDP will decline in the range of 0.222%–0.227% relative to the baseline in 2030, with investment

[13] The World Bank database does not have data on all ADB's DMCs. Presented data are only those available.

[14] The impact assessment used GEM-E3, a recursive dynamic computable general equilibrium model. Variables are determined simultaneously through the interactions between the economy, the energy system, and the environment.

Figure 11: CBAM Products Exported to the EU (% of total CBAM products exports to world)

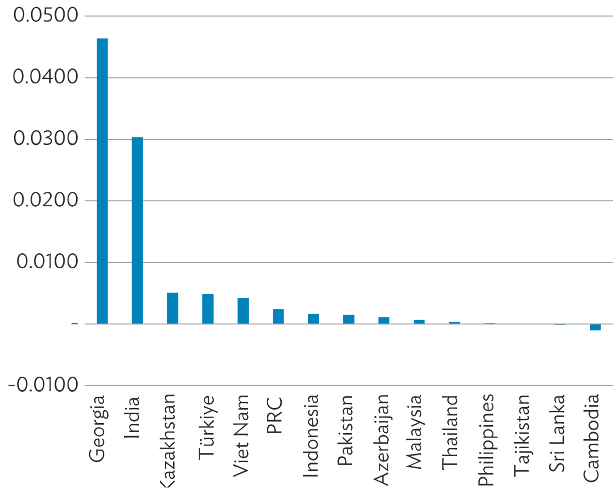


CBAM = the EU Carbon Boarder Adjustment Mechanism, EU = European Union, PRC = People's Republic of China.

Note: CBAM products include cement, electricity, fertilizers, iron and steel, and aluminum.

Source: World Bank CBAM exposure index.

Figure 12: Aggregate Relative CBAM Exposure Index



CBAM = the EU Carbon Boarder Adjustment Mechanism, PRC = People's Republic of China.

Note: CBAM products include cement, electricity, fertilizers, iron and steel, and aluminum.

Source: World Bank CBAM exposure index.

increasing by 0.36%–0.40% and consumption declining by 0.50%–0.56%.[15] The impact on trade would be much larger: CBAM would lead imports in CBAM sectors to decline by 0.9%–11.1% by 2030, with an overall average decline in imports and exports in these sectors of about 10% (Magacho et al. 2022).[16]

Eicke et al. (2021) considers a larger scope for the risks inherent in a country's capacity to meet the demands of the CBAM. The study shows smaller developing countries face higher related risks compared to larger emerging economies. Smaller developing countries tend to be more exposed to CBAM implementation due to their limited statistical capacity and less-developed climate targets. In Asia, Bhutan, Cambodia, and Viet Nam were identified as being particularly vulnerable.

Besides the inaugural six sectors under CBAM, the European Commission is slated to consider an expanded scope. As this may include embedded emissions in transport, which is naturally a function of the distance to EU importers, countries that are geographically more distant from the EU would be at a greater disadvantage. Asian DMCs—especially in East Asia, the Pacific, and Southeast Asia—could lose out to other competitors that are geographically closer to the EU such as those in Africa and the Middle East.

QUANTITATIVE SCENARIOS FOR NET ZERO FROM THE LITERATURE

Extensive global modelling suggests that, if the world is to avoid a potentially catastrophic change in its climate and associated environmental systems, it needs to keep global temperatures from rising less than 1.5°C relative to pre-industrial levels, the threshold determined by the Intergovernmental Panel on Climate Change. To do this, scientists suggest that carbon emissions must be reduced to net zero by 2050. This will take a massive, concerted global effort. Given the stakes, a successful transition to net zero is without doubt the most important international policy challenge of our times.

15 The baseline refers to the EU Reference Scenario 2020, the main elements of which are depicted in the annex of the impact assessment for the revision of EU ETS Directive. It assumes the continuation of free allocation of allowances to operators of installations from sectors and subsectors at a significant risk of carbon leakage.

16 Magacho et al. (2022) offer a critique of the impact assessment.

How the transition will play out is not clear: countries have different goals, and many possible national, regional, and international pathways to net zero exist. There are several key models which have tried to gauge the economic implications of such pathways. This section briefly describes major studies focused on net zero scenarios and then considers studies that estimate trade and climate change scenarios.

Estimates of the Net Zero Pathway

The International Energy Agency (IEA 2021) conducted a comprehensive study on the net zero transition for the energy sector, which accounts for three-fourths of greenhouse gases. The influential study put forward three main scenarios: (i) Stated Policy Scenario, including specific plans already in place or announced by governments; (ii) Announcement Pledges Case, where all announced national zero pledges were assumed to be achieved on time; and (iii) Net Zero Scenario by 2050, which forms the core of the analysis in the paper. The Stated Policy Scenario would lead global temperatures to rise 2.7°C, while the rise in the Pledges Case scenarios would be 2.1°C (each with a 50% probability). Net zero would be consistent with a 1.5°C rise (with a 50% probability).

The study's net zero scenario stipulates the necessary conditions for the global energy sector to reach net zero emissions by 2050.[17] The policy challenges are daunting. The net zero pathway assumes the world economy in 2030 will be two-fifths larger than today but will use 7% less energy, requiring an energy intensity improvement of 4% per year on average to 2030, or about 3 times that achieved over the past 2 decades. It will require a major increase in renewable energy use, energy efficiency, and clean energy innovations, while fossil fuels will have to shrink to about one-fifth of the energy supply by 2050, from about four-fifths today. Moreover, the net zero scenario requires that global energy demand by 2050 fall by 8%, posing a considerable challenge with 2 billion additional people on the planet. Emissions from industry, transport, and buildings will have to fall by 95% by 2050, requiring major efforts to build new and retool existing infrastructure.

Investments associated with the shift toward net zero are massive. The IEA study uses modeling undertaken with the International Monetary Fund to calculate annual investment requirements for the energy sector. It concludes that such investments will need to more than double to $5 trillion by 2030, from about $2.3 trillion currently. On the positive side, this should add 0.4% to annual global GDP growth. The net zero scenario considers other macro and micro (i.e., sector) variables in depth but does not consider trade, except references to certain commodities (e.g., about half of global ammonia and a third of synthetic liquid fuels are traded in 2050). That employment in clean energy rises by 14 million jobs and contracts in fossil fuel-related sectors by 5 million people underscores a public policy challenge. The study recognizes the risk that its assumptions may be off base; for example, (difficult-to-predict) changes in the actions of individuals, changes in technology, and the speed and effectiveness with which new technologies are implemented will have an important bearing on results—e.g., the net zero scenario had about 60% of heavy industry emissions reductions in 2050 as coming from technologies that are not yet ready for the market.

Another important study that develops global scenarios to understand the implications of the net zero transition is found in ADB (2023a). Using the World Induced Technical Change Hybrid (WITCH) model,[18] the report's thematic chapter, *Asia in the Global Transition to Net Zero*, simulates five core scenarios designed to show not only the implications of the net zero transition (or the costs of stasis) but also how ambition in terms of timing and scope as well as international coordination can make critical differences in outcomes.

The first three scenarios create a vector of endogenous "bottom up" policies that extrapolate government commitments by: *Current Policies*, which include no effort beyond policies already in place in 2020; *NDC Effort*, in which policies for unconditional Nationally Determined Contributions (NDCs) are put into place until 2030 and then continue to be gradually strengthened; and *Uncoordinated Net Zero*, in which countries unilaterally implement NDC plans until 2030 and reach their net zero commitment at a later date.

The last two scenarios are exogenous or "top down" in that they are subject to a carbon budget that requires significant global cooperation. *Global Net Zero* assumes implementation of NDCs until 2030 and a global effort to restrict carbon emissions to a level that would keep the rise in global temperatures close to (or less) than the 2.0°C peak. In 2030, it establishes a global carbon market that transitions to equal per capita allowances by 2050. Finally, *Accelerated Global Net Zero* follows the same rules as *Global Net Zero*, except that global efforts accelerate in 2023, rather than 2030. Analysis of the scenario simulations mostly focuses on comparing *Current Policies* (essentially the baseline) to *Accelerated Global Net Zero* outcomes. The WITCH model is coupled with other models to allow it to evaluate implications of climate policy for health, labor, and equity, which are critical to the long-term political viability of climate change abatement plans.

The endogenous scenarios will likely fail to meet Paris Agreement goals in contrast to the exogenous scenarios. The model forecasts a rise in global temperatures of 3.0°C under *Current Policies*, an outcome with significant deleterious effects. Climate policies remain fragmented and will fail to meet the Paris Agreement goals. The *NDC Effort* scenario does better, with emissions rising by 19% less than in the *Current Policies* scenario. Nevertheless, global temperatures still rise by 2.4°C and, hence, this scenario also fails. The uncoordinated *Global Net Zero* scenario does technically keep the rise in temperatures to 2°C but, with a margin of error, there is a good chance it might fall short. In fact, under this scenario, countries with net zero commitments take on a disproportionate burden of adjustment, which could be difficult diplomatically to sustain.

[17] Note that in its estimates it includes no offsets outside of the energy sector and features a low reliance on negative emissions technologies.
[18] WITCH is a form of Integrated Assessment Model used by the UNFCCC.

Nevertheless, the two exogenous global net zero scenarios come close to achieving the Paris Agreement goals, with mean temperatures rising by 1.7°C by 2100 and a 67% probability of staying below 2°C. Under the *Global Net Zero* scenario emissions drop rapidly after 2030 and under the accelerated scenario, they fall by 40% by 2030 relative to the benchmark *Current Policies* scenarios. This underscores the importance of global coordination and speed in addressing the climate challenge.

ADB (2023a) also considers at length the policy costs of net zero—e.g., for carbon pricing and investment—as well as the benefits under the different scenarios. It stresses the importance of carbon pricing and trading, relative to regulatory measures that have dominated the Asian approach to decarbonization. It underscores that poorer countries in developing Asia have the most to gain from international carbon trading, and notes that revenues could be potentially greater than the costs associated with decarbonization. Removing negative carbon pricing by phasing out fossil fuel subsidies would also need to be a policy priority in many economies. The study notes that these subsidies cost developing Asia 0.7% of GDP in 2021, which is two-thirds of the cost of the model's most aggressive decarbonized scenario.

Trade Scenarios

Trade is widely regarded as an important contributor to greenhouse gases, given that it accounts for about 30% of total production-based emissions globally. However, it also can be an important part of the solution through, for example, trade in environmental goods and services, including to cope after climate-induced shocks, trade-related investment in green sectors, technology transfer associated with trade in green sectors and the dissemination of "best practices," and incentivizing investments in low-carbon technologies by increasing scale. Moreover, countries open to international trade have a greater capacity to adjust to climate change, with the WTO finding a positive relationship between climate change adaptivity[19] and trade openness (WTO 2022). In this subsection, we consider studies that model trade scenarios along net zero pathways.

Climate change can alter the comparative advantages of countries. It is also inevitable that the net zero transition will have an important bearing on the relative competitiveness of countries and sectors. WTO (2022) uses the WTO Global Trade Model (WTO GTM)[20] to show how the net zero transition by 2050 could affect trade patterns. Particularly, the model assumes that the net zero transition is accomplished by international cooperation and the adoption of global carbon pricing. The scenario includes a blend of global emissions reductions with announced NDCs until 2030. It also assumes that fossil fuel extraction and consumption is phased out by 2050 and electrification and renewable energy use rise to attain a low-carbon emissions outcome by 2050. It finds overall that energy trade in 2050 is 38% smaller than in 2022 and the composition of trade changes significantly: the global share of fossil fuel exports in total energy exports decreases while the share of trade in renewable energy rises according to the level of green ambition.

Another set of trade and climate scenarios are modeled on work at the WTO by Bekkers et al. (2022) using the WTO GTM. Consistent with other climate models reviewed in this brief, their results underscore that international cooperation is critical for realizing Paris Agreement goals. In the baseline scenario, countries maintain mitigation policies at 2021 levels. This leads to global temperatures rising by 3°C by 2100. The next is a "divided world" scenario, in which countries take unilateral mitigation action, including carbon pricing, consistent with their NDC pledges until 2030. This will be followed by the adoption of border carbon adjustments by high carbon price countries on imports from countries with lower carbon prices. The lack of international cooperation leads to an average global temperature rise of 1.9°C in 2050 and 2.6°C in 2100. Also, a low-carbon cooperation scenario sees countries joining in an ambitious green agenda in which global carbon emissions fall significantly and average global temperatures are kept to 1.7°C by 2050.

Finally, the WTO GTM is also employed to consider the effects of trade liberalization on clean- and renewable-energy-related environmental goods, and environmentally preferred products that, over the life cycle of production of a good, cause significantly less environmental harm than alternatives. Under the best scenario, world exports of clean and renewable-energy-related environmental goods increase by 5% and environmentally preferred products by 14%, relative to the baseline. Global GDP rises by 0.8% by 2030 and global emissions would fall by 0.58%, with tariff elimination and nontariff reductions each causing about half the change.

Other studies have also considered the trade and emissions link. Cristea et al. (2013) use a GTAP-based computable general equilibrium (CGE) model augmented by estimates of international transport costs by mode to simulate changes in the composition and the value of trade due to trade liberalization. They calculate implications for trade and emissions growth and find that the trade liberalization scenarios have very limited impact on trade, emissions, and GDP, although the effects of full liberalization are more significant. As the liberalization effect is higher for more distant countries and trade rises, the effect on transport costs and emissions is greater. Transport emissions rise faster than trade.

CONCLUSION: POLICY TOOLS FOR THE FUTURE

Climate change is arguably the greatest challenge of today. To prevent what could well be catastrophic consequences, all nations need to take swift and decisive actions. With developing

[19] Based on the ND-GAIN Climate Readiness Index.

[20] For a technical description of the WTO GTM, see Aguiar et al. (2019).

countries already suffering disproportionately from climate change impacts, advanced economies have a greater responsibility to act faster and more aggressively than their low-income counterparts. Yet, without considerable carbon reductions in Asia and the Pacific, the world will not be able to meet its climate goals. The economies in Asia and the Pacific also have more at stake in climate change given their vulnerabilities to climate-related disasters, carbon-intensive industrial structures, and funding and capacity constraints.

Developing countries in Asia and the Pacific must step up their efforts for climate change mitigation. Although many Asian economies have made commitments in NDCs, very few nations are on track to fulfill their climate commitments. ADB (2023a) sums up the policy challenges by delineating three key policy options to attain net zero: (i) reform price incentives through carbon pricing and reduce climate-damaging subsidies such as for fossil fuels and agriculture; (ii) use regulations and incentives to elicit low-carbon responses and fund decarbonization; and (iii) ensure environmental policies are fair, equitable, and inclusive. Unfortunately, the Paris Agreement and the current commitments reflected in the NDCs do not expound on the role of trade and trade policy for achieving the goals.

This brief reviews trends in greenhouse gas emissions by production, industry, and trade, how they have changed over time, and the challenges ahead as countries develop pathways to net zero. In particular, the brief has focused on the role of trade in climate change, both as a problem and as a solution. Openness to trade and investment are vital ingredients in the Asian economic success story; hence, ensuring that trade supports the net zero transition is critical to the region's economic and environmental future. This brief identifies many ways this can be done, such as through the liberalization of trade in environmental goods and services, effective carbon pricing and other actions to avoid carbon leakage, facilitating technology transfer, supporting efficiency through competition, and disseminating best practices.

In light of the important nexus between trade and climate change, vast opportunities exist to use trade and trade policy tools to support inclusive growth and green transition in Asia and the Pacific.

(i) **Mainstream trade and trade policy into NDCs.** Governments in Asia and the Pacific should devise and implement ambitious, creative, and effective strategies, from carbon pricing and regulation to financing the green transition. Given the important role of trade in inclusive growth and development across the region, more explicit and stronger inclusion of trade-related actions should be reflected in NDCs to make the transition to net zero smooth and just.

(ii) **Reduce tariffs and trade restrictions on environmental goods and services** to promote allocation of resources to more carbon efficient production and investment. Tariff reductions together with increasing environmental awareness and regulations also help change consumption patterns in favor of environmentally friendly goods and services, in turn getting the market incentives to promote production and investment in less carbon emitting countries and sectors.

(iii) **Promote transfer of technology.** Trade measures such as tariffs and environmental provisions in trade and investment agreements can support the transfer of greener technologies and technology spillovers to developing countries. Broader deployment of current low-carbon technologies in energy, industry, and transport can contribute to considerable reductions in global greenhouse gas emissions (Pigato et al. 2020).

(iv) **Accelerate trade facilitation and logistics reforms** to reduce delays at borders and remove bottlenecks along the supply chain. Sustainable and resilient trade and transport facilitation including cross-border paperless trade implementation have strong potential to reduce carbon emissions and environmental burdens (Duval and Hardy, 2021).

(v) **Develop national carbon-pricing strategies and strengthen regional carbon market cooperation.** Governments and industry leaders should work together to develop standards, codes, and industry norms to reduce embodied carbon emissions. Initially, environmental policies and regulations can promote best practices by rewarding best efforts given the realities of measuring carbon footprints in low- and middle-income countries.

(vi) **Strengthen international cooperation** to maximize effectiveness and minimize costs of green transition. Governments should work together to develop more efficient and effective policy frameworks for the region by leveraging the trade and climate nexus, promoting green finance and investment, and finding equitable solutions along the pathways to net zero. Cooperation is also a must to scale up technical assistance and capacity building on carbon measurement techniques and traceability.

It is important to stress that climate change is a crisis of the global commons and requires global solutions. For example, unilateral approaches to carbon pricing create significant distortions and, according to some modeling exercises, make the Paris Agreement goals more difficult to achieve. International cooperation ensures that free-rider problems and "regulatory chill" are avoided. The EU CBAM case study suggests that approaches to carbon-border adjustments can be far more efficient through coordinated action that avoids deleterious spillover effects, especially for developing economies.

With such high stakes for Asia and the Pacific, the priority needs to be placed on devising effective, efficient, and realistic scenarios for various pathways to net zero by exploring the trade and climate change nexus. This study is the first part of an initiative that considers the policy implications of the region's net zero transition. The next step will introduce new tools for filling gaps in research, including developing a CGE model equipped with environmental-economic data for analyzing interdependencies between key sectors in the region.

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