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Global Trends and Developments in Carbon Pricing

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This comprehensive report delves into the global trends and developments in carbon pricing, a pivotal tool for governments, companies, and investors to mitigate climate change and achieve net-zero emissions by 2050. Our analysis of global carbon-pricing mechanisms reveals significant progress during the past few decades, with a marked increase in both the coverage of emissions and the sophistication of pricing instruments. Carbon pricing is a powerful tool for achieving net-zero emissions, providing financial incentives for reducing greenhouse gas emissions and supporting the development of low-carbon technologies. The Real Carbon Price Index offers a transparent global benchmark for carbon pricing, enabling better decision making for policymakers, businesses, and investors. Investors should care about carbon pricing because it affects the profitability of high-emission companies. Understanding the trends in carbon pricing will also assist investors in managing carbon-pricing-related regulatory risks. In the journey to net zero, investors play an important role in accelerating the shift to cleaner technologies, supporting sustainable long-term growth, and ensuring portfolios are resilient in a low-carbon economy.

Carbon pricing started in the early 1990s, when Finland became the first jurisdiction in the world to formally adopt a scheme mandating a price on carbon pollution. Although many countries and regions followed Finland's lead, jurisdictions with mandated carbon prices today remain in the minority. Only about 24% of global greenhouse gas (GHG) emissions are covered by a carbon price—through either an emissions trading scheme (ETS) or a carbon tax (World Bank 2024).

Putting a price on carbon has a single overriding aim: to create a financial imperative for organizations to consider the cost of emitting carbon (or polluting) in their operations and activities. As such, carbon pricing aims to incentivize organizations to cut emissions. According to CFA Institute Research and Policy Center (Urwin 2024), the net-zero transition journey relies on much more significant policy interventions by governments, including a much more robust carbon-pricing framework. The Carbon Pricing Leadership Coalition—composed of a number of economies, civil society representatives, and international institutions, such as the World Bank and the International Monetary Fund (IMF)—calls carbon pricing "one of the strongest policy instruments available for tackling climate change."[1]

Although all carbon-pricing schemes require polluters to pay to pollute, ETSs have the additional attribute of financially rewarding some organizations for abating pollution. From its starting point slightly more than three decades ago, carbon pricing has evolved slowly and disparately into today's somewhat fragmented global array of schemes, with many different mechanisms and inconsistent pricing, compliance, and enforcement levels. Carbon prices vary enormously, from as high as US$153 per tonne in Uruguay to as little as US$0.085 in Poland[2] and zero in the many jurisdictions that do not set a price on carbon. The scope of emissions covered within individual systems is as fragmented as the pricing, with no uniformity about which forms of pollution and polluting are covered. Encouragingly, amid increasing global pressure to reduce emissions, a degree of convergence in the design and pricing of schemes is becoming apparent. The ultimate end point would be a uniform global carbon price, which would mean the cost of polluting becomes independent of location or activity, and the reward for abatement would be consistent and universal. Complexities around measurement, compliance, enforcement, and political and other factors, however, may mean this outcome may never be fully realized.

Because of the highly disparate nature of existing carbon-pricing schemes, measuring and analyzing them in aggregate has been difficult. To try to overcome the inherent challenges, researchers at the Monash Centre for Financial Studies—in collaboration with carbon-focused businesses C2Zero and SparkChange—have developed the world's first global carbon price index. Based on mandated carbon prices set by regulators and governments worldwide, the Real Carbon Price Index (RCPI) provides a notional composite global price of carbon, which, like other financial indexes, can be tracked over time. Combined with its various subindexes and related source material for interpretation, the RCPI is a powerful new tool for researchers, investors, and others seeking to draw meaningful conclusions about the disparate but growing collection of carbon-pricing schemes globally.

[1]See www.carbonpricingleadership.org/what.

[2]As of 31 October 2024.

Background and Significance

The net-zero commitment of various stakeholders in the global economy, including governments, companies, and investors, aims to balance GHG emissions produced and removed from the atmosphere by 2050. This concept is rooted in the UN Intergovernmental Panel on Climate Change's Fifth Assessment Report (Intergovernmental Panel on Climate Change 2014) and emphasized in a special report on limiting global warming to 1.5°C (Intergovernmental Panel on Climate Change 2018). Net-zero investing involves transforming investment strategies to reduce emissions, support low-emission technologies, and engage in policy advocacy. Integrating systemic thinking, net-zero investing emphasizes long-term sustainability and resilience against climate risks, aligning financial returns with environmental impact.

Carbon pricing is a critical incentivizing mechanism for decarbonization to achieve net zero, particularly for companies and investors, because it internalizes the environmental cost of carbon emissions. Carbon-pricing mechanisms enhance the overall efficiency of capital markets by correcting market failures related to the externalities of carbon emissions (Urwin 2024). Carbon pricing creates financial incentives for businesses to reduce their carbon footprint and adopt low-carbon technologies by assigning a monetary value to carbon emissions. For investors, this pricing model aligns economic interests with environmental goals, making responsible investments more attainable and viable.

Investors play a crucial role in driving the transition to a net-zero economy. Decarbonization has been integrated into the investment process through both strategic and tactical asset allocation by both asset owners and asset managers. The integration is a multifaceted approach that involves investors setting their net-zero commitment with clear carbon reduction targets, divesting from high-carbon assets, investing in climate solutions and companies with progressive transition, engaging with companies on climate issues, and using advanced data to form climate-related portfolio strategies. Investors can influence corporate behavior by directing capital toward more sustainable ventures, thus driving innovation and growth in the green economy. This strategic shift reflects the realization of climate change as a significant financial risk and the net-zero transition as an opportunity for long-term value creation.

There is a growing recognition of the significance of carbon costs in the long-term risks and opportunities associated with climate change for companies. These factors affect how investors manage the financial risks posed by carbon-intensive assets, which is critical in ensuring that investment portfolios are resilient to climate-related risks.

The transparent and predictable nature of carbon pricing allows investors to make informed decisions, supporting companies leading the transition to a low-carbon economy. The RCPI is the world's first and most comprehensive index of carbon prices, providing a transparent, global benchmark for carbon pricing. This index reflects the true cost of carbon emissions across various jurisdictions, enabling investors to make more-informed decisions. Understanding the real carbon price helps investors assess the financial risks and opportunities associated with carbon-intensive and low-carbon assets—and thus achieve better and optimal capital allocation toward responsible investment. Finally, putting the right price on carbon can encourage and finance innovation in green technologies, which are crucial for the transition to a net-zero economy (Cui, Ruthbah, Cohen, Ahrens, and Pham 2021).

Historical Evolution of Carbon-Pricing Mechanisms

The journey of carbon pricing reflects a progressive but uneven evolution over the past three decades. Initially implemented as a pioneering tool for GHG emissions, carbon-pricing mechanisms have grown in scope and sophistication. This section delves into the historical development and diversity of carbon pricing strategies.

Carbon Pricing Mechanisms

Carbon pricing is a crucial strategy for mitigating climate change by internalizing the external costs of GHG emissions. The main pricing mechanisms used globally are compliance systems, such as carbon taxes and market-based ETSs, and voluntary mechanisms.

Carbon Taxes

A carbon tax directly sets a price on carbon by defining a tax rate on GHG emissions or the carbon content of fossil fuels. This straightforward mechanism provides a clear economic signal to emitters. Companies must pay for every tonne of GHGs they emit, which motivates them to reduce emissions in order to lower their tax burden. Carbon taxes offer predictability in terms of carbon prices but do not guarantee a specific level of emission reduction.

The effectiveness of carbon taxes in reducing carbon emissions is well documented in various contexts and industries. A study by Floros and Vlachou (2005) indicates that a carbon tax of US$50 per tonne significantly reduced both direct and indirect carbon emissions from 1998 levels in Greek manufacturing. Alper (2018) shows that carbon taxes effectively reduce post-2020 industrial carbon emissions as carbon prices rise. Among 30 investigated provinces, Inner Mongolia, Shandong, Shanxi, and Hebei rank as the top four provinces in China with the largest potential for industrial CO_2 reduction following the implementation of a carbon tax, owing to their significant coal production/consumption and total energy consumption (Dong, Dai, Geng, Fujita, Liu, Xie, Wu, Fujii, Masui, and Tang 2017). Sweden's experience, detailed by Andersson (2019), demonstrates that high carbon taxes can significantly cut CO_2 emissions without hindering economic growth.

Market-Based ETSs

An ETS sets a cap on the total level of GHG emissions and allows industries to buy and sell permits to emit these gases. The cap is typically reduced over time to decrease total emissions. Under an ETS, companies that reduce their emissions below their allocated permits can sell their excess permits to other companies. This dynamic creates a financial incentive for companies to reduce emissions more cost effectively. An ETS provides flexibility and economic efficiency by letting the market determine the carbon price, although the price can be more volatile than a carbon tax.

The effectiveness of ETSs in reducing carbon emissions is supported by substantial empirical evidence. Using machine-learning systematic review and meta-analysis, Döbbeling-Hildebrandt, Miersch, Khanna, Bachelet, Bruns, Callaghan, Edenhofer, et al., (2024) demonstrate that at least 17 of 21 carbon trading schemes have led to substantial emission reductions, ranging from −5% to −21% (adjusted to −4% to −15% after accounting for publication bias). Other studies suggest that the EU ETS has successfully reduced GHG emissions. For example, Bayer and Aklin (2020) show that the EU ETS saved approximately 1.2 billion tonnes of CO_2 emissions from 2008 to 2016, equivalent to 3.8% relative to total emissions. Furthermore, Brohé and Burniaux (2015) and Teixidó, Verde, and Nicolli (2019) reveal that the EU ETS encourages businesses to invest in greener technologies.

Voluntary Carbon Markets

Beyond regulatory mechanisms, numerous voluntary carbon markets exist where carbon credits are traded. These credits represent realized or unrealized carbon abatement and allow for voluntary offsetting of pollution. Voluntary carbon markets are characterized by their fragmentation and lack of regulation, leading to significant variation in carbon credit prices. Despite their potential to foster innovation in carbon reduction projects, these markets often face challenges with respect to transparency, credibility, and standardization.

Specialized Offsets and Allowances

Some industries and sectors use specialized offsets and allowances tailored to their specific carbon reduction needs. Examples include offsets for aviation emissions under the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) and allowances under sector-specific regulatory frameworks, such as the large-scale generation certificates issued by the Australian government for renewable energy generation projects.

The voluntary mechanism and specialized allowances are not included in the scope of the Monash/C2Zero RCPIs.

Carbon Taxes Over Time

In January 1990, when Finland introduced the world's first carbon tax, its tax rate was initially set at only US$1.75 (€1.12) per tonne of CO_2 emitted, and the scheme accounted for only 0.1% of global emissions (Khastar, Aslani, and Nejati 2020; Sumner, Bird, and Dobos 2011; World Bank 2021). Since 1990, however, Finland's carbon price has significantly increased; by 2024, it was about US$72 (€62) per tonne (World Bank 2024). As of 31 October 2024, 21 European countries have carbon taxes, ranging from US$0.085 per tonne in Poland to US$153.013 per tonne in Uruguay. A further nine countries outside Europe have also introduced carbon taxes: Canada, Mexico, Colombia, Argentina, Uruguay, Chile, Japan, Singapore, and South Africa. According to the World Bank's Carbon Pricing Dashboard, a total of 31 national jurisdictions are covered by some form of carbon tax.

Japan's carbon tax program, introduced in 2012, is among the most comprehensive in the world—covering all fossil fuels for all sectors—and accounts for a greater share of global emission coverage than any other national or subnational tax initiative. Covering 80% of Japan's emissions, it represents 1.51% of global GHG emissions (Hofbauer Pérez and Rhode 2020; World Bank 2024). This results in part from Japan being the world's fifth-largest emitter of GHG emissions,[3] with 90% coming from energy-related activities (Timperley 2018).

In addition, there are eight subnational carbon tax programs covering five regions in Mexico, two in Canada, and one in Taiwan. In total, the national and subnational tax programs accounted for approximately 5 gigatons of CO_2 emissions in 2024, representing 6% of global GHG emissions (World Bank 2024).

ETSs Over Time

Under ETSs—also referred to as cap-and-trade schemes—governments (or regulators) typically allocate or auction emission allowances to polluters, with a "cap" or upper limit on the quantity of emissions allowed within the system. Participants can trade allowances among themselves, buying them to cover their polluting activities or selling surplus allowances to other polluters. Over time, emission caps are lowered, forcing companies collectively to reduce their emissions through investment in sustainable technologies.[4]

One of the first ETSs was the EU ETS, launched in January 2005. As of June 2024, it covers emissions from electricity and heat, aviation, mining and extraction, and industry across the 27 EU member countries plus Iceland, Liechtenstein, Norway, and Northern Ireland, and it accounts for 2.59% of global

[3]See the World Population Review, "Greenhouse Gas Emissions by Country 2024." https://worldpopulationreview.com/country-rankings/greenhouse-gas-emissions-by-country.

[4]The various schemes are characterized by many similarities—and many differences—that are not covered in full detail in this document. For more information, see, for example, International Carbon Action Partnership (2021).

emissions. Nearly all pollution permits were allocated for free during the initial phase (Abnett 2020).

The introduction of the EU ETS led to a significant increase in the percentage of emissions covered by carbon pricing globally, from approximately 0.5% in 2004 to 5% in 2005, with the EU scheme accounting for 2.59% of global GHG emissions (World Bank 2024). At the time of its launch, however, the system was heavily oversupplied with allowances, resulting in a low, suboptimal carbon price that did little to discourage emissions (Abnett 2020). Since then, the scheme has been amended in each phase to control the oversupply of allowances and ensure higher, more robust carbon prices to achieve emission reduction targets. The most notable change was the introduction in 2019 of the Market Stability Reserve, a mechanism established to reduce the surplus of emission allowances in the market (European Commission 2021). These Phase 3 changes led to dramatic increases in the price of EU allowances, from around US$6 in April 2013 to US$69.94 in October 2024.

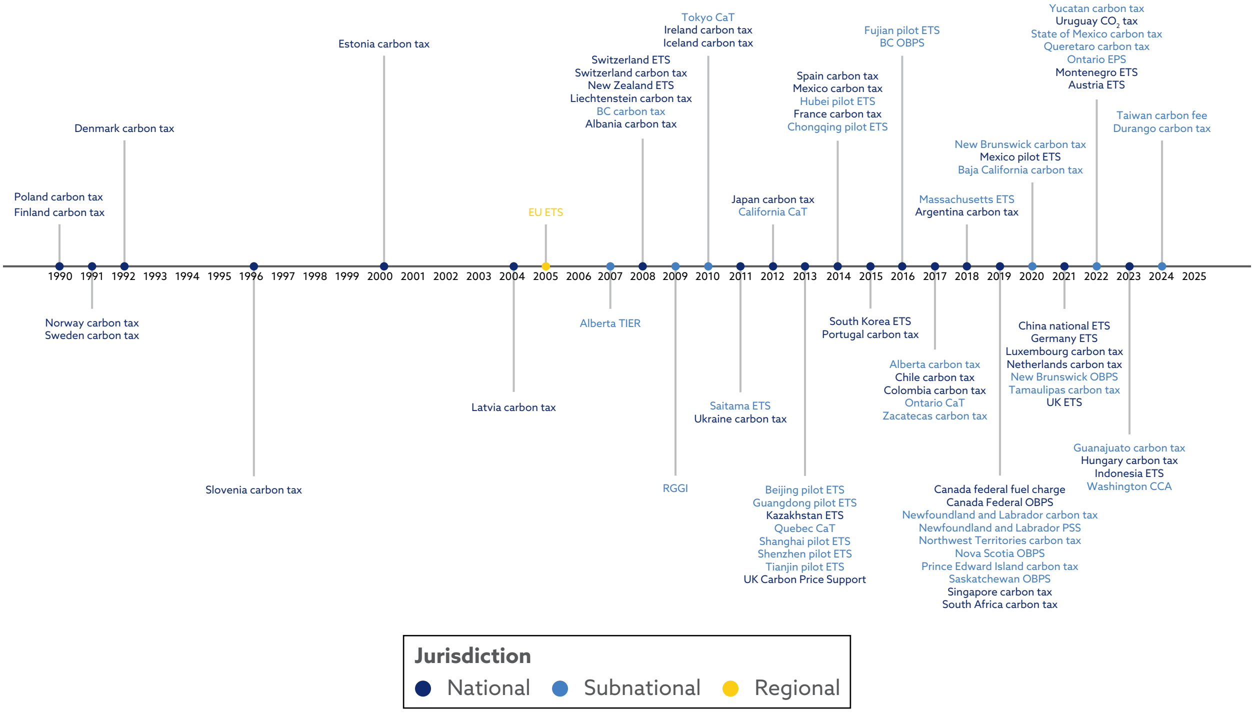
The EU ETS has inspired the development of emission trading in other countries and regions, including China's new national ETS, which accounts for the largest share of global GHG emissions—9.30%. Eleven ETSs are operating nationally: in Austria, Canada, Germany, Indonesia, Kazakhstan, Mexico (a pilot scheme), Montenegro, New Zealand, South Korea, Switzerland, and the United Kingdom. In addition, 20 ETS initiatives are operating in various subnational jurisdictions. Eight of these programs operate in the Chinese provinces of Beijing, Chongqing, Fujian, Guangdong, Hubei, Shanghai, Shenzhen, and Tianjin, part of China's pilot ETS program. Another significant scheme is the subnational cap-and-trade system for California and Quebec, known as the Western Climate Initiative (WCI). Established in 2014, it allows companies to buy and sell emission allowances on each other's carbon markets. The combined markets of the WCI and the Regional Greenhouse Gas Initiative (RGGI)—a joint initiative of several eastern US states—account for 0.28% of global GHG emissions (World Bank 2024). The Canadian province of Nova Scotia also introduced an ETS in 2018. These programs cover 10.18 gigatons of CO_2 emissions, or approximately 18% of global GHG emissions.

Exhibit 1 includes a timeline tracking the introduction of carbon taxes and ETSs in various jurisdictions.

Considering both carbon taxes and ETSs, 75 jurisdictions have a price on carbon, covering 23.35% of global carbon emissions. However, the physical carbon price is still zero for approximately 76% of global emissions, including those from many of the world's biggest polluters—including India, Russia, Brazil, Iran, Saudi Arabia, Turkey, and Australia.[5]

[5]Listed from highest emissions to lowest, those seven countries collectively account for about 20% of global emissions, according to data from the European Commission's EDGAR (Emissions Database for Global Atmospheric Research) Community GHG Database (https://edgar.jrc.ec.europa.eu/report_2023).

Exhibit 1. Timeline of the Introduction of Carbon Taxes and ETSs



Source: Data from World Bank (2024).

The Development of a Global Carbon Price Index

Carbon pricing is fragmented, with varying approaches and price levels across regions and countries. This fragmentation challenges businesses operating globally, because they must navigate a complex landscape of diverse carbon-pricing mechanisms. Differences in carbon prices can lead to competitive imbalances, where companies in regions with lower or no carbon pricing gain an unfair advantage. Fragmented pricing also complicates efforts to achieve global emission reduction targets, because of the lack of uniformity needed to drive consistent and effective climate action.

Governments, businesses, and international organizations are also increasingly supporting a unified global carbon price and coordinated global carbon-pricing framework. For example, the IMF proposes an international carbon price floor, which sets a minimum price for GHG emissions: US$75 per tonne in high-income economies, US$50 in middle-income economies, and US$25 in low-income economies. This tiered approach reflects differing economic capacities while promoting global emission reductions (Parry, Black, and Roaf 2021). The World Trade Organization initiated a Global Framework for Climate Mitigation policy, which sets a global average carbon price to meet climate goals; adjusts prices based on historical emissions, economic development, and climate impact costs; allocates revenues to support vulnerable economies; and allows alternative emission reduction policies, aiming to reduce economic disparities and prevent policy fragmentation (Bekkers, Yilmaz, Bacchetta, Ferrero, Jhunjhunwala, Métivier, Okogu et al. 2024).

A single carbon price enhances market efficiency by simplifying the carbon trading market, reducing complexity, and increasing transparency. This uniformity creates a level playing field for businesses globally, eliminating competitive disadvantages and preventing "carbon leakage," whereby companies relocate to regions with lower or no carbon pricing.

Methodology of the RCPI Construction

The development of a robust and transparent global carbon price index requires a comprehensive and meticulous methodology. The RCPI leverages a blend of quantitative and qualitative data sources to capture the diverse and fragmented nature of global carbon pricing mechanisms. This section outlines the approach taken to construct the RCPI, highlighting the criteria used and the key data sources that underpin its accuracy and utility.

Criteria and Data Sources Used for RCPI

Index Constituents

Because of the absence of comprehensive and reliable data from the early years of carbon pricing in Europe, the Monash/C2Zero RCPI shows the evolution of the global aggregate carbon price from a starting point of 2013. By this time, the carbon price index "universe" consisted of 20 national, regional, and subnational jurisdictions. In subsequent years, the scope covered by the index increased, as did the number of instrument constituents. As of October 2024, 75 national, subnational, and regional jurisdictions had implemented a carbon tax or carbon ETS (World Bank 2024). Our indexes cover 70 of those jurisdictions. The other jurisdictions were excluded because of the lack of available data. Of the 36 jurisdictions with an ETS, the index includes only 32 for which data are available.[6]

Scope Data

The data on each jurisdiction's coverage of global GHG emissions (or scope) are sourced from the World Bank's Carbon Pricing Dashboard.[7] We updated our scope as the dashboard included more jurisdictions with scope information.

[6]For example, for the two Mexican subnational jurisdictions—Baja California and Tamaulipas—the scope or the tax rates were unavailable, prompting their exclusion from the index. The emissions covered by the UK Carbon Price Support overlap 100% with the EU ETS and are excluded from the index. The Kazakhstan ETS was implemented in 2013, but data for it are only available beginning in December 2019; therefore, Kazakhstan has been included in the index only since 2019.

[7]For 7 of the 70 jurisdictions in our index universe—Estonia, Iceland, Latvia, Liechtenstein, Prince Edward Island, the Northwest Territories, and the Netherlands—the scope was missing from the dashboard in 2021 when we introduced the index. For these jurisdictions, the scope was extracted from the "GHG emissions in the jurisdictions (2015)" and "Share of jurisdiction's GHG emissions covered" individual jurisdiction pages on World Bank's dashboard.

Price Data

Pricing is not available from a single source. Price disclosure varies across markets and instruments, and certain instruments' prices are not always available daily. Carbon tax rates in local currency units (LCUs) and US dollars are collected from the World Bank's annual State and Trends of Carbon Pricing reports, the Carbon Pricing Dashboard, and various government websites.[8] ETS carbon prices are sourced from various market data providers, including Bloomberg, Refinitiv, and WIND, as well as various government websites. Liquid spot prices (where available) are used for ETS carbon pricing. For jurisdictions with unavailable ETS spot prices, ETS auction prices or prices adjusted from ETS futures are used. In the event that no new prices for a particular jurisdiction are available, the index will continue to be calculated based on the last available prices.

Exhibit 2 shows the prices and the GHG percentage covered by each jurisdiction included in the RCPI as of 31 October 2024.

Large gaps remained among the average carbon prices set by the jurisdictions included in the RCPI and the target range of US$50–US$100 by 2030 suggested by the High-Level Commission on Carbon Prices (World Bank 2017) and the IMF's suggested 2030 price floor of US$75 per tonne for advanced economies and US$50 for high-income emerging market economies.[9] Only six jurisdictions—Finland, Liechtenstein, Norway, Sweden, Switzerland, and Uruguay, in order of ascending carbon price—have a carbon price higher than US$75, as of the end of October 2024. China's national ETS—the biggest contributor in terms of the percentage of global GHG emissions—and other pilot ETSs in China all price carbon at a fraction of the IMF's target.

Index Construction

The RCPI provides a comprehensive measure of global carbon prices, representing all carbon prices and all emissions from all jurisdictions globally. It includes both emissions subject to carbon prices and those with no price; the latter are included in the index using a price of zero. The index allows the calculation of a global carbon price and its evolution over time (adding dispersion and other measures) and provides tools for interpretation and analysis.

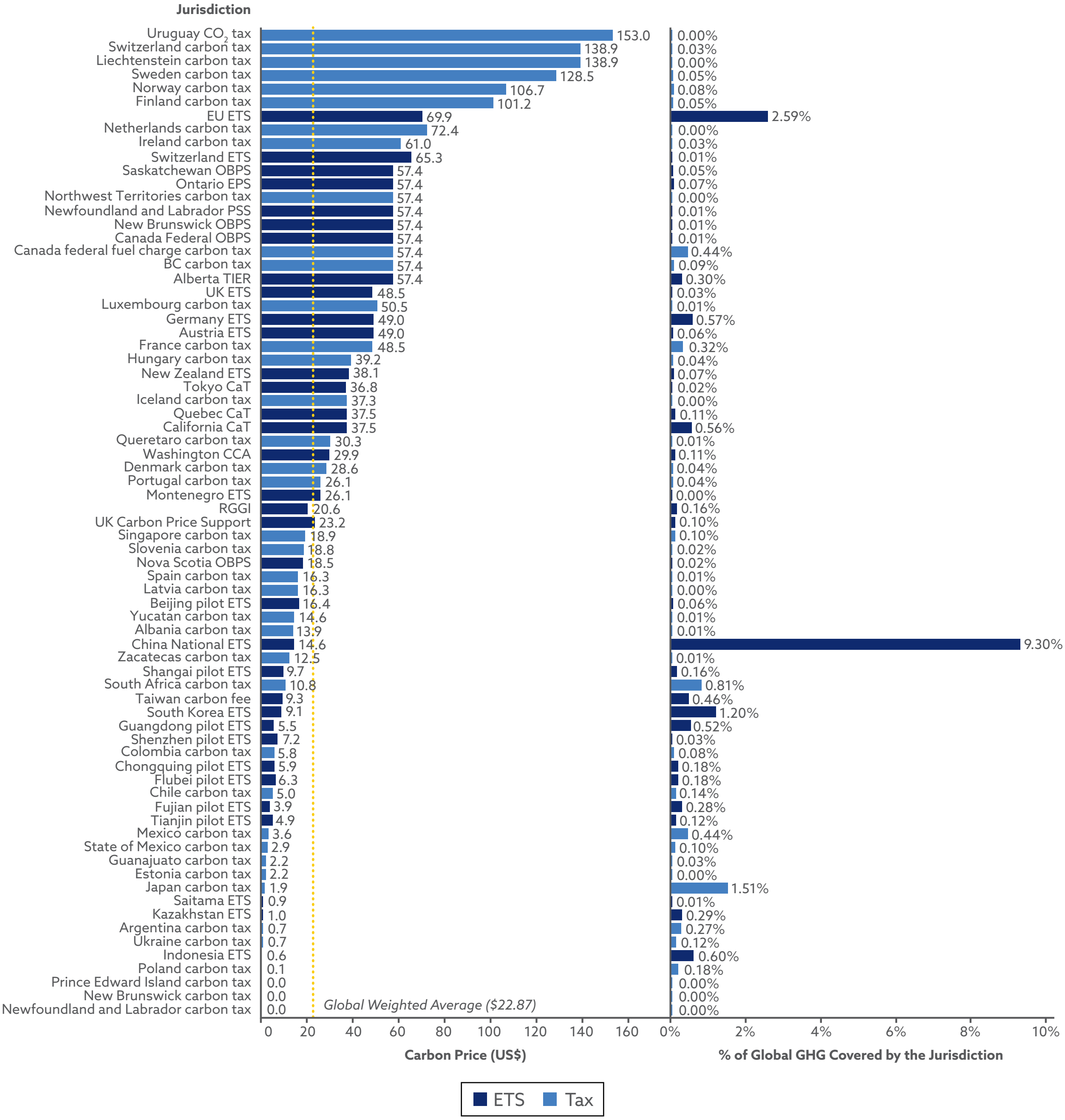
We use the following formula to calculate the level of the RCPI at any point in time:

$$\text{Index level} = \frac{1}{n}\sum_i w_i fx_i P_i,$$

[8]See www.realcarbonindex.org/indices.

[9]To keep warming below 2°C, the IMF suggested a 2030 price floor of US$75 per tonne for advanced economies, US$50 for high-income emerging market economies such as China, and US$25 for lower-income emerging markets such as India. See Parry (2021).

Exhibit 2. Carbon Price and the Scope of Global GHG Emissions Covered by Jurisdictions, 31 October 2024



where

- w_i is the percentage global scope (weighting) of emissions covered by instrument i, including the scope with zero price,
- $n = \sum_i w_i + w(\text{no carbon price})$: n is 100% for the global index and otherwise is the percentage coverage for relevant subindexes including the weighting for zero prices,
- $\sum_i w_i$ represents the scope or percentage of emissions in the index for which the price is nonzero,
- P is the price in the local currency of instrument i (note that for tax-based instruments, P_i will be largely static), and
- fx_i is the relevant foreign exchange rate for converting P_i (the local price) into the index currency.

Historical Carbon Price Movements

Various regional ETSs and carbon taxes were introduced in the last three decades, with European countries initially leading the way. China's pilot ETS in Guangdong, Hubei, Tianjin, and other regions appeared around 2014–2015, and Mexico, Portugal, and South Korea implemented their carbon taxes around 2015–2017. The introduction of carbon prices in new jurisdictions during the last few decades has significantly increased both the carbon price level and the scope of emissions covered under the index.

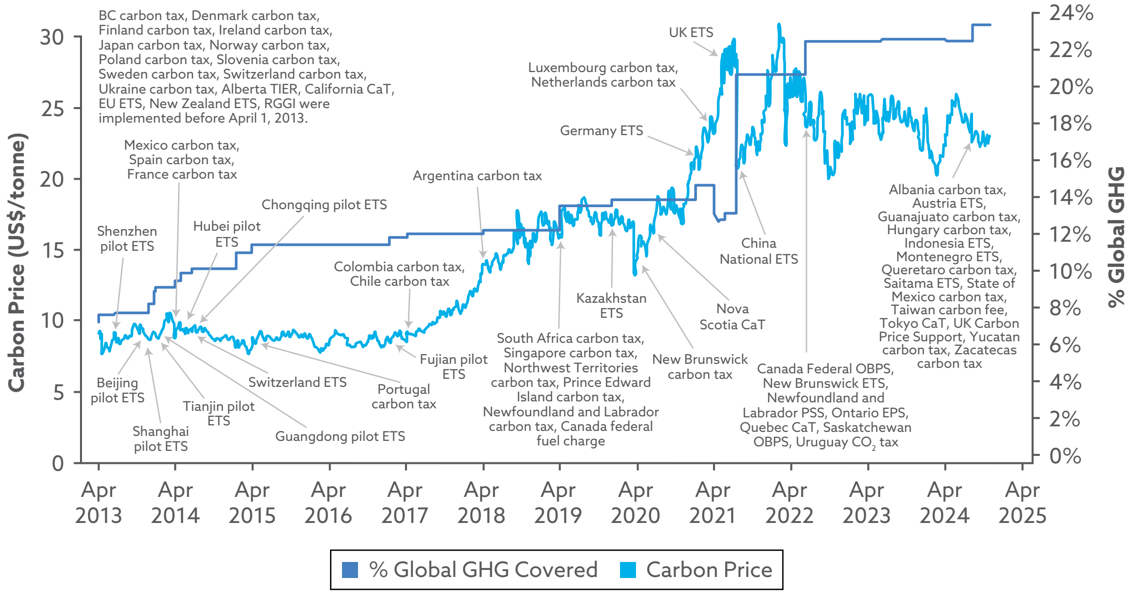
As shown in **Exhibit 3**, the RCPI has dramatically increased since the starting point, by almost 670%, from around US$0.70 in 2013 to US$5.34 in October 2024. The carbon price rose noticeably starting around 2017, coinciding with new implementations, such as the Fujian pilot ETS and carbon taxes in Argentina, Chile, and Colombia. The implementation of China's national ETS in July 2021 pushed the RCPI to a record high and extended the coverage to beyond 20% of global GHG emissions; this ETS represents the largest carbon market in the world.[10]

The coverage of global GHG emissions by both ETSs and carbon taxes has grown substantially, indicating a broader adoption of carbon-pricing mechanisms worldwide. Exhibit 3 highlights the expanding reach and evolving dynamics of carbon-pricing instruments in mandatory regimes during the last decade.

ETS coverage of global GHG emissions increased from 5.01% in 2013 to 17.69% in October 2024; during the same period, carbon tax regimes' coverage grew more modestly, from 2.87% to only 5.65%. The significant increase in ETS coverage reflects its growing role as a key tool in global climate policy. ETSs are

[10]China's national ETS covers more than 2,200 fossil-fuel power plants in China with about 5 billion tonnes of CO_2, which is 40% of the country's emissions; see https://icapcarbonaction.com/system/files/ets_pdfs/icap-etsmap-factsheet-55.pdf.

Exhibit 3. The RCPI and the Timeline of Jurisdiction Inclusion, 2013–2024

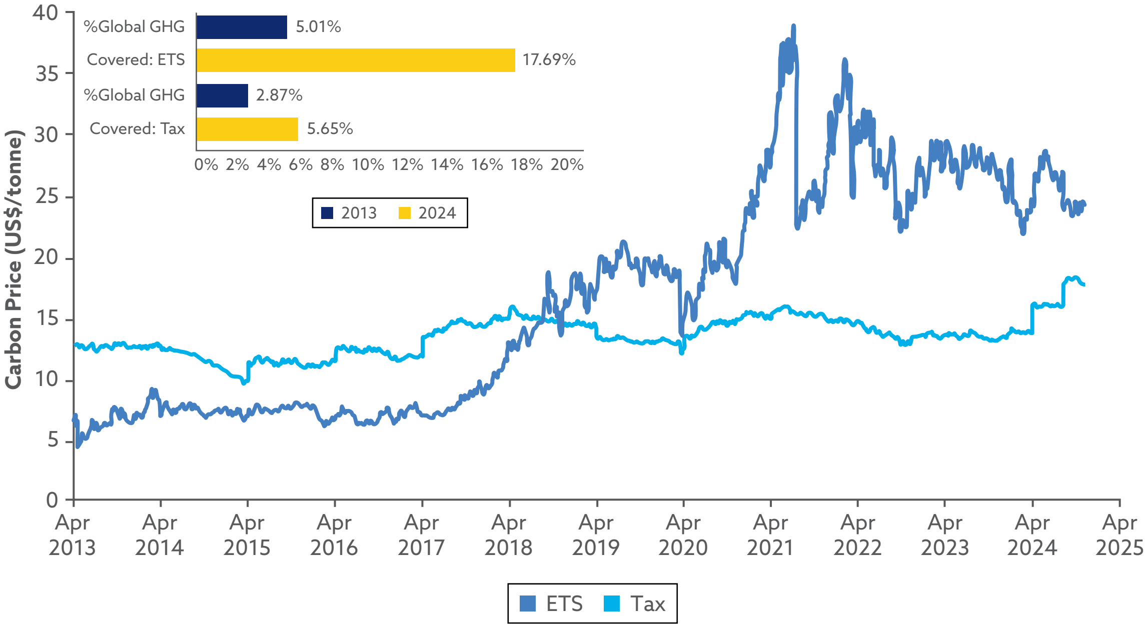


gaining popularity because they operate as a market-based mechanism that offers companies the flexibility to trade emission allowances and enables them to find the most cost-effective way to reduce emissions.

Exhibit 4 illustrates different pricing dynamics between ETSs and carbon taxes. The price index in Exhibit 4 represents the weighted average of ETSs and carbon taxes in jurisdictions that have carbon pricing. The weights are based on the scope of the GHG emissions covered. The price index of ETS jurisdictions has grown substantially since 2017–2018 and exhibited high volatility while the market price of carbon traded on these ETSs responds to major events and crises, such as the COVID-19 pandemic. Since mid-2018, the ETS carbon price has remained significantly higher than that of the carbon tax index. The steep rise in ETS prices from 2018 onward suggests increasing market activity, high carbon prices introduced by new ETSs (such as the UK ETS and Germany's ETS), and possibly stronger regulatory measures driving up the cost of emission allowances. An ETS typically sets a cap on total emissions, ensuring that the environmental goal is met. As the cap is reduced over time, total emissions decrease, putting upward pressure on the ETS's carbon prices.

In contrast, the carbon tax price index remained relatively steady—between US$10 and US$18 per tonne throughout the 2013–24 period—because jurisdictions do not often change their carbon tax level dramatically once it has been introduced. Its price level changes only when new jurisdictions join the index. The steadier nature of carbon tax prices suggests carbon taxes provide a more predictable cost for emissions but may lack the dynamic pricing signals of an ETS and flexibility for companies.

Exhibit 4. Carbon Prices under ETS and Tax Regimes, 2013–2024



Carbon Economy

Compliance carbon-pricing mechanisms are implemented to provide a financial incentive to invest in decarbonization technologies. They are not meant to be a penalty to fund climate change mitigation. Thus, to assess carbon-pricing levels in the context of the clean energy transition, it is imperative to evaluate abatement technology cost curves required to achieve the transition to a low-carbon future.

The High-Level Commission on Carbon Prices (World Bank 2017) found that a global average carbon price of US$50–US$100 per tonne is needed by 2030 to achieve the goals of the Paris Agreement. Parry, Black, and Zhunussova (2022, p. 15) found that a "price floor of $75, $50, and $25 per tonne for high-, medium- and low-income countries, respectively, would be sufficient to align global CO_2 emissions in 2030 with keeping global warming below 2°C, even with only six participants (Canada, China, EU, India, United Kingdom, United States)." Both estimates have a wide range for climate-transition-aligned carbon prices, but even the lowest ranges lead to a bleak verdict: The global average carbon price is nowhere near where it needs to be to incentivize the investments required to decarbonize the global economy and limit global warming below 2°C.

To put it in a broader context of the cost to the economy, the social cost of carbon has increased more than tenfold, from an estimated US$21 per tonne of carbon dioxide in 2010 to the latest estimate of US$225 in 2024 (See 2024). This increase highlights the need for faster movement in compliance carbon prices to incentivize changes in business behaviors and investments in decarbonization technology.

The IMF recognizes that different regions require different carbon prices, and the regional developments mirror this dynamic. Carbon-pricing mechanisms vary significantly across regions, as explained in the following section.

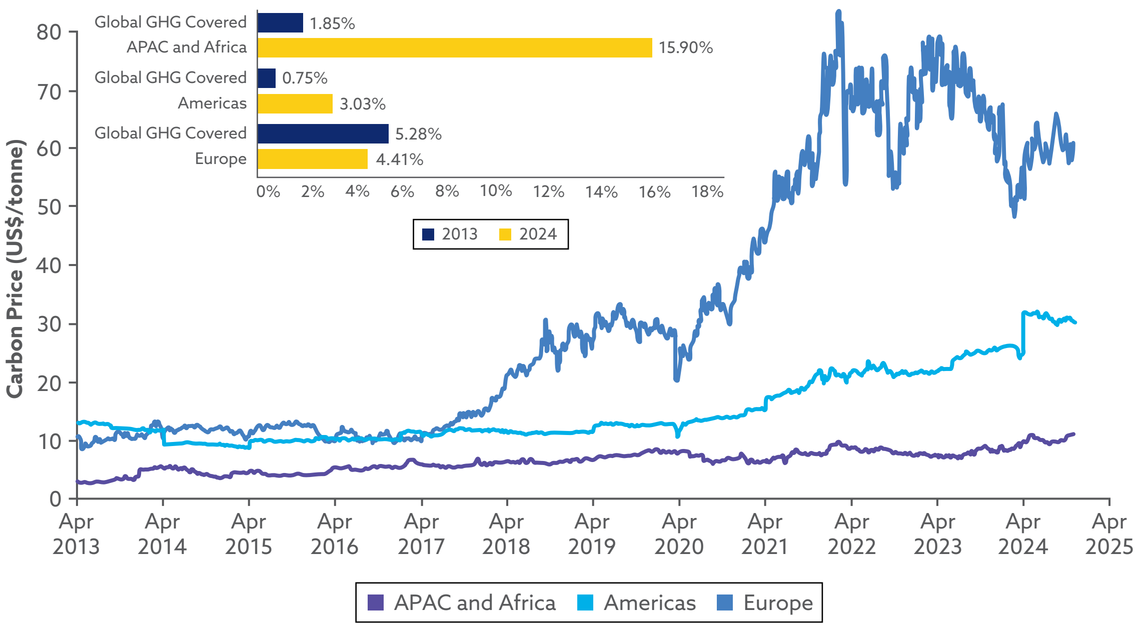
Regional Disparities

It is fascinating to examine regional disparities in the adoption of carbon-pricing mechanisms and the different levels of carbon prices. **Exhibit 5** provides a comprehensive overview of carbon prices in Asia Pacific (APAC) and Africa, the Americas, and Europe, together with the change in the scope of global GHG emissions covered by these regions during the last decade.

Although Europe exhibits a strong and increasingly stringent carbon market, the Americas and the APAC and Africa regions show more stable and steady price changes. The European regional index shows a significant upward trend during the last 10 years. Starting from around US$5 per tonne in 2013, it grew to around US$59 per tonne, on average, in 2024. This trend indicates a progressively tightening carbon market in Europe.

Notably, the European regional index peaked at US$83.25 per tonne in February 2022 but dropped below US$55 in March 2022 following the outbreak of the Russia–Ukraine War. The EU ETS, the major market in Europe, reached a historic peak of US$110.08 in early February and then plummeted by 14.25% within four trading days following the onset of the war (Real Carbon Price Index 2022). This drop marked one of the largest drawdowns in the history of the RCPI and the European regional index. Since then, both have also experienced a considerable increase in volatility.

Exhibit 5. Carbon Prices by Region, 2013–2024



The European regional index experienced another large drawdown in August 2022 when the EU ETS declined by 14.57% in response to Russia's extended shutdown of Nord Stream 1 and the growing likelihood of more sales of allowances to help fund the energy transition to reduce EU dependence on Russian fossil fuels—the RePowerEU plan (Real Carbon Price Index 2022).

The recent trends in carbon prices in Europe illustrate how susceptible these prices are to geopolitical risks and conflicts.

Case Study: The EU ETS

The EU ETS is a cornerstone of the EU's strategy to combat climate change and GHG emissions. Launched in 2005, the EU ETS operates across all EU countries plus Iceland, Liechtenstein, and Norway, covering approximately 40% of the EU's GHG emissions. It functions on a cap-and-trade principle, limiting the total emissions allowed from covered sectors (i.e., power and heat generation, energy-intensive industries, and commercial aviation) within the European Economic Area.

The EU ETS has evolved through four key phases. Phase 1 (2005–2007) was a pilot phase focused on establishing the market infrastructure and basic rules, primarily allocating free emission allowances. Overallocation led to a surplus, however, and hence a significant drop in carbon prices. Phase 2 (2008–2012) addressed this issue by tightening the cap and including additional gases, such as nitrous oxide and perfluorocarbons. This phase aligned with the Kyoto Protocol by allowing the use of international credits. Phase 3 (2013–2020) introduced significant reforms, including an EU-wide cap, expanded sector coverage, and the Market Stability Reserve, to enhance market stability. Phase 4 (2021–2030) aims to reduce net emissions by at least 62% by 2030, compared with 2005 levels. On 14 July 2021, the European Commission introduced some reforms to the Fit for 55 package, including revisions to the EU ETS. These revisions expand the EU ETS to cover maritime transport and introduce ETS 2 for buildings, road transport, and additional sectors. They also establish the Social Climate Fund, with €86.7 billion from 2026 to 2032 to support vulnerable groups; increase funding for the Innovation and Modernisation Funds; and adjust free allocation rules, including phasing out allowances for aviation and other industries.

Since its inception, the EU ETS has proven instrumental in driving down emissions from power and industrial plants by 37% through its cap-and-trade mechanism. Moreover, since 2013, the EU ETS has generated significant revenues, exceeding €152 billion, which contribute to national budgets. Beyond its financial impact, the EU ETS has served as a global model for similar carbon markets, illustrating the effectiveness of market-based mechanisms in combatting climate change on a worldwide scale.

The future trends in carbon prices are expected to be shaped by stronger climate policies, the expansion of carbon markets, economic conditions, technological advancements, investor and corporate actions, market dynamics, global cooperation, and social and political factors.

As governments set more ambitious climate targets, caps on emissions in ETSs will likely tighten, leading to higher carbon prices. The implementation of the EU's Carbon Border Adjustment Mechanism could raise carbon prices further by making it more expensive to import carbon-intensive goods.

The Americas and the APAC and Africa regions have shown more steady development during the last 10 years. The minimal change in carbon prices in APAC and Africa suggests either that carbon markets are still in nascent stages or that there are significant barriers to the implementation of more aggressive carbon-pricing strategies in these regions. However, the substantial increase in the proportion of global GHG emissions covered by carbon pricing in APAC and Africa from 2013 to 2024 indicates a promising trend toward greater engagement in climate action. Nevertheless, governments may need to develop more comprehensive and robust carbon-pricing policies to drive emission reductions.

The regional difference also illustrates the need for governments to improve on global coordination on carbon-pricing policies to prevent carbon leakage, where companies may choose to relocate to regions with less stringent carbon pricing.

Case Study: China's National ETS

In the late 2000s, China recognized the urgent need to control its rapidly increasing carbon emissions, leading to a commitment to international climate agreements and a shift in national policy direction toward more sustainable practices. Before implementing a nationwide carbon market, China launched pilot carbon trading systems in seven regions in 2013. These pilot projects, located in Beijing, Chongqing, Guangdong, Hubei, Shanghai, Shenzhen, and Tianjin, aimed to test and refine carbon-trading mechanisms suited to the Chinese context.

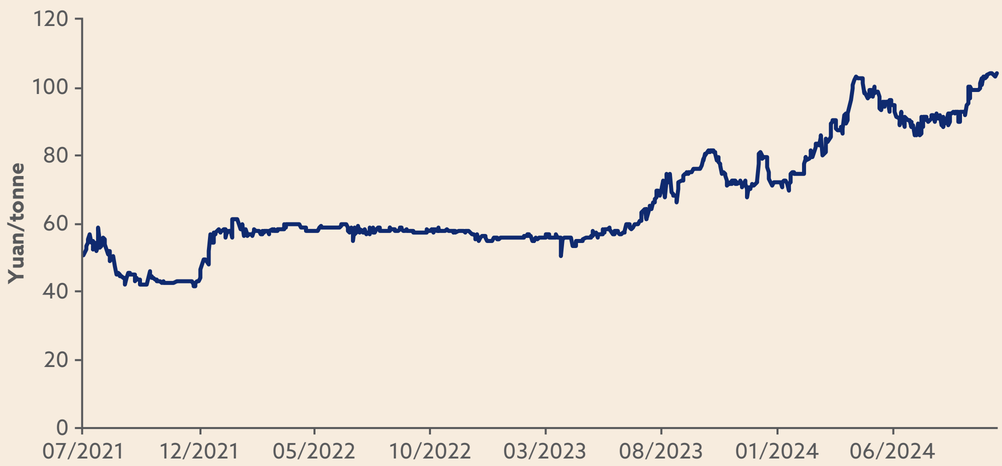
China announced its national ETS in 2017, with the official launch in January 2021. The Chinese Ministry of Ecology and Environment published key ETS policy documents, and by July 2021, trading commenced on the platform operated by the Shanghai Environment and Energy Exchange. Upon its inception, China's ETS became the world's largest carbon market, three times bigger than the European Union's system.

The national ETS initially covers more than 2,200 major emitters in the power sector. The current scope of the ETS includes annual emissions of nearly 5 billion tonnes of CO_2 a year, roughly 32% of China's total emissions and 9.3% of global total emissions (World Bank 2024). One allowance permits a company to emit 1 tonne of carbon. China plans to expand the ETS to include sectors like steel, cement, and aluminium by the end of 2024. This expansion is expected to cover around 60% of the country's total GHG emissions, thereby broadening the market's scope and potentially enhancing liquidity.

Trades are conducted electronically, allowing only spot transactions. Transactions are categorized as either listed or over-the-counter bulk trades. Currently, only covered entities are permitted to trade, excluding financial institutions and other speculators. Consequently, trading volumes and liquidity are major concerns. However, the Chinese government has indicated potential changes to enhance market dynamics and liquidity. As illustrated in **Exhibit 6**, on 24 April 2024, China's carbon price exceeded ¥100 (US$13.88) for the first time since the market's launch in mid-2021. On 21 October 2024, China's carbon price hit the record high of ¥104.25 (US$14.64) driven by large polluters increasing purchases ahead of stricter standards, yet permits remain significantly cheaper than equivalent permits in the EU, which closed at ~€61.4 (~US$66.4) per tonne on the same date.

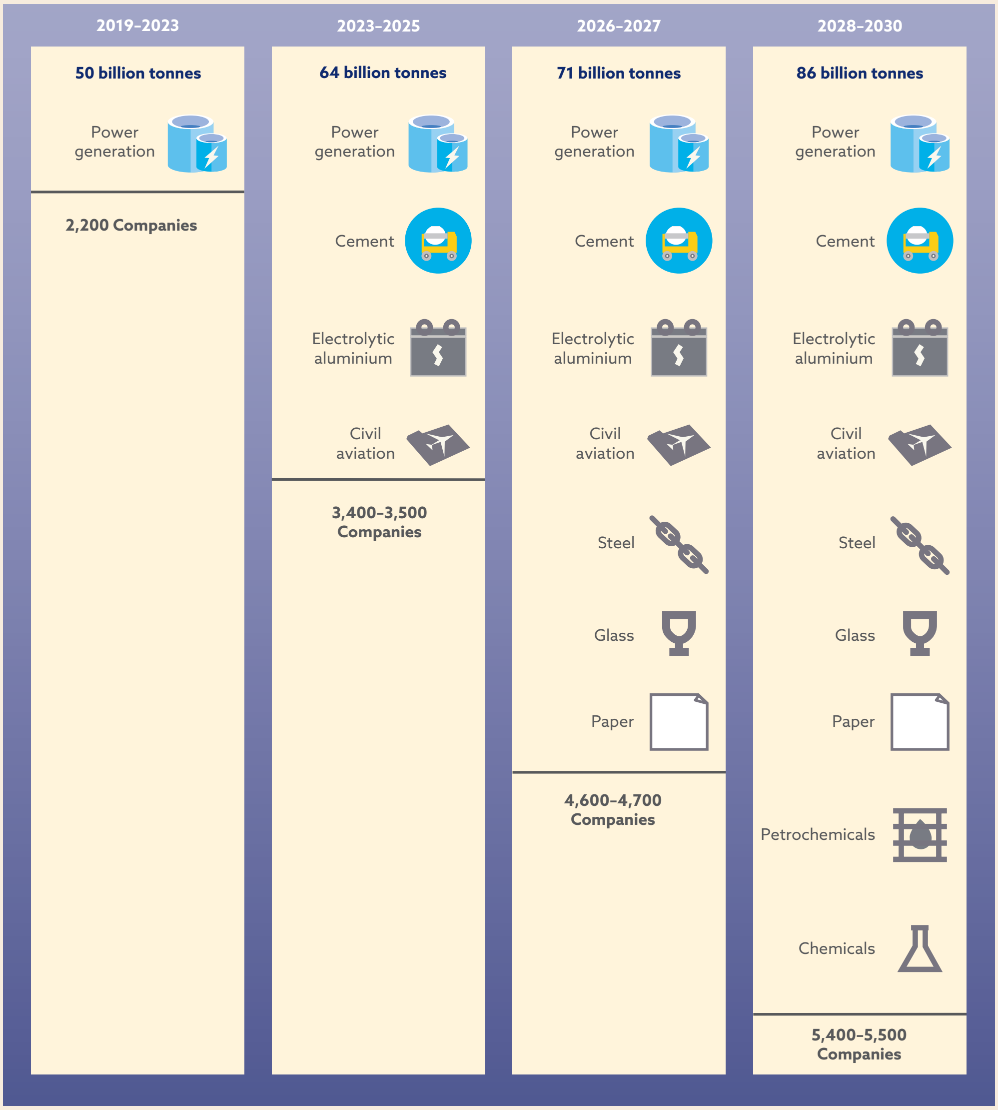
Investors can anticipate significant changes in China's carbon markets. China's ETS is set to expand, with plans to include heavy industry and manufacturing sectors, such as cement, aluminum, and steel, in response to the Carbon Border Adjustment Mechanism. This expansion will make it the largest global climate policy, covering more emissions than all other carbon markets worldwide combined.

Exhibit 6. China's National ETS Carbon Price, 2021–2024



According to the Center for Energy and Environmental Policy Research (2024), as shown in **Exhibit 7**, by the end of 2030, the annual number of enterprises covered by the national carbon market is expected to rise to approximately 5,500. The annual coverage of carbon dioxide emissions will exceed 8.6 billion tonnes, accounting for about 74% of the national total carbon dioxide emissions. The average transaction price of allowances is expected to surpass ¥200 per tonne.

Exhibit 7. Outlook on the Roadmap for Expanding Industry Coverage in China's National Carbon Market



Source: Center for Energy and Environmental Policy Research (2024).

Unlike the European Union's system, however, China's national ETS uses an emission-intensity-based approach, adjusting the cap according to actual production levels rather than an absolute cap. Additionally, quotas have been allocated for free during the first and second compliance cycles. Power generators with emission intensities exceeding the benchmarks face an allowance deficit. Although this approach boosts efficiency and phases out aging, inefficient thermal plants, it does not address overall absolute emissions.

During nearly a decade of pilot programs and three years focused on the national ETS, China's carbon market has established an institutional framework that clarifies stakeholder roles, enhances platform efficiency and data quality, and develops mechanisms for carbon price discovery and emission reduction incentives. Challenges persist, however, including limited industry coverage, lack of product variety, delayed allowance issuance, and low liquidity. To meet China's "dual carbon" goals, further improvements to the market system are essential.

Implications of Carbon Pricing for Capital Reallocation and Investors

Carbon price risk is significant for many companies, particularly for heavy-emitting companies. Therefore, it is essential that these companies manage such risks by developing an internal carbon price. An internal carbon price serves various purposes, ranging from business planning to driving carbon reduction initiatives. The following section discusses various internal carbon-pricing mechanisms and reports the discrepancies observed between reported internal prices and mandatory market prices. Companies should focus on increasing the adoption of internal carbon-pricing mechanisms and improving the transparency of their disclosures to align better with market realities and enhance accountability. The section also delves into the implications for investors' strategies including investing, hedging, engaging with their portfolio companies, and investment stewardship.

Implications for Capital Reallocation

Companies must stay abreast of evolving carbon-pricing regulations, particularly in regions where policies are more stringent, such as Europe. Noncompliance can result in significant penalties and legal risks. Firms operating in multiple regions need to navigate a complex landscape of different carbon-pricing mechanisms, requiring robust compliance and reporting frameworks.

Carbon pricing is no longer limited to companies participating in mandatory cap-and-trade programs. Today, businesses worldwide must incorporate carbon pricing into their models to accurately evaluate their assets, liabilities, and performance. A strategy to manage carbon price risk, especially for heavy-emitting companies, is to assess and integrate geopolitical risk into their internal carbon-pricing strategies. Companies can conduct scenario analyses of sudden changes in carbon prices and/or the introduction of new pricing mechanisms or new jurisdictions. These scenarios should consider various geopolitical, economic, and regulatory events and their potential impacts on carbon price levels and market stability. Setting an internal carbon price that accounts for potential disruptions can help manage financial risks associated with the volatile external carbon markets. Integral to this process is the ability to access accurate and updated carbon price information to benchmark the internal assumptions used in budgeting, capital allocation, and investment decisions.

According to the Carbon Disclosure Project (CDP)[11] survey in 2023, companies use internal carbon prices for various purposes—including business planning, project valuation for capital expenditure decisions, applying a carbon levy to business air travel, and internal allocation of costs to fund investments in energy efficiency and other carbon reduction initiatives. Although most companies use internal carbon pricing for all capital-expenditure decisions, some mentioned using it for only marginal projects. Some also reported using models that allow them to integrate carbon-related costs into traditional financial capital budgeting metrics.

There are three main alternative mechanisms for setting an internal carbon price: an internal carbon fee, a shadow price, and an implicit price.

An internal carbon fee is an internally determined fixed fee per tonne of carbon emitted by the organization. For example, Microsoft determines its carbon price from the total funds needed for all environmental initiatives divided by its projected emissions. The price is then charged to each business unit based on the emissions associated with their energy consumption and business air travel. Funds are collected from the business units to spend on environmental initiatives, such as energy-efficiency projects and carbon-offset projects. This approach is adopted in Australia by investment giant AMP and insurer QBE.

Alternatively, companies may use a shadow price—a hypothetical price used as a surcharge when evaluating the price of projects that involve the creation of carbon emissions. The purpose of the price was to support initiatives that are more emission efficient. Their prices ranged from just less than US$1.00 to almost US$150, with several companies using a substantially wide range of prices for scenario analysis.

The third alternative mechanism—an implicit price—generally involves organizations applying an average cost per tonne of emissions to meet their emission reduction targets.

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[11]See CDP Climate Change 2023 Questionnaire: https://guidance.cdp.net/en/guidance?cid=46&ctype=theme&idtype=ThemeID&incchild=1&microsite=0&otype=Questionnaire&tags=TAG-13071%2CTAG-605%2CTAG-599.

The main difference between an internal fee and the other two mechanisms—the shadow price and the implicit price—is that only the internal fee results in real financial flows within organizations. An example of this scenario occurs when a company uses an internal fee as a carbon levy on all business air travel (Scope 3) spent across the entire company. The funds from the levy are either used to purchase offsets or allocated to environmental initiatives.

Many companies are also engaging in voluntary markets to generate or purchase carbon offsets. The carbon prices from the mandatory market could serve as an anchor price for voluntary markets and, therefore, should be considered in such decisions.

Yet according to the CDP's worldwide survey in 2023,[12] only 13% of 10,475 companies responding to the survey reported using an internal carbon price. Another 19% reported that although they currently do not have an internal carbon price, they anticipate using one in the next two years. The remaining 78% either did not anticipate having one in the next two years or did not respond to the question.

The large disparities among countries on the level of corporate internal carbon pricing and the gap between internal carbon prices and the carbon prices set by the compliance markets, including taxes and ETSs, are illustrated in **Exhibit 8**.

Exhibit 8 highlights the varying degrees of alignment between corporate internal carbon pricing and national mandatory carbon pricing across various countries, among those companies that disclosed the internal carbon prices in the CDP survey (Carbon Disclosure Project 2023).[13] The exhibit illustrates the median internal carbon prices compared with the average carbon taxes and ETS prices weighted by the global GHG emissions covered by each scheme in the market, if there are various schemes in a single market.

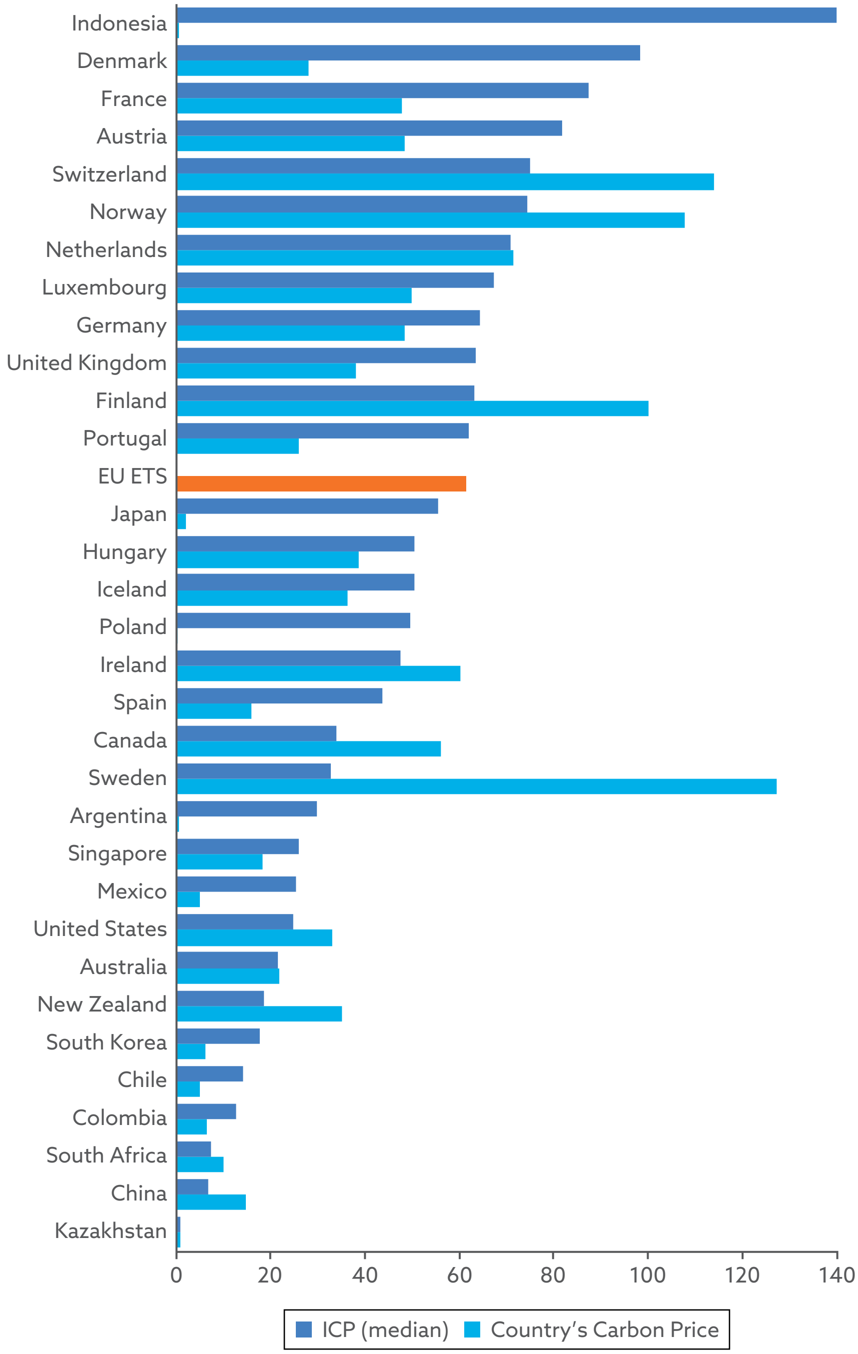
Corporations in some countries, such as Austria, Denmark, France, Germany, Luxembourg, Poland, and the United Kingdom, are proactively setting higher internal prices compared with the mandatory price of carbon. Notably, many of these countries are members of the EU ETS. Conversely, in other countries, such as Canada, China, Finland, Ireland, Norway, Sweden, Switzerland, and the United States, mandatory carbon prices are higher than companies' internal carbon prices.

The analysis reveals that the adoption of internal carbon prices among companies is still relatively low. Among those that have disclosed using an internal carbon price, there are significant discrepancies between their internal prices and the mandatory market prices. The authors recommend that

[12]CDP 2023 Climate Change Survey Dataset: www.cdp.net/en/data/corporate-data.

[13]Data for the internal price of carbon were taken from Question C11.3-C11.3a_C8 of the survey: "Provide details of how your organization uses an internal price on carbon: Actual price(s) used—minimum per metric ton CO_2e (in local currency)" (Carbon Disclosure Project 2023). Data for mandatory carbon prices were taken from the World Bank Carbon Dashboard.

Exhibit 8. Internal Carbon Prices vs. Carbon Prices in the Compliance Markets



Note: The carbon price for the EU ETS appears in orange to distinguish it from the other data because it tends to serve as a benchmark for markets participating in the EU ETS.

companies increase the adoption of internal carbon pricing and enhance the transparency of their disclosures.

Companies should also enhance their communication of measures taken to manage carbon price risks as part of their climate-related financial disclosures. Transparent reporting on how companies could be affected by future carbon costs, and the resulting corporate strategies, can build investor confidence in their net-zero investing journey.

Implications for Investors

Investing and Hedging

Carbon has also been considered one of the newest investment asset classes. In 2023, the carbon market reached US$909 billion in terms of traded value, with 12.5 billion tonnes of carbon allowances (Verma and Chestney 2023). Investors may also want to invest in carbon allowances either directly as a commodity or indirectly via synthetic products via the futures market to hedge against carbon price risks. With several liquid and investable markets, such as the EU ETS, the UK ETS, the Californian CaT, and the RGGI,[14] investors are increasingly able to access this new asset class.

First, the asset class can attract investors because returns are uncorrelated and the future returns profile looks attractive. Carbon has low correlations with traditional asset classes (such as equity and fixed income), providing an opportunity for investors searching for uncorrelated absolute returns. Furthermore, carbon markets usually include increasing scarcity by design, as ambitious emission reduction policies imply a decline in annually available carbon allowances.

Exhibit 9 shows a correlation matrix for the global carbon price, EU ETS, China ETS, US equity, US bond, global equity, and global bond returns.[15]

The return from the RCPI and the regional indexes[16] all have very low correlations with US equity, global equity, US bond, and global bond returns. For example, the RCPI's correlation with the US equity and US bond returns are 0.1638 and 0.0202, respectively, while its correlations with global equity and global bond returns are 0.2151 and −0.0074, respectively.

[14]These are the four most actively traded carbon markets in the world, each serving as the underlying index for ICE futures contracts (ICE EUA, ICE CCA, ICE RGGI, and ICE UKA futures contracts). The ICE Global Carbon Futures Index provides exposure to all four.

[15]The RCPI and aggregate carbon price for Europe and China span from 1 April 2013 to 31 October 2024. Daily returns are calculated using daily price data. Comparison indexes used for analysis are as follows: US equities, S&P 500 Index; global equities, MSCI World Index; US bonds, Bloomberg U.S. Aggregate Bond Index; and global bonds, Global Aggregate Bond Index (LEGATRUH).

[16]Note that the RCPI and the regional indexes are not directly investable.

Exhibit 9. Correlation between Returns of Carbon Price Indexes and Equity and Bond Returns, 2013 to October 2024

	RCPI Return	Europe RCPI Return	China RCPI Return	US Equity Return	Global Equity Return	US Bond Return	Global Bond Return
RCPI Return	1						
Europe RCPI Return	0.9106	1					
China RCPI Return	0.1831	0.0302	1				
US Equity Return	0.1638	0.1773	0.0131	1			
Global Equity Return	0.2151	0.2249	0.0334	0.9535	1		
US Bond Return	0.0202	0.0163	−0.0030	−0.0383	−0.0016	1	
Global Bond Return	−0.0074	−0.0164	−0.0033	−0.0147	0.0153	0.9323	1

Second, investors can be increasingly impacted in their equity and fixed income portfolios: As polluters face higher compliance carbon costs, they will aim to pass these costs on to consumers. If they are successful, this will impact inflation and therefore interest rates. Ferdinandusse, Kuik, and Priftis (2024) found that the EU climate policy may increase inflation in the Eurozone by up to 0.4 percentage points in 2026. In addition, Ruf (2024) found that carbon pricing may impact global equities by up to −10.9% by 2030.

Given that traditional investors are increasingly affected by carbon allowance prices, investors can hedge such exposure with EU carbon allowances overlay strategies (Huck 2023). By measuring the carbon price exposure of their investment portfolio and adding a carbon allowance overlay strategy, investors can expect the portfolio to achieve higher risk-adjusted returns.

Third, investing in emission allowances implies reducing the available supply of pollution permits to polluters and thus forces companies to decarbonize faster. Even if these allowances are released back into the market in the future, the concept of the time value of carbon[17] implies that such strategies benefit the environment.

[17]For more information on the time value of carbon, see, for example, Bradley (2024).

Responsible Investment and Stewardship

Carbon price is an important factor for investors on the path to net zero. It is essential for investors to understand how their portfolio companies are exposed to carbon price risks and, consequently, how these risks affect their overall portfolio. Key geopolitical, economic, and regulatory changes may substantially affect the supply and demand for carbon allowances among different ETSs globally, each to varying degrees. Like companies, investors must incorporate these risks into their strategic planning, risk management, and financial disclosures to navigate the volatile landscape effectively. The regional differences in carbon price trajectories and volatilities discussed in the previous section also highlight the need for investors to diversify their portfolios by investing in a mix of regions and sectors to reduce exposure to market volatility caused by geopolitical conflicts.

Carbon pricing has profound implications for responsible investment. By understanding and integrating the risks and opportunities associated with carbon prices, responsible investors can manage financial risks, capitalize on green investment opportunities, enhance ESG integration, and align their portfolios with global climate goals of reaching net zero.

Companies with significant carbon emissions face higher operational costs as carbon prices rise. Investments in fossil-fuel-based industries risk becoming stranded assets as carbon prices make these operations economically unfeasible. Responsible investors must assess how these costs impact company profitability and long-term viability and demand that companies have an effective transition plan to mitigate such risks.

Carbon pricing affects different sectors and different regions unevenly. Energy-intensive industries, such as utilities, manufacturing, and transportation, are more affected than others. Regions with higher and more volatile carbon prices, such as Europe, face different risks compared with regions with lower prices or emerging carbon-pricing systems, such as APAC and Africa.

Higher carbon prices, however, make renewable energy projects more competitive. Investing in solar, wind, hydro, and other renewable sources aligns with responsible investment principles and offers growth opportunities. Other potential investment candidates are companies that invest in energy efficiency technologies or commit to shifting the energy mix to reduce their carbon footprints and operational costs. Diversifying investments across sectors with smaller carbon footprints and across various markets can balance these risks.

As carbon pricing pressures companies to improve their sustainability performance, investors should prioritize engaging with investee companies about corporate climate strategies to mitigate the adverse impact of carbon price movements and build resilience to undesirable climate outcomes. This is how investors can support the transition to net zero in the real economy.

Conclusion

The journey toward achieving net-zero emissions by 2050 is complex and multifaceted, requiring coordinated efforts across global economies, industries, and financial markets. Carbon pricing emerges as a critical instrument in this endeavor, effectively internalizing the environmental costs of GHG emissions and creating financial incentives for businesses and investors to reduce their carbon footprints.

The analysis of global carbon-pricing mechanisms reveals significant progress during the past few decades, with a marked increase in both the coverage of emissions and the sophistication of pricing instruments. When it comes to price levels, however, most mechanisms exhibit low prices. This dynamic reflects either unambitious short-term decarbonization targets or weak mechanism design in which most carbon allowances are handed out free of charge. The RCPI provides a comprehensive measure of global carbon prices, reflecting the true cost of carbon emissions and serving as a valuable tool for investors and policymakers. Although price levels have increased during the past few years, they are nowhere near the required levels to incentivize enough investment in low-carbon technology. However, some regions are leading the way.

The EU ETS and China's national ETS illustrate the diverse approaches and challenges faced by different regions. Although the EU ETS has demonstrated substantial success in driving emission reductions on the back of high prices and generating revenue for climate initiatives, China's ETS highlights the potential for large-scale impact, albeit with ongoing challenges related to market liquidity, price levels, and scope of coverage.

For companies and investors, understanding and integrating carbon pricing into strategic decision making is essential. Internal carbon-pricing mechanisms, such as shadow prices and internal carbon fees, can help organizations prepare for future regulatory changes and manage financial risks associated with carbon-intensive assets.

Investors play a crucial role in the net-zero transition. By aligning their portfolios with climate goals and supporting companies with robust decarbonization strategies, they can drive innovation and growth in the green economy. Furthermore, the integration of carbon prices into investment strategies can enhance portfolio resilience and generate long-term value.

In the future, the continued evolution and harmonization of carbon-pricing mechanisms globally will be vital to achieving a uniform global carbon price. Such convergence will not only reduce competitive imbalances and carbon leakage but also accelerate the global transition to a sustainable, low-carbon economy. The future of carbon pricing will be shaped by stronger climate policies, technological advancements, and increased global cooperation, ultimately paving the way for a more sustainable and resilient world.

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